SING\textsuperscript{15}
The 15th European Meeting on Game Theory

Turku, 2-4 July, 2019

Book of abstracts
Abstracts of 15th European Meeting on Game Theory (formerly Spain-Italy-Netherlands Meeting on Game Theory – SING15)

July 2-4, 2019, University of Turku, Finland

Edited by Mitri Kitti
Dear Colleagues,

we want to welcome you all to the 15’th European Meeting on Game Theory (formerly Spain-Italy-Netherlands Meeting of Game Theory – SING15). The conference takes place on July 2’nd – July 4’th, 2019, at the Turku School of Economics, University of Turku, Finland.

We have received 215 abstract submissions, and the scientific program consists of 158 talks and 4 plenary lectures. We would like to thank the authors and the invited speakers for their contributions, and all the participants for taking part in this event.

We are grateful to the people of Visit Turku, City of Turku, and Aboa Congress and Event Services for their help in organizing this conference. We would also like to acknowledge the generous financial support from the Federation of Finnish Learned Societies, the Yrjö Jahnsson Foundation, and the Jenny and Antti Wihuri Foundation.

Sincerely yours,

The Organizing Committee:

Mitri Kitti
Ville Korpela
Matti Pihlava
Hannu Salonen (Chair)
Organizing committee
Hannu Salonen (Chair)
Mitri Kitti
Ville Korpela
Matti Pihlava

Scientific committee
Encarnación Algaba (Spain)
Gustavo Bergantinos (Spain)
René van den Brink (Netherlands)
André Casajus
Marco Dall’Aglio (Italy)
Andrea Di Liddo (Italy)
Vito Fragnelli (Italy)
Gianfranco Gambarelli (Italy)
Michel Grabisch (France)
Ruud Hendrickx (Netherlands)
Manfred Holler (Germany)
Ville Korpela (Finland)
Mitri Kitti (Finland)
Sascha Kurz (Germany)
Marcin Malawski (Poland)
Jacek Mercik (Poland)
Stefano Moretti (France)
Stefan Napel (Germany)
Marina Núñez Oliva (Spain)
Hannu Nurmi (Finland)
Agnieszka Rusinowska (France)
Hannu Salonen (Finland)
Joaquín Sánchez-Soriano (Spain)
Marco Slikker (Netherlands)
Izabella Stach (Poland)
Frank Steffen (United Kingdom)
Judith Timmer (Netherlands)
The SING history

The history of SING dates back to the beginning of the 1980s with the first meetings held in Italy. Then, subsequently, meetings were added in Spain, the Netherlands and Poland.

Italy

The first time the Italian researchers joined together for a meeting on Game Theory was due to the initiative of the mathematician Gianfranco Gambarelli and the economist Michele Grillo. On the 12th October 1983, a working day was held in Bergamo entitled: “A discussion between economists and mathematicians: recent contributions of Game Theory to Economics”. One year later, Pierangelo Mori and Fioravante Patrone organized in Pavia (December 14 and 15) the first meeting under the name that would last for a long time: “Convegno di Teoria dei Giochi ed Applicazioni”, called the “second meeting” to acknowledge the relevance of the “working day” held in Bergamo the year before. From then on meetings took place almost annually with the name “Convegno di Teoria dei Giochi ed Applicazioni”: Florence (1986, organised by Andrea Battinelli), again Bergamo (1987, Gianfranco Gambarelli), Cagliari (1988, Andrea Battinelli), Modena 1989 (Gianni Ricci), Florence (1991, Piero Tani), Pisa (1992, Giacomo Costa), Genoa (1993, Fausto Mignanego and Fioravante Patrone), Siena (1995, Stefano Vannucci), Bergamo (1996, Gianfranco Gambarelli), Milan (1997, Michele Polo and Mario Gilli), Genoa (1998, Fioravante Patrone) and Bologna (1999, Elettra Agliardi). After this date, the conferences began to form part of the joint venture described later.

Spain

The first Spanish Meeting on Game Theory was organised in 1994 in Bilbao by Federico Valenciano and Jose Zarzuelo. This was followed by meetings in Santiago de Compostela (1996, organised by Ignacio García Jurado), Barcelona (1998, Carles Rafels) and Valencia (2000, Amparo Urbano). During the world meeting on Game Theory Society, organised in 2000 in Bilbao by Federico Valenciano, the idea arose of a joint venture that will be discussed later.

The Netherlands

There is no tradition of organising Dutch Game Theory conferences. Before the SING joint venture only periodic seminars and impromptu conferences were held. As far as seminars are concerned, monthly ones were organised by Stéf Tijs in Nijmegen at the beginning of the 1980s; others followed in Tilburg under the responsibility of Peter Borm. Again in Tilburg, a monthly seminar has been held since the mid 1980s on the closely related area of social choice organised by Ton Storcken, Ad van Deemen, and Harrie de Swart. Several workshops on cooperative game theory have been organised by Gerard van der Laan and René van den Brink in Amsterdam and by Theordriessen in Enschede.

Regarding conferences, in 1996 the Third International Meeting of the Society for Social Choice and Welfare was organised in Maastricht by Hans Peters and Ton Storcken. In 1998, the 8th International Symposium on Dynamic Games and Applications was organised in Maastricht-Va by Frank Thuijsman and Koos Vrieze. The first conference on Logic, Game Theory and Social Choice (LGSI) was organised in Tilburg-Oisterwijk by Harrie de Swart in 1999. In 2002, Peter Borm c.s. organised a Game Theory conference on the occasion of Stef Tijs’ 65th birthday in Tilburg.

Poland

While some of the pioneering works in Game Theory are due to Polish mathematicians such as Hugo Steinhaus and Jan Mycielski, no national meeting on this area was ever established in Poland. Since the 1970s the groups working on Game Theory and related topics in Warsaw and Wroclaw held regular seminars that used to be rather interdisciplinary. In 2004 Andrzej Wieczorek organised an international conference in Game Theory and mathematical economics in Warsaw, and in 2008 the 13th International Symposium of Dynamic Games was organised by Andrzej Nowak in Wroclaw just after SING4.

SING: the joint venture

In 2000 Federico Valenciano organized in Bilbao GAMES 2000, the first Meeting of the Game Theory Society. During this conference Fioravante Patrone, director of the Italian CITG, took the initiative of looking for a “joint venture” between Italy and Spain, suggesting the alternation of Italian and Spanish meetings. The agreement of this idea by the involved researchers lead to the meetings of Ischia (2001), Sevilla (2002), Urbino (2003) and Elche (2004).

During the Meeting of Urbino the idea of The Netherlands as a “new entr” into the Italian-Spanish alternation, proposed by Patrone, was eagerly approved. The first edition of SING (Spanish-Italian-Netherlands Game Theory Meeting) was organized by Hans Peters in Maastricht from 24 to 26 June 2005. Andrea di Liddo organized the second edition, SING2, in Foggia. Juan Tejada organized SING3 in Madrid in 2007. It was then agreed that other European countries wishing to enter the rota had to participate first as guest organisers and only after a second participation in this role could they then actually join SING. In 2008 the conference was organized outside one of the three SING countries for the first time: Jacek Mercik organized SING4 in Wroclaw. In 2009 SING5 was held in Amsterdam, organized by René van der Brink. In 2010 SING6 has been organized in Palermo by Dario Bauso. The following two years the conference is again outside the SING countries: in 2011 Michel Grabisch organized SING7 in Paris; in 2012 László Á. Kóczy organized SING8 in Budapest. SING9 was organized respectively in Vigo in 2013 by Gustavo Bergantiños.
Poland was the guest organiser for the second time in 2014 (Kraków, organized by Izabella Stach) for SING10 and Poland became an actual member of SING. In 2014, a decision has been made not to change the acronym, in view of the fact that it has become well-known, but to transform the name of the meetings from 2015 on to “SING - European Meeting on Game Theory”. In 2015, the SING11 Meeting taken place in St. Petersburg, organised by Leon Petrosyan. The 2015 edition (SING11) also involved the 9th International Conference on Game Theory and Management (GTM2015). The 2016 edition (SING12) took place in Odense, Denmark, organized by Peter Sudhölter. In 2017 SING returned to France: at Paris Dauphine Stefano Moretti organized SING13 and France became a SING member. In 2018 SING took place in Germany: SING14 was organized in Bayreuth by Frank Steffen.

In 2019, for the first time, SING takes place in Finland. SING15 is organized by Hannu Salonen in Turku. In 2020, SING 16 will take place in Reggio Calabria organized by Massimiliano Ferrara.

<table>
<thead>
<tr>
<th>year</th>
<th>Name</th>
<th>Location</th>
<th>Organiser</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Italy/Spain 1</td>
<td>Ischia</td>
<td>Jacqueline Morgan</td>
</tr>
<tr>
<td>2002</td>
<td>Italy/Spain 2</td>
<td>Sevilla</td>
<td>Jesús Mario Bilbao, Francisco Fernández</td>
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<tr>
<td>2003</td>
<td>Italy/Spain 3</td>
<td>Urbino</td>
<td>Gian Italo Bisci</td>
</tr>
<tr>
<td>2004</td>
<td>Italy/Spain 4</td>
<td>Elche</td>
<td>Joaquín Sánchez Soriano</td>
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<tr>
<td>2005</td>
<td>SING 1</td>
<td>Maastricht</td>
<td>Hans Peters</td>
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<tr>
<td>2006</td>
<td>SING 2</td>
<td>Foggia</td>
<td>Andrea Di Liddo</td>
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<tr>
<td>2007</td>
<td>SING 3</td>
<td>Madrid</td>
<td>Juan Tejada</td>
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<tr>
<td>2008</td>
<td>SING 4</td>
<td>Wroclaw</td>
<td>Jacek Mercik</td>
</tr>
<tr>
<td>2009</td>
<td>SING 5</td>
<td>Amsterdam</td>
<td>René Van den Brink</td>
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<tr>
<td>2010</td>
<td>SING 6</td>
<td>Palermo</td>
<td>Dario Bauso</td>
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<tr>
<td>2011</td>
<td>SING 7</td>
<td>Paris</td>
<td>Michel Grabisch</td>
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<tr>
<td>2012</td>
<td>SING 8</td>
<td>Budapest</td>
<td>László Kóczy</td>
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<tr>
<td>2013</td>
<td>SING 9</td>
<td>Vigo</td>
<td>Gustavo Bergantiños</td>
</tr>
<tr>
<td>2014</td>
<td>SING 10</td>
<td>Kraków</td>
<td>Izabella Stach</td>
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<tr>
<td>2015</td>
<td>SING 11</td>
<td>St. Petersburg</td>
<td>Leon Petrosyan</td>
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<tr>
<td>2016</td>
<td>SING 12</td>
<td>Odense</td>
<td>Peter Sudhölter</td>
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<tr>
<td>2017</td>
<td>SING 13</td>
<td>Paris</td>
<td>Stefano Moretti</td>
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<tr>
<td>2018</td>
<td>SING 14</td>
<td>Bayreuth</td>
<td>Frank Steffen</td>
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<tr>
<td>2019</td>
<td>SING 15</td>
<td>Turku</td>
<td>Hannu Salonen</td>
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**SING - Best Student Paper Prize**

The SING – Best Student Paper Prize is established to provide incentives for young researchers to write good papers and submit them to the SING meetings. Since 2017 (SING13), the prize is awarded every year at the SING meeting.

**Participation rules**

1. The SING – Best Student Paper Prize is awarded to young researchers. The candidates must have been PhD students on or after January 1 of the year preceding the SING Meeting, or have received their PhD after that date. Appropriate documentation for eligibility has to be provided, including the name of the advisor when applicable.

2. In order to compete for the Best Student Paper Award the candidates have to submit an unpublished paper which they are authors or co-authors of before the deadline fixed by the organizing committee of the SING Meeting. The submitted paper must present original research conducted primarily by the candidate (the paper cannot be submitted by more than one of its authors in the same year). The paper has to be submitted and accepted for the SING meeting of that year.

3. The paper has to be submitted in anonymous form, without the name(s) of author(s) or any phrases allowing identification of its author(s). In addition, the candidate has to submit a resume of at most one page specifying the state-of-the-art and the new contributions of the paper, and a Word document or a pdf stating the candidate’s contact information, the contact information of his/her primary research advisor and all co-authors, the paper title and appropriate keywords.

4. After the deadline, the organizing committee of the SING meeting selects the award committee appointing five Full or Associate Professors from different SING Countries (Spain, Italy, The Netherlands, Poland, France) that are not advisors of the participants or co-authors of submitted papers or members of the organizing committee.

5. The SING organizing committee sends all submitted papers and resumes to each member of the award committee.

6. The award committee selects at most one paper.
7. The author of the selected paper, if any, receives the Prize in the form of a certificate.

8. The names of other competitors for the Best Student Paper Prize will not be made public.
Scheduled sessions

All sessions will take place at the ground floor and the first floor of Turku School of Economics.

**Day 1 - July 2nd, 2019:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>8:00 – 8:45</td>
<td>Registration (Lobby)</td>
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<tr>
<td>8:45 – 9:00</td>
<td>Opening Session (Osuuskauppa-sali)</td>
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<tr>
<td>9:00 – 10:40</td>
<td>Parallel Session 1</td>
</tr>
<tr>
<td>10:40 – 11:00</td>
<td>Coffee break</td>
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<tr>
<td>11:00 – 12:40</td>
<td>Parallel Session 2</td>
</tr>
<tr>
<td>12:40 – 14:00</td>
<td>Lunch break</td>
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<tr>
<td>14:00 – 15:40</td>
<td>Parallel Session 3</td>
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<tr>
<td>15:40 – 16:00</td>
<td>Coffee break</td>
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<tr>
<td>16:00 – 17:20</td>
<td>Plenary Session 1 (Osuuskauppa-sali)</td>
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<tr>
<td>17:20 – 18:20</td>
<td>SING Representatives Meeting (Ls08)</td>
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<td>19:30 – 21:30</td>
<td>Welcome Reception</td>
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**Day 2 - July 3rd, 2019:**

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<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>9:00 – 10:40</td>
<td>Parallel Session 4</td>
</tr>
<tr>
<td>10:40 – 11:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>11:00 – 12:20</td>
<td>Plenary Session 2 (Osuuskauppa-sali)</td>
</tr>
<tr>
<td>12:20 – 12:40</td>
<td>SING Prize Announcement (Osuuskauppa-sali)</td>
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<tr>
<td>12:40 – 14:00</td>
<td>Lunch break</td>
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<tr>
<td>14:00 – 15:40</td>
<td>Parallel Session 5</td>
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<tr>
<td>15:40 – 16:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>16:00 – 17:20</td>
<td>Plenary Session 3 (Osuuskauppa-sali)</td>
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</tbody>
</table>

**Day 3 - July 4th, 2019:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>9:00 – 10:40</td>
<td>Parallel Session 6</td>
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<tr>
<td>10:40 – 11:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>11:00 – 12:20</td>
<td>Plenary Session 4 (Osuuskauppa-sali)</td>
</tr>
<tr>
<td>12:40 – 14:00</td>
<td>Lunch break</td>
</tr>
<tr>
<td>14:00 – 15:40</td>
<td>Parallel Session 7</td>
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<tr>
<td>15:40 – 16:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>16:00 – 16:15</td>
<td>Closing Session (Osuuskauppa-sali)</td>
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<tr>
<td>16:15 – 17:00</td>
<td>SING-EMGT Assembly (Osuuskauppa-sali)</td>
</tr>
<tr>
<td>19:00 – 22:00</td>
<td>Conference dinner</td>
</tr>
</tbody>
</table>
Scientific program

Day 1 - July 2nd

Parallel Session 1 - July 2nd, 9:00–10:40
Session: Incomplete Information - Room: Ls07 - July 2nd, 9:00–10:40
Rationalizable Implementation under Incomplete Information (Roberto Serrano and Takashi Kunitomo) ........................................ 1
Persuading Voters With Private Communication Strategies (Tiago Kerman, P. Jean-Jacques Herings and Dominik Karos) .................. 1

Session: LQG Information Design (Takashi Ui) ................................. 1

Session: Uncertain Rationality, Depth of Reasoning and Robustness in Games with Incomplete Information (Fabrizio Germano, Jonathan Weinstein and Peio Zuazo-Garin) ........................................... 2

Session: Structure of Voting of Jurors in Some Classical Music Competitions (Leanne Streekstra and Honorata Sosnowska and Pawel Zawislak) .................................................. 2

Session: Fair Allocation Problems for Several Public Resources (Antonio J. Mayor-Serra, Ana Mica and Jose A. Garcia-Martinez) ....... 3

Session: Common Pool Values for Cooperative Games (Marcin Malawski) ................................................................................... 3

Session: On the Potential of the Shapley Value for Centrality Measures in Interconnected Influence Networks (Francesco Cordiello) .......................................................................... 4

Session: The Two-Step Average Tree Value for Graph and Hypergraph Games (Liying Kang, Anna Khmelevskaya, Erfang Shan, Dolf Talman and Guang Zhang) ........................................ 5

Session: Fuzzy Shapley Value for Communication Network (Barbara Gladysz, Jacek Mircik and Stach Izabella) ........................................... 5

Session: The Nucleus and Inheritance of Properties in Communication Situations (Jop Schouten, Bas Dietzenbacher and Peter Borm) ........................................................................ 5

Session: The On the Nucleus of the Irreducible Form of a Minimum Cost Spanning Tree Game (Leanne Streekstra) ........................... 5

Session: Cooperative Differential Games in Marketing with Network Structure (Leon Petrovitsin, Anastasiya Malakhova and Ekaterina Gromova) ........................................... 6

Session: Sustainable Cooperation in Multistage Games with Vector Payoffs (Denis Kuzyutin and Nadezda Smirnova) ......................... 6

Session: Backward Induction in Games Without Perfect Recall (John Hillas and Dmitriy Kvasov) ..................................................... 6

Session: Non- Cooperative Differential Games with Continuous Updating and Applications (Ovanes Petrosian) ........................................... 7

Session: Cooperative Games I - Room: Ls13 - July 2nd, 9:00–10:40
Egalitarianism in surplus-sharing problems and the Dutta-Ray solution (Pedro Calleja, Francesc Llerena and Peter Sudhölter) .......... 8

Session: The Procedural Egalitarian Solution and Egalitarian Stable Games (Bas Dietzenbacher) ..................................................... 8

Session: Values under Uncertainty (Sascha Kurz and Alexander Mayer) ......................................................................................... 8

Session: Fair Allocation Problems for Several Public Resources (Natasha Naumova) ................................................................. 8

Parallel Session 2 - July 2nd, 11:00–12:40
Session: Power Indices - Room: Ls07 - July 2nd, 11:00–12:40
Harsanyi power solutions for cooperative games on voting structures (Encarnacion Algaba, Sylvain Béal, Eric Rémiu and Philippe Solal) ... 9

Session: The Notion of Criticality in (3,2)-Games (Montserrat Pons and Josep Freixas) ............................................................... 9

Session: Influence in Weighted Committees (Sascha Kurz, Alexander Mayer and Stefan Napel) ..................................................... 9

Session: Power Indices with Multiple Alternatives in Voting Systems (Xavier Molinero and Joan Blasco) ........................................... 9

Session: Ranking - Room: Ls09 - July 2nd, 11:00–12:40
Minimal Consistency Properties for Voting and Ranking (Aleksis Kondratiev and Alexander Nesterov) ........................................ 10
On Scale-Invariant Citation Indices (Josep Freixas, William Zwerker and Roger Hoerl) ................................................................. 10
The Connectedness Power Measure (Anna Khmelevskaya, Manuel Laszlo Maglo and Dolf Talman) .................................................. 10
Structure of Voting of Jurors in Some Classical Music Competitions (Honora Sosnowska and Pawel Zawislak) ......................... 11

Session: Auctions - Room: Ls010 - July 2nd, 11:00–12:40
An Experiment on Partnership Protocols for Bilateral Trade with Incomplete Information (Barry Sopher and Reuven Sopher) 12
New Mechanism for Infinite Repeated Posted Price Auction Without Discounting (Nikita Kalinin) .................................................... 12
Reserve Price Signaling in First-Price Auctions with an Uncertain Number of Bidders (Toshihiro Tsukihashi) ........................ 12

For papers with multiple authors, the speaker of the associated talk is underlined.
Session: Voting I - Room: Ls12 - July 2nd, 11:00–12:40

The Prevalence and Consequences of Ballot Truncation in Ranked-Choice Elections (D. Marc Kilgour, Jean-Charles Grégoire and Angèle M. Poirier)

Platform Polarization and Electoral Accountability with Endogenous Valence (Kanganu Devchoudhury and Michael Kraus)

Electoral spatial competition model with valence (Tchouante Ngamo Elise Flore, Mathieu Martin and Ngan-men Zephirin)

Preference Rankings and Proportional Representation: Mismatches in Germany, 2005-2017 (Matthew Braham, Mostapha Diss and Frank Steffen)

Session: Claims Problems - Room: Ls13 - July 2nd, 11:00–12:40

Claims problems with indivisible packages of different sizes (M Teresa Estea, Natividad Llorca, Ricardo Martinez and Joaquín Sanchez-Sorzano)

Sequential claims problem (Arantza Estévez-Fernández, José-Manuel Giménez-Gómez and María-José Solís-Baltodano)

A strategic justification of the Talmud rule based on lower and upper bounds in bankruptcy problems (Juan D. Moreno-Ternero, Min-Hung Tsay and Chun-Hsien Yeh)

Bargaining over Liabilities (Péter Csoka and P. Jean-Jacques Herrings)

Session: GAMENET - Room: Ls14 - July 2nd, 11:00–12:40

Equilibria in large semi games (Miklos Pinter)

Existence of justifiable equilibrium (János Flesch, Dries Vermeulen and Anna Zseleva)

The Value Functions of Constrained Markov Decision Processes (Galit Ashkenazi-Golan and Eilon Solan)

Stopping games played on finite directed graphs (Jeroen Kuipers, János Flesch, Gijs Schoenmakers and Koos Vrieze)

Parallel Session 3 - July 2nd, 14:00–15:40

Session: Social Choice I - Room: Ls07 - July 2nd, 14:00–15:40

Electioning a committee with constraints (Egor Ianovska)

The Italian Referendum: what can we get from Game Theory? (Michela Chessa and Vito Fragnelli)

Social Acceptability of Condorcet Committees (Mostapha Diss and Mohammad Mahane)

Does deliberation improve the reliability of epistemic democracy (Huhui Ding and Marcus Pivato)

Strategic voting in grading systems (Daria Boratyn)

Session: Bargaining - Room: Ls09 - July 2nd, 14:00–15:40

Simultaneous-Offers Bargaining with a Mediator (Shunsuke Hanato)

Accounting for asymmetric bargaining power in automated negotiation processes - a procedural approach (Claus-Jochen Haake and Thomas Streck)

A foundation of Nash bargaining solution from strategic uncertainty (Philippe Bich and Wael Saker)

Bargaining over uncertain profit shares (Yigal Gerechik and Eugene Kheninuky)

The option of sequential alliances for cooperative investments (Fumi Kyotaki and Toshihi Miyakawa)

Session: Applications 1 - Room: Ls010 - July 2nd, 14:00–15:40

Preference Reversal and Temporal Discounting by Optimizing Growth Rates (Domínes Macroyannis, Alexandre Adamou, Yahiaan Berman and Ole Peters)

Bertrand-Edgeworth Competition with Capacity Uncertainty - Feasting on Leftovers (Robert Somogyi and Wouter Vergote)

Managing employee turnover (Saara Hämäläinen and Veivo Petrikaite)

Endogenous lobbying with uncertainty (Yi Zheng and Saara Hämäläinen)

Search theory with preferences for searching (Thomas Favory and Luciana Fiorini)

Outsource to or Compete with a More Efficient Input Supplier? Strategic Outsourcing in Vertical Markets. (Konstantinos Papadopoulos)

Monopoly with uncertain demand (Klaus Kutts)

Who becomes the Quality Leader? A Dynamic Model of Vertical Differentiation. (Nima Jouchaghi)

Regulatory risk, vertical integration, and upstream investment (Rolfade Fracco and Dongyu Guo)

Market coverage with quality dependent unit production costs (Cesaltina Pacheco Pires, Margarida Catalão-Lopes, Silvia Ferreira Jorge and Pedro Garees)

Session: Asymmetric Information - Room: Ls13 - July 2nd, 14:00–15:40

Selecting a pooling equilibrium in a signaling game with a bounded set of signals (Miguel Angel Ropero)

Directed search with multi-unit demands (Mats Godenheim)

Bayesian Elicitation (Mark Whitmeyer)

Signalling Expertise (Alexandros Rigos, Maria Kozlovskaia and Matteo Foschi)

Plenary Session 1 - July 2nd, 16:00–17:20

Games on hierarchies (Rene van den Brink)

Day 2 - July 3rd

Parallel Session 4 - July 3rd, 9:00–10:40

Session: Dynamic Games II - Room: Ls07 - July 3rd, 9:00–10:40

Descriptive Set-Theoretic Properties of Bayesian Updating (Yehuda Levy and Ziv Hellman)
Optimal stopping in a principal-agent model with hidden information and no monetary transfers (Eugen Kovac, Daniel Kramer and Tymon Tatar) .......................................................... 29
Sender-receiver stopping games (Aditya Aradhya, Janos Flesch, Mathias Staudigl and Dries Vermeulen) .......................................................... 30
Social Learning with Endogenous Order of Moves (Daniel Hauser, Pauls Martiņš and Juuso Välimäki) .......................................................... 30
Session: Shapley Value II - Room: Ls09 - July 3rd, 9:00–10:40 .......................................................... 31
On the Shapley value of constant-sum games (Tamás Solymosi) .......................................................... 31
Marginality, dividends, and the value in games with externalities (Frank Huettner and Andre Casajuas) .......................................................... 31
The canonical extension of the Shapley value for cooperative games with externalities (Andre Casajuas and Frank Huettner) .................. 31
Session: Voting II - Room: Ls010 - July 3rd, 9:00–10:40 .......................................................... 32
Voting paradoxes in restricted domains (Hanna Nurmi) .......................................................... 32
Double Majority and Generalized Brexit: Explaining Counterintuitive Results (Werner Kirsch, Wojciech Słomczyński, Dariusz Stolicki and Karol Życzkowski) .......................................................... 32
Scoring Run-off Rules, Single-peaked Preferences and Paradoxes of Variable Electorate (Eric Kamwa, Vincent Merlin and Faty Mbaye Topp) .......................................................... 32
On the manipulability of social choice functions (Dezső Bednai, Attila Tasnádi and Sonal Yadav) .......................................................... 33
Session: Matching and Assignment - Room: Ls12 - July 3rd, 9:00–10:40 .......................................................... 34
The set of Pareto optimal simple outcomes: A natural solution concept for the one-sided assignment game (David Pérez-Castrillón and Mariíta Sotomayor) .......................................................... 34
Strategy-proofness in experimental matching markets (Pablo Guillén and Robert Vezey) .......................................................... 34
Assignment markets with middlemen (Sandra El Obadi, Stella Michel and Marina Núñez) .......................................................... 34
von Neumann-Morgenstern Farsightedly Stable Sets of Assignment Games (Ryo Kawasaki and Tomokazu Matsuo) .......................................................... 34
Session: Networks II - Room: Ls13 - July 3rd, 9:00–10:40 .......................................................... 36
A measurement of linkages power in corporate networks (Cesarino Bertini, Jacek Mercik and Izabella Stecz) .......................................................... 36
Network games with heterogeneous preferences (Olena Orlovska) .......................................................... 36
Stronger bonds with less connected agents in stable resource sharing networks (Anastas Tenev) .......................................................... 36
Core stability in information graph games (Marina Núñez and Juan Vidal-Puga) .......................................................... 36
Plenary Session II - July 3rd, 11:00–12:20 .......................................................... 37
Agency Contracts in a Matching Market (Inés Macho-Stadler) .......................................................... 37
Parallel Session 5 - July 3rd, 14:00–15:40 .......................................................... 38
Session: Applications II - Room: Ls010 - July 3rd, 14:00–15:40 .......................................................... 38
Cooperative approach to a plant location problem with positive externalities (Adriana Navarro-Ramos and Gustavo Bergezòn) ................. 38
Sequencing situations under learning and deterioration effects (Alejandro Saavedra-Nieves, M. Gloria Fiestras-Sánchez and Manuel A. Mosquera Rodríguez) .......................................................... 38
Gain-sharing in Urban Consolidation Centers (Behzad Hezarkhani, Marco Slikker and Tom Van Woensel) .......................................................... 38
On How to Allocate the Fixed Cost of Transport Systems (Teresa Estan, Natividad Llorca, Ricardo Martínez and Joaquín Sánchez-Soriano, Marco Slikker and Tom Van Woensel) .......................................................... 39
Equilibrium arrivals to a queue under Last-Come First-Serve Preemptive-Resume (Jesper Breinbjerg, Trine Tornoe Platz and Lars Peter Østergaard) .......................................................... 39
Session: Transferable Utility - Room: Ls07 - July 3rd, 14:00–15:40 .......................................................... 40
On the core of many-to-many matching markets with transferable utility (Ate Atay, Marina Núñez and Tamás Solymosi) .......................................................... 40
The R Package CoOpGame for cooperative game theory, further software for cooperative games with partitions and communication structures and some new results (Jochen Staudacher and Johannes Anwander) .......................................................... 40
Primal and dual algorithms, and the number of iterations needed to compute the nucleolus (Martin Beneke, Tri-Dung Nguyen and Joerg Fiege) .......................................................... 40
Consistency of the equal split-off set (Bas Dietzenbacher and Elena Yanovskaya) .......................................................... 41
Monotonicity and weighted prenucleoli: A characterization without consistency (Pedro Colletta, Francesc Llerena and Peter Sudhölter) .......................................................... 41
Session: Noncooperative games I - Room: Ls09 - July 3rd, 14:00–15:40 .......................................................... 42
Competing Travelling Salespersons with Multi-payoffs (Evelin Eisenstadt and Amiram Moshaiov) .......................................................... 42
Beyond the self-interest. Maxmin preferences in strategic models (M Angeles Caraballo, Asunción Zapata, Luis Monroy and Amparo Marrón) .......................................................... 42
Nash Blocks (Peter Wickman) .......................................................... 42
Emergent Collaboration in Social Purpose Games (Robert Giles, Lina Mallozzi and Roberta Messalli) .......................................................... 43
Partially exclusive contests (Samuel Leppälä) .......................................................... 43
Session: Information Transmission - Room: Ls12 - July 3rd, 14:00–15:40 .......................................................... 44
Optimal Lying and Lie-Detection in Bayesian Persuasion Games with Costly Information Acquisition and Truth-Propositional Beliefs (Manitas Rodznias and Todd Stambaugh) .......................................................... 44
Strategic Information Release on a Communication Network (Aidan Smith) .......................................................... 44
Cheap Talk with Multiple Experts and Uncertain Biases (Gašan Karakoc) .......................................................... 44
Learning to agree over large state spaces (Michele Crescenzi) .......................................................... 45
Two-sided Strategic Information Transmission (Saori Ohba and Kazumi Hori) .......................................................... 45
Session: Matching - Room: Ls13 - July 3rd, 14:00–15:40 .......................................................... 46
Stability in Weighted College Admissions Problems (Britta Hoyer and Nadja Stroh-Maraun) .................................................. 46
Incentives in a Job Market Clearinghouse (Ryan Tierney) ................................................................................................................. 46
Decentralized Two-Period Matching (Sergei Balakken) ..................................................................................................................... 46
Family Ties: School Assignment With Siblings (Umuth Dur, Thayer Morrill and William Phan) ...................................................... 47
Efficiency in Weighted School Choice Problems (Nadja Stroh-Maraun) ...................................................................................... 47
Plenary Session III - July 3rd, 16:00–17:20
Quitting Games (Edlon Solan) ............................................................................................................................................. 48

Day 3 - July 4th

Parallel Session 6 - July 4th, 9:00–10:40
Session: Applications III - Room: Ls010 - July 4th, 9:00–10:40
Price and Treatment Strategic Decisions in Epidemics (Andre Di Liddo) .................................................................................. 49
On optional extraction under asymmetric information over reclamation costs (Pauli Lappi) ...................................................... 49
Same-Sex Marriage, the Great Equalizer (Sergey Popov and Alexei Parakhonyak) .............................................................. 50
Shapley Value III - Room: Ls07 - July 4th, 9:00–10:40
Relations equal treatment of equals and affine combinations of values for TU games (Yukihiro Funakiri) ............................................. 51
A characterization of the Shapley value for cooperative games with fuzzy characteristic function. (Josef Manuel Gallardo Morilla and Andrs Jimenez Losada) ........................................................................................................................................ 51
A new Shapley value for game with fuzzy coalitions (Manuela Basaloite, Carmen Hernandez-Mancera and Andrs Jimenez-Losada) .......................................................... 51
Shapley value in controlling company value without holding a qualified majority of shares (Barbara Gladysz, Jacek Merek and Isabella Stack) ........................................................................... 51
Session: Networks III - Room: Ls09 - July 4th, 9:00–10:40
Informativity vs. Conformity: Opinion Sharing In Social Networks (Itai Arieli, Ron Levy and Jonathan Wagner) .................. 52
Union Formation in Network Spill-over Games (Marraam Namunyan and Simon Schopohl) .................................................. 52
Inheritance of convexity for some partition-restricted games (Alexandre Skoda) ................................................................. 52
Voting III - Room: Ls12 - July 4th, 9:00–10:40
Weighted representative democracy (Arnold Sol and Marcus Pivato) ...................................................................................... 54
Multiple independent unions (Gero Henseler) ............................................................................................................................ 54
Work Productivity and Income Redistribution in a Voting Experiment (Natalia Jimenez-Jimenez, Elena Molis and Anal Solano) .................................................................................................................. 54
Successful Leadership and Political Compromise (Joseph Armel Mama Kenfack and Roland Pougou) ................................................... 54
Equilibrium and Conjectures in Dynamic Differentiated Duopoly Games (Shinji Kobayashi and Koji Takenaka) ........................................ 55
The route to chaos in congestion games. Population increase leads to chaos with Price of Anarchy equal to one. (Fryderyk Fabkowski) ......................................................................................................................... 55
Stochastic Stability of Mixed Equilibria (Alexander Aurell, Lee Dinetan and Gustav Karreskog) .................................................. 55
Reinforcement Learning with Foregone Payoff Information in Normal Form Games (Naoki Funakiri) ................................................ 56
Session: Social Choice II - Room: Ls14 - July 4th, 9:00–10:40
Bi-Proportional Apportionments (Mirko Bezi, Gianfranco Gambarelli and Giuliana Angela Zibetti) ............................................. 57
New Characterizations of Single-Peaked and Single-Caved Preferences (Mostapha Diss and Muhammad Mahayne) .............. 57
Fair Division Procedures for Goods with Market Value (Boaz Shapir and Shmuel Zamir) ........................................................ 57
Voting IV - Room: Ls14 - July 4th, 9:00–10:40
Nash implementability and related properties of the union of externally stable sets (Andrej Subochev) ...................................... 58
Plenary Session IV - July 4th, 11:00–12:20
Fairness and efficiency for probabilistic allocations with endowments (Federico Echenique, Antonio Miraides, and Jan Zhang) .......................................................... 59
Parallel Session 7 - July 4th, 13:00–15:40
Session: Noncooperative games II - Room: Ls07 - July 4th, 14:00–15:40
Do Arabian babblers play mixed strategies in a “volunteer’s dilemma”? (Aviad Heifetz, Ruth Heller and Rons Cost) ............ 60
Static stability in games (Igal Milchtaich) ........................................................................................................................................ 60
Heterogeneity in Cognition and Equilibrium Switching in Coordination Games (Janzun Lyu) ...................................................... 60
Sequential games with distributions as strategies (Steve Alpern and John Howard) .............................................................. 61
Session: Cooperative Games II - Room: Ls09 - July 4th, 14:00–15:40
A General Derivation of Axiomatizations for Allocation Rules: Duality and Anti-Duality Approach (Yukiyuki Oshita) ...................................................................................................................... 62
The risk-based core for cooperative games with uncertainty (Laszlo A. Koczy) ........................................................................... 62
A Unique Core allocation and Competitive Equilibrium in General Coalition Formation Games (Satoshi Nakada and Ryo Shiraoka) .................................................................................................................. 62
Shirakawa) .................................................................................................................................................................................. 62
Do coalitions matter in designing institutions? (Michele Lombardi, Ville Korpela and Hannu Virtanen) ........................................ 63
Session: Experiments - Room: Ls010 - July 4th, 14:00–15:40
The future of human-AI interaction (Jurgis Karpas, Adrian Kruger, Babador Bahrami and Opheka Derry) ........................................ 64
A School Choice Experiment: Cognitive Ability and Information (Naoki Watanabe, Tetsuya Kawamura and Ryo Ogasawara) ........................................................................................................................................ 64
Opawaja) .................................................................................................................................................................................. 64
Revealed fairness (Yosushi Agatsuma) ........................................................................................................................................ 64
Day 1 - July 2nd

Parallel Sessions 1

Session: Incomplete Information - Room: Ls07 - July 2nd, 9:00–10:40

Rationalizable Implementation under Incomplete Information

Roberto Serrano* and Takashi Kunimoto
Brown University

Following our recent work for complete information (forthcoming, Mathematics of Operations Research), we investigate rationalizable implementation of social choice sets in general incomplete information environments and identify the conditions for implementation in rationalizable strategies. Weakenings of incentive compatibility and Bayesian monotonicity, which are the key conditions that characterize implementation in Bayesian Nash equilibrium, are central to our results. We focus on two conditions. The first one is called uniform Bayesian monotonicity, a generalization to incomplete information settings of the uniform monotonicity that we proposed in the MOR forthcoming paper. The second one is called rationalizable incentive compatibility (RIC), which is a new condition that may lead to important new implications in incentive theory. RIC asks that, in the suitably defined direct mechanism for each function in the social choice set, truth-telling be a rationalizable message.

Persuading Voters With Private Communication Strategies

Toygar Kerman*, P. Jean-Jacques Herings and Dominik Karos
Maastricht University

We consider a symmetric information model, where a Sender wants to implement a new proposal by persuading a sufficiently large portion of Receivers with homogeneous preferences to vote in favor of it. There are two states of the world: the proposal either benefits or harms Receivers. Sender and Receivers share a common prior belief about the true state of the world and Sender wants to implement the proposal regardless of the true state. In contrast to Sender, Receivers want to change the status quo only if the proposal benefits them. Without intervention all receivers prefer the status quo. Prior to the vote Sender shares information about the proposal by choosing an informative communication strategy about the true state of the world, which sends private correlated signals to all Receivers. We start by assuming that Receivers vote sincerely (and Sender preferred in case of indifference). First, we show that Sender can improve upon a public communication strategy. We then characterize the unique optimal communication strategy; but we show that sincere voting does not constitute an equilibrium under this communication strategy. This is because under the optimal communication strategy, if all players vote according to their beliefs, a player is pivotal if and only if the proposal harms the Receivers. Hence, independent of this player’s signal the following holds: if the proposal is beneficial, voting against the proposal has no payoff effect; while if the proposal is harmful, voting against it is strictly beneficial. In order to overcome this issue, we characterize the set of communication strategies under which sincere voting constitutes a Bayes Nash equilibrium (BNE). We show that Sender can implement sincere voting as a BNE such that the probability of implementing the proposal is still higher than under a public communication strategy. Again, we characterize the optimal communication strategy.
LQG Information Design
Takashi Ui
Hitotsubashi University

A linear-quadratic-Gaussian (LQG) game is an incomplete information game with quadratic payoff functions and Gaussian information structures. It has many applications such as a Cournot game, a Bertrand game, a beauty contest game, and a network game among others. LQG information design is a problem to find the Gaussian information structure from a given collection of feasible information structures that maximizes the expected value of a quadratic function of actions and payoff states when players follow a Bayesian Nash equilibrium. Special cases of the quadratic functions include the total payoffs. In this problem, the variable to be determined is represented as the covariance matrix of actions and payoff states; the objective function is represented as a Frobenius inner product of a constant symmetric matrix and the covariance matrix; the constraints are represented as linear equalities of the covariance matrix which must be positive semidefinite. This implies that we can formulate LQG information design as semidefinite programming. Thus, we can numerically obtain the optimal information structures, and in some cases, we can analytically obtain them. If the constant matrix in the objective function is negative semidefinite, then no information disclosure is optimal. If it is neither negative semidefinite nor positive semidefinite, then partial information disclosure is optimal. However, even if it is positive semidefinite, full information disclosure may not always be optimal. We provide a sufficient condition for the optimality of full information disclosure. In the case of symmetric LQG games, we characterize the optimal symmetric information structure as a closed-form expression. In the case of asymmetric LQG games, we characterize the optimal public information structure as a closed-form expression. In both cases, we discuss what properties of the constant matrix in the objective function determine the optimal information structures as well as some examples.

Uncertain Rationality, Depth of Reasoning and Robustness in Games with Incomplete Information
Fabrizio Germano*, Jonathan Weinstein and Peio Zuazo-Garin
Universitat Pompeu Fabra

Predictions under common knowledge of payoffs may differ from those under arbitrarily, but finitely, many orders of mutual knowledge; Rubinstein’s (1989) Email game is a seminal example. Weinstein and Yildiz (2007) showed that the discontinuity in the example generalizes: for all types with multiple rationalizable (ICR) actions, there exist similar types with unique rationalizable action. This paper studies how a wide class of departures from common belief in rationality impact Weinstein and Yildiz’s discontinuity. We weaken ICR to ICR\(\lambda\), where \(\lambda\) is a sequence whose term \(\lambda_n\) is the probability players attach to \((n-1)\)th-order belief in rationality. We find that Weinstein and Yildiz’s discontinuity remains when \(\lambda_n\) is above an appropriate threshold for all \(n\), but fails when \(\lambda_n\) converges to 0. That is, if players’ confidence in mutual rationality persists at high orders, the discontinuity persists, but if confidence vanishes at high orders, the discontinuity vanishes.
The alpha-constant-sum games

Wenna Wang, Rene Van Den Brink, Genjiu Xu, Hao Sun and Zhengxing Zou

*Vrije Universiteit Amsterdam

Given any \( \alpha \in [0, 1] \), an \( \alpha \)-constant-sum game on a finite set of players, \( N \), is a function that assigns a real number to any coalition \( S \subseteq N \), such that the sum of the worth of the coalition \( S \) and the worth of its complementary coalition \( N \setminus S \) is \( \alpha \) times the worth of the grand coalition. This class contains the constant-sum games of Khmelnitskaya (A.B. Khmelnitskaya, Shapley value for constant-sum games, International Journal of Game Theory 32 (2003) 223-227.) (for \( \alpha = 1 \)) and games of threats of Kohlberg and Neyman (E. Kohlberg, A. Neyman, Games of threats, Games and Economic Behavior 108 (2018) 139-145.) (for \( \alpha = 0 \)) as special cases. An \( \alpha \)-constant-sum game may not be a classical TU cooperative game as it may fail to satisfy the condition that the worth of the empty set is 0, except when \( \alpha = 1 \). In this paper, we will build a value theory for the class of \( \alpha \)-constant-sum games, and mainly introduce the \( \alpha \)-quasi-Shapley value. We characterize this value by classical axiomatizations for TU games. We show that axiomatizations of the equal division value do not work on these classes of \( \alpha \)-constant-sum games.

How allocating the costs of cooperation with pairwise reductions

Antonio J. Mayor-Serra*, Ana Meca and José A. García-Martínez

*Miguel Hernández University (UMH)

We consider a cooperation model, with a priori information, in which agents agree to coordinate their actions to individually reducing their costs as consequence of sharing resources, knowledge or infrastructure. The a priori information is given by means of the costs of each agent in each of the possible coalitions in which he could participate. It is a bilateral interaction of multiple and independent partners that act in pairs in such a way that the cost reductions are coalitionally independent, which means that the cost each agent reduces to another agent does not depend on the others and, consequently, they remain constant in any possible coalition. This bilateral cooperation between agents allows both to reduce their costs respectively so that the total reduction of the cost of each agent in a coalition is the sum of the reductions generated by the rest of the members of that coalition. We define the associated cost game as the one that measures the cost of each coalition in a linear way according to the costs of each member of the coalition. We call them monotonic linear games with pairwise cost reduction. We prove that it is profitable for the agents in this game to form the grand coalition to obtain a significant reduction in costs; i.e. monotonic linear games with pairwise cost reduction are concaves. Then, we propose the Shapley value as a stable and easy-to-calculate cost allocation.

Common pool values for cooperative games

Marcin Malawski
Leon Kozminski University

The paper proposes a unified approach to some classes of values of cooperative TU games such that players’ individual values are obtained as expectations of their gains over all random orderings of players. In any ordering, each player retains some given part of his marginal contribution to the coalition of all predecessors, and what remains goes to the common pool which afterwards is divided among all players using some given allocation rule. The first values of this kind (besides the Shapley value and the egalitarian value, which are degenerate cases of one of the parts equal to zero) were introduced by Joosten and are now known as egalitarian Shapley values. We study values resulting from more elaborate rules of both what is retained by players and how the common pool is divided. In particular, when the proportions retained by players depend only on their places in the ordering and the common pool is divided equally, the resulting values belong to the class of procedural values. Various interesting nonsymmetric generalizations obtain when the shares in the common pool and / or the proportions of marginal contributions retained are proportional to (unequal) weights of players.
On the Potential of the Shapley value for centrality measures in interconnected influence networks

Francesco Ciardiello
University of Sheffield

Spreading of information on networks is becoming a vital topic in modern societies. Identifying influential nodes that lead to faster and wider spreading in complex networks is of theoretical and practical significance. Besides, identifying influential nodes has remarkable practical value: controlling rumor, disease spreading, viral marketing, and social leadership. Most real-world networks are not isolated. There are many examples of interconnected networks. Nodes belong to communities, which are held together by common interests, e.g., hobbies, similar lifestyle, political views. There are many ways to measure the importance of nodes in networks. The historical measures used in the literature are degree centrality, eigenvalue centrality, betweenness centrality to mention few names. However, their computational effort is high and they cannot provide nice results on networks with heterogeneous scale distributions. Many more recent centrality indices are, a priori, defined and then tested on real networks and compared among them in terms centrality tradeoffs. However, to evaluate the centrality of a node, one needs to take into account the potential contribution among several groups of nodes, and not merely the potential reward of the single component by itself. We fill the gap in this literature and we propose centrality measures through the Shapley value. We define the components of the Shapley value, i.e., as the finite variations of the additive components of the potential of the Shapley value. We enlighten the suboptimal role of the components of the potential of the Shapley value. Significantly, we show that the potential of the Shapley value is additive, in our settings, and we provide some centrality measures. As a minor but intriguing result, we show how there exists a node whose potential influence centrality decreases if a network increases its number of links, has the same potential and its bridges satisfy some topological assumptions.
The two-step average tree value for graph and hypergraph games

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Saint-Petersburg State University & Institute of Control Sciences of Russian Academy of Sciences

The average tree solution (AT solution) for cooperative games with restricted cooperation represented by means of undirected graphs was introduced by Herings, van der Laan, Talman, and Yang (2008). The AT solution was generalized recently by Kang, Khmelnitskaya, Shan, Talman, and Zhang (2018, yet unpublished) to TU games in which restrictions on cooperation are introduced by hypergraphs. The AT solution assigns to each player as a payoff the average of the player’s marginal contributions to his successors in all admissible spanning trees of the given communication graph/hypergraph. Together with the procedure of averaging over the entire set of admissible spanning trees one may consider another, two-step averaging procedure, when first, for each vertex of the given graph/hypergraph we find the average over all admissible spanning trees having this vertex as the root, and then we consider the average of the results obtained at the first step over all vertices of the graph/hypergraph. It is clear that when at least one of the vertices appears to be the root of more than one admissible spanning tree, these two approached lead to different solution concepts. In the paper we study the properties of the two-step average tree solution for graph and hypergraph games and provide a comparative analysis of both solution concepts.

Fuzzy Shapley value for communication network

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The paper presents the problem of cost allocation in a communication network. Values of connection between two nodes are defined by a fuzzy utility function. The utility function can refer to both existing communication nodes and new node’s proposals. As the allocation mechanism, the Shapley value is built for a complete coalition of all paths connecting the root of the tree (here: source / entry) with all nodes of the given network. In practice, parameters of communication networks, like cost, time, etc. are not deterministic. In transportation problems, they depend on intensity of traffic at given times of a day, season, weather conditions and many other factors. In general, communication networks depend on analogous parameters which describe the nature of transmission. In our opinion, the fuzzy model describes the nature of communication networks well.

The nucleolus and inheritance of properties in communication situations.

Jop Schouten*, Bas Dietzenbacher and Peter Borm

Tilburg University

This paper studies the nucleolus of graph-restricted games as an alternative for the Shapley value in communication situations (cf. Myerson, 1977). We focus on the inheritance of properties of cooperative games related to the nucleolus: balancedness (the nucleolus is in the core), compromise stability and strong compromise admissibility (both properties allow for a direct, closed formula for the nucleolus). We characterize the families of graphs for which the graph-restricted games inherit these properties from the underlying games. Moreover, for each of these properties, we characterize the family of graphs for which the nucleolus is invariant, that is, the nucleolus of the graph-restricted game equals the nucleolus of the underlying game of a communication situation.

On the nucleolus of the irreducible form of a minimum cost spanning tree game

Leanne Streekstra

University of Southern Denmark

Minimum cost spanning tree (m.c.s.t.) problems study how to connect a group of agents efficiently to a source, when the cost of implementing an edge is fixed. After an efficient tree has been found, the subsequent question is how to allocate the total cost among the agents involved. One well-studied solution for this problem is the so-called folk rule, which applies the Shapley value to the largest reduction of the cost matrix that does not lower the cost of an efficient tree (the irreducible cost matrix). In this paper we introduce a new cost sharing solution for m.c.s.t. games; the nucleolus applied to the irreducible cost matrix. Unlike m.c.s.t. games in general, the game associated with the irreducible cost matrix of a m.c.s.t. problem is concave. As this means that the minimum excess over all coalitions, given an allocation can be computed in polynomial time, the nucleolus of such games can be computed efficiently as well (Faigle et al., 2001). We study the axioms satisfied by this new cost sharing solution and compare it with the axiomatization of the folk rule (Bergantinos and Vidal-Puga, 2007). Bergantinos, G., & Vidal-Puga, J. J. (2007). A fair rule in minimum cost spanning tree problems. Journal of Economic Theory, 137(1), 326-352. Faigle, U., Kern, W., & Kuipers, J. (2001). On the computation of the nucleolus of a cooperative game. International Journal of Game Theory, 30(1), 79-98.
Cooperative differential games in marketing with network structure
Leon Petrosyan, Anastasiya Malakhova* and Ekaterina Gromova
Saint-Petersburg State University

In the recent literature, dynamic processes in marketing which evolve over time are often described in the framework of differential game theory. But there are only a few papers in which marketing is considered with network structure of participants, especially in continuous time formulation. We consider cooperative form of differential games with network structure applied for a marketing model of goodwill accumulation. The new classes of strategies are introduced. These strategies include the possibility of cutting the link with neighboring players during the game dependent from current state of the game. This corresponds to the real-life situations in the market and also allows us to simplify the solution of the cooperative game.

Sustainable cooperation in multistage games with vector payoffs
Denis Kuzyutin* and Nadezhda Smirnova
Saint Petersburg State University

The paper is mainly focused on the dynamic aspects of cooperation in n-person multicriteria games (or games with vector payoffs). Namely, we deal with multicriteria multistage games in extensive form with perfect information. In order to achieve and implement a long-term cooperative agreement in multicriteria dynamic games we have to solve the following problems. First, when players seek to achieve the maximal total vector payoff of the grand coalition, they need to agree on the specific method for choosing a unique Pareto efficient payoffs vector. In the dynamic setting this method has to satisfy time consistency, i.e. a fragment of the optimal cooperative trajectory in the subgame should remain optimal in this subgame. We consider the rule of minimal sum of relative deviations from the ideal payoffs vector and prove its time consistency. After choosing the cooperative trajectory it is necessary to construct a vector-valued Characteristic Function. We suggest an approach how to construct CF which is weakly superadditive. To determine the optimal payoff allocation we explore the vector analogues of two well known cooperative solutions, namely the core and the Shapley value. Lastly, to guarantee the sustainability of the achieved long-term cooperative agreement one can use a consistent imputation distribution procedure or a payment schedule (PS) to redistribute the player’s payoff along the optimal path. We formulate the conditions a PS should satisfy to guarantee that the core is strongly time consistent. Namely, we employ the Shapley value as a “supporting” imputation within the core and design appropriate supporting PS. Any deviation from this supporting imputation in favor of another imputation within the subgame core is admissible since the players will eventually get the payoffs vector that is also contained in the core of the original dynamic game. Some examples and possible applications are provided.

Backward Induction in Games Without Perfect Recall
John Hillas and Dmitriy Kvasov*
Waseda University

The equilibrium concepts that we now think of as various forms of backwards induction, namely subgame perfect equilibrium (Selten, 1965), perfect equilibrium (Selten, 1975), sequential equilibrium (Kreps and Wilson, 1982), and quasi-perfect equilibrium (van Damme, 1984), are explicitly restricted to games with perfect recall. In spite of this the concepts are well defined even in games without perfect recall. There is now a small literature examining the behaviour of these concepts in games without perfect recall. We argue that in games without perfect recall the original definitions are inappropriate. Our reading of the original papers is that the authors were aware that their definitions did not require the assumption of perfect recall but they were also aware that without the assumption of perfect recall the definitions they gave were not the “correct” ones. We give definitions of two of these concepts, sequential equilibrium and quasi-perfect equilibrium, that identify the same equilibria in games with perfect recall and exhibit the same inclusions as the original concepts exhibit in games with perfect recall. In particular, perfect and quasi-perfect equilibria should be sequential equilibria which, in turn, should be Nash equilibria. Moreover in generic games perfect, quasi-perfect, and sequential equilibria should coincide. We also extend these definitions to nonlinear games. Finally we give the appropriate re-definition of perfect equilibrium in games without perfect recall for both linear and nonlinear games.
Non-cooperative Differential Games with Continuous Updating and Applications

Ovanes Petrosian
Saint-Petersburg State University

The work is devoted to a new class of differential games with continuous updating. It is assumed that at each time instant, players have or use information about the game defined on a closed time interval. However, as the time evolves, information about the game updates, namely, there is a continuous shift of time interval, which determines the information available to players. Information about the game is the information about motion equations and payoff functions of players. For this class of games, direct application of classical approaches to the determination of optimality principles such as Nash equilibrium is not possible. The subject of the current paper is construction of solution concept similar to Nash equilibrium for this class of differential games and corresponding optimality conditions, in particular modernized Hamilton-Jacobi-Bellman equations and Pontryagin’s maximum principle. Also, the linear quadratic case of differential game model with continuous updating is considered. Linear quadratic case for this class of games is particularly important for practical problems arising in engineering of human-machine interaction. The explicit form of Nash equilibrium for linear quadratic case is presented. Also, the case of dynamic updating for linear quadratic differential game is studied and uniform convergence of Nash equilibrium strategies and corresponding trajectory for a case of continuous updating and dynamic updating is demonstrated.
Egalitarianism in surplus-sharing problems and the Dutta-Ray solution

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The constrained egalitarian surplus-sharing rule divides the surplus so that the poorer players’ resulting payoffs become equal, but not larger than any remaining player’s status-quo payoff. We show that this rule is characterized by Pareto optimality, path independence, requiring that the assigned shares remain unchanged when applying the rule consecutively to any partition of the surplus, and less first (LF), requiring that a player does not gain if her status-quo payoff exceeds that of another player at least the surplus. We use this result to show that on the domain of convex games Dutta-Ray’s egalitarian solution is characterized by aggregate monotonicity (AM), requiring that no player suffers if the grand coalition becomes richer, bounded pairwise fairness, similar LF, and the bilateral reduced game property (2-RGP) à la Davis and Maschler. We also show that 2-RGP can be replaced by individual rationality and bilateral consistency à la Hart and Mas-Colell. Finally, we prove that the egalitarian solution is the unique core selection that satisfies AM and constrained equal treatment (CET), requiring that the poorest players cannot be made richer without assigning to the complement less than its worth. Strengthening CET by replacing “poorest” by “poorer” allows to eliminate AM. For the results using consistency axioms all convex games with players in a universe of at least 3 elements are needed, whereas the other characterizations work for a fixed player set.

The procedural egalitarian solution and egalitarian stable games

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This paper studies the procedural egalitarian solution on the class of egalitarian stable games. By deriving several axiomatic characterizations involving consistency and monotonicity, we show that the procedural egalitarian solution satisfies various desirable properties and unites many egalitarian concepts defined in the literature. Moreover, we illustrate the computational implications of these characterizations and relate the class of egalitarian stable games to other well-known classes.

Values under uncertainty

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Sharing costs or benefits obtained through cooperation is a central economic problem. One way to address this issue is to model the cooperative environment as a characteristic function form game and then to use a value, i.e., sharing rule, to determine a division. However, a shortcoming of this approach is that a real-valued number has to be assigned to each subset of players. This asks for too much in many applications since evaluating the precise worth of every coalition is either impossible or comes at a high cost. A useful tool to handle such situations are cooperative interval games. They assign an interval of real numbers to each coalition. We are interested in the computation of bounds for values of realizing cooperative games within those ranges and present corresponding algorithms. Our approach proves to be particularly useful if the true but unknown game has additional structure (e.g., monotonicity).

Fair allocation problems for several public resources

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We consider problems of "fair" distribution of several different public resources. If \( \tau \) is a partition of a finite set \( N \), each resource \( c_j \) is distributed between points of \( B_j \in \tau \). We suppose that either all resources are goods or all resources are bads. There are finite projects, each project use points from its subset of \( N \) (its coalition). \( A \) is the set of such coalitions. The gain/loss function of a project at an allocation depends only on the restriction of the allocation on the coalition of the project. We consider the following 4 solutions. If all resources are goods, the lexicographically maxmin solution with respect to the set of the gain functions is defined. It generalizes the restricted nucleolus. If all resources are bads, the lexicographically minmax solution with respect to the set of the loss functions is defined. It generalizes the restricted antinucleolus. A generalization of Wardrop solution is also considered. The fourth solution depends on an undirected graph \( \Gamma \), where \( A \) is the set of its nodes. The projects compare their gains/losses at fixed allocation if their coalitions are adjacent in \( \Gamma \). For fixed gain/loss functions, an allocation is envy stable (or envy free) with respect to \( \Gamma \) if for each pair of coalitions that are adjacent in \( \Gamma \), either their gains are equal or the coalition with greater gain gets 0 at the allocation. We describe conditions on \( A, \tau, \) and \( \Gamma \) that ensure the existence of envy stable solutions, the exclusion of the first three solutions in envy stable solution, and conditions for coincidence the first three solutions at each gain functions.
This paper deals with Harsanyi power solutions for cooperative games in which partial cooperation is based on specific union stable systems given by the winning coalitions derived from a voting game. This framework allows for analyzing new and real situations in which there exists a feedback between the economic influence of each coalition of agents and its political power. We provide an axiomatic characterization of the Harsanyi power solutions on the subclass of union stable systems arisen from the winning coalitions from a voting game when the influence is determined by a power index. In particular, we establish comparable axiomatizations, in this context, when considering the Shapley-Shubik power index, the Banzhaf index and the Equal division power index which reduces to the Myerson value on union stable systems. Finally, a new characterization for the Harsanyi power solutions on the whole class of union stable systems is provided and, as a consequence, a characterization of the Myerson value is obtained when the equal power measure is considered.

The notion of criticality in (3,2)-games

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Some power indices defined in simple games can be obtained under a similar probabilistic approach by: 1) establishing a bargaining model, 2) deciding which kind of winning coalitions are assumed to be formed. The power indices which can be defined under this approach include, among others, the well-known Banzhaf, Johnston or Deegan-Packel indices. When extending these power indices to (3,2)-games a third important aspect must also be considered: the notion of criticality to be used.

Influence in Weighted Committees

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Committee decisions on more than two alternatives much depend on the adopted voting rule. So does the distribution of power among committee members. We quantify how different aggregation methods such as pairwise majority votes, plurality with runoff, or Borda rule map asymmetric numbers of seats, shares, voting weights, etc. to influence on outcomes when preferences vary. A generalization of the Penrose-Banzhaf index is proposed and applied to the IMF Executive Board’s election of a Managing Director. A priori voting power analysis is extended from binary voting games to collective choice between multiple options.

Power indices with multiple alternatives in voting systems

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Game theory arises in the first half of the 20th century from the need to study formally situations of conflict and cooperation between intelligent rational decision-makers. From the beginning, a relevant branch of game theory has been cooperative game theory. It is closely related with other disciplines such as decision theory, voting theory, social choice theory, among others. Here we study the relevance of each player/agent or each coalition (players/agents that act together) in particular voting system. We study these voting systems using power indices with multiple alternatives. In particular, we consider agreement, rejection and abstention. In this work, we also consider qualified majority, simple majority and relative majority, among other possibilities. Finally, we present extensions of this concept, always applied to real situations related with electoral systems, decision theory and social choice theory. Acknowledgements X. Molinero has been partially supported by funds from the Spanish Ministry of Economy and Competitiveness (MINECO) and the European Union (FEDER funds) under grants MTM2015-66818-P (VOTA-COOP) and MDM-2014-044 (BGSMath).
Minimal consistency properties for voting and ranking

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Aggregating individual opinions into common ranking is typically done using scoring rules. We study scoring rules with respect to consistency of ranking. A rule is consistent (for variable candidates) if it gives the same ranking after the winner (loser) has been removed. Consistency of ranking is crucial for applications in presence of uncertainty. We rank job candidates to send them offers sequentially, and this order should not depend on whether the top candidate is available (the bottom candidate is unacceptable). In sports, winners can be removed due to doping allegations, and the ranking of others better be consistent. In two-stage elections where inconsistent rule is used for shortlisting, the final outcome may be not consistent. Unfortunately, no scoring rule is consistent. Motivated by this impossibility, we weaken consistency by requiring unanimity. A ranking rule is consensus if its outcome is independent from deleting unanimous winner (I UW) and independent from deleting unanimous loser (IUW). IUW is the weakest form of independence of irrelevant alternatives and is a minimal requirement against dummy spoiler candidates, yet few popular voting rules do not satisfy it. We show that Nanson’s rule, proportional veto core, best-worst scoring rule, antiplurality rule violate IUW. IUW is important in ranking and multiwinner elections. The Nauru Parliament voting rule violates IUW when more than one representative is elected. Scoring rules used in sports competitions (e.g., FIA Formula One, Biathlon World Cup) violate IUW without exception. We show that a scoring rule is consensus (satisfies IUW and IUW) iff the scores form a geometric row or the Borda row. In the limit this family also includes the generalized plurality and generalized antiplurality rules. Overall, we want to highlight the importance of minimal consistency in ranking and voting, and our result pin down a very narrow family of appropriate scoring rules.

On scale-invariant citation indices

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A number of citation indices have been proposed for measuring and ranking the research publication records of scholars. Some of the best known indices, such as that proposed by Hirsch and Woeginger, are designed to reward most highly those records x that strike some balance between productivity P (number of publications) and impact I (frequency with which ones papers are cited); a large number of rarely cited publications will not score well, nor will a very small number of heavily cited papers. We propose some new citation indices that share common properties and that present several advantages with respect to the most used one, the Hirsh index. We mainly focus in one of them which is axiomatically characterized by a set of axioms that have a close relationship, in discrete version, with the bipersonal bargaining cooperative model by Nash. Among the list of advantages, when compared with the Hirsh index, of the proposed index we find: It produces fairer ranking within subdisciplines, improved decisiveness, fewer ties and more dynamic, the improved grow over time via increments that are both more frequent are smaller, enhanced centrality and tail balancedness.

The connectedness power measure

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In this paper we introduce the connectedness power measure that assigns to every node in any graph the number of connected sets the node is a part of. The connectedness power measure is uniquely characterized on any reducible subclass of graphs by two axioms, isolated node normalization and neighbor separability. Isolated node normalization requires the power of every isolated node to be one, while neighbor separability requires the power of any node with a neighbor to be equal to the power the node has without its neighbor plus the power what the node has when it is merged with its neighbor. Based on its properties, some formulas are also provided to calculate the connectedness power measure for any graph. In particular, we give closed form formulas for component complete and component linear graphs. The connectedness power measure can be used to rank nodes in given networks and the average connected contribution value (a solution concept for graph games) is also based on it.
Structure of voting of jurors in some classical music competitions
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The structures of jurors’ votings in the International Henryk Wieniawski Violin Competition and International Fryderyk Chopin Piano Competition are analysed. The Borda count was used during final stage of the last Henryk Wieniawski Violin Competition. This competition is the most important violin competition in Poland with international members of jury and competitors. Some articles in newspapers appeared. They were titled “War of jurors”. Cliques of jurors were searched. In this paper we try to analyze a structure of jurors’ voting using the network theory. The network of jurors is constructed on the basis of voting in the final. Statistical rank tests are used. Two jurors are joined in the network if the correlation of their orders of participants is greater than established threshold. Kendall tau and Spearman rho are used. In case of the Henryk Wieniawski Violin Competition a disconnected network is obtained. So, the structure of jurors’ voting is not homogeneous in the case of this competition. Some special ranking method was used in the final of the Fryderyk Chopin Piano Competition, one of the most known international piano competitions. The same method of constructing the network is used in case of this competition. It appears that the obtained network is a connected one. So, analyzed competitions have different structures of jurors’ voting. Another question is whether it is possible to find influential jurors in a jury. The method of minimum spanning tree network is used to obtain an answer to this question.
An Experiment on Partnership Protocols for Bilateral Trade with Incomplete Information

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We study “partnership protocols” of the sort proposed by Kalai and Kalai (2010), for bilateral trade games with incomplete information. We utilize the double auction with a buyer and seller with value and cost independently distributed uniformly on (0,100). The usual rules of the game are for the buyer and seller to submit price bids and asks, and for trade to occur if and only if the buyer’s bid price exceeds the seller’s ask price, in which case trade occurs at the average of the bid and the ask price. We compare the efficiency of trade in this standard game to those in other versions of the game, including games in which cheap talk is allowed prior to trade, games with the formal mechanisms proposed by Kalai and Kalai available as an option for the traders to use, and games with both the mechanisms and cheap talk available. We consider both ex ante and interim mechanisms. That is, traders simultaneously choose whether to opt in to the mechanism either prior to knowing their own information, or after knowing their own information. In the last two versions of the game, cheap talk takes place prior to the opt-in decision. We find that the formal mechanisms significantly increase the efficiency of trade in both the ex ante and interim cases. Specifically, in the baseline game, traders captured 73% of the available surplus (compared to a theoretical maximum of 84% possible with optimal strategies). Efficiency rises to 87% and 82% for the ex ante and interim mechanisms, respectively, and further rises to 90% and 84% when cheap talk is also allowed with the mechanisms. When only cheap talk is allowed, traders capture 81% (for ex ante talk), but only 70% (for interim talk).

New mechanism for infinite repeated posted price auction without discounting

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On ad exchange platforms the place for advertisement is sold through different kinds of auctions. However, it is not uncommon the situation where the seller repeatedly encounters only one buyer, thus the posted price auction degenerates into a monopoly-monopsony game with asymmetric information and nearly an infinite number of rounds; on each round the seller proposes the price and the buyer accepts or rejects it. I learned this problem from a discussion with members of Yandex research team and my main motivation was to find an incentive-compatible seller’s strategy. In this short paper such a strategy is proposed and a corresponding distortion at the top type lower bound (Spence-Mirrlees property, actually) for the surplus of the buyer is established; this shows that the proposed strategy is the best possible. The key ingredients are the following. The main leash that the buyer has is the frequency of accepted deals. Once this frequency (as a function on the buyer’s type) is fixed, the strategy randomly chooses between the rewarding price which incentivises the buyer to reveal his type (the higher the type, the more average surplus the buyer has), the adaptation price which allows the buyer to communicate that his type is higher than the current guess of the seller, and the type confirmation price which disincentivises the buyer to pretend that his type is higher than it is.

Reserve Price Signaling in First-Price Auctions with an Uncertain Number of Bidders

Toshihiro Tsuchihashi

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We study first-price auctions in which the number of bidders is the seller’s private information. When the seller is faced with many bidders, she has an incentive to transmit this information to the bidders. Thus, we investigate the use of a reserve price to signal this private information. We use the D1 criterion to refine the equilibrium and then characterize a unique symmetric separating equilibrium. In this equilibrium, the reserve price increases with the number of bidders. Moreover, we discuss whether using a secret reserve price is advantageous to reserve price signaling from the viewpoint of the seller. Without a commitment device, the seller prefers a secret reserve price to reserve price signaling whenever the number of bidders is large on average.
Contests with Insurance
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We study all-pay auctions under incomplete information in which contestants have non-linear effort functions. Before the contest begins, the designer offers the option of insurance for which a contestant pays a premium to the contest designer. If a contestant does not win he is reimbursed the cost of his effort. We demonstrate that contests with insurance may be profitable for a designer who wishes to maximize his expected revenue as based on the contestants’ expected total effort, the premium of the insured contestants, and their reimbursement.
The Prevalence and Consequences of Ballot Truncation in Ranked-Choice Elections

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In ranked-choice elections, voters vote by indicating their order of preference over the candidates. A ballot is truncated when the ordering is incomplete (this is called partial voting). Sometimes truncation is forced — voters are allowed to name only a limited number of candidates — but sometimes it is voluntary. During the counting process, a truncated ballot is exhausted when all of the candidates it names have been eliminated. Ballot exhaustion, and therefore ballot truncation, is a concern in single-winner elections when the margin of victory in the final stage is less than the number of exhausted ballots. This concern motivates our study. We review evidence from actual single-winner ranked-choice elections and conclude that voluntary ballot truncation is very common. Moreover, it is difficult to explain strategically. To assess the significance of ballot truncation, we simulate ranked-choice elections with four, five, and six candidates, using both spatial and random models of voter preference. Does truncation change the probability that a Condorcet winner wins the election? Does the winner change as the amount of truncation increases? We find that even small amounts of truncation can alter the election outcome.

Platform Polarization and Electoral Accountability with Endogenous Valence

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We build a three stage stochastic model that marries the Wittmann-Roemer family of two party models of spatial political competition with the literature on endogenous valence competition using a linear contest. The political parties care about both their vote share as well as proximity to their ideal point. Voters care about both the perceived competence(valence) of the party as well as its proximity to their ideological bliss point. In the first stage, the parties are engaged in spatial competition for representation in the parliament. Once they are in the parliament, they can take up costly actions that increase the perceived competence of their party in the next election. The third stage is once again a spatial competition with the valence advantage determined in the previous stage. We establish that decreased electoral accountability can drive platform polarization, an observation in line with empirical literature about American elections. We also investigate the connection between platform polarization, incumbency advantage and shifts in voter preferences.

Electoral spatial competition model with valence

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In a two candidates electoral competition (downsian model), there is no Nash equilibrium (in pure strategies) in general as soon as there are at least two dimensions in the Euclidean space in a majority game (Plott, 1967). This negative result implies an important instability in the voting game, instability which is not verified with empirical studies (Tullock, 1981). Several arguments are proposed in the literature in order to explain this lack of instability and one of them is the valence of the candidates. Valence is the candidates’ characteristic which are independant of the policy they propose: charisma, competence... Taking into account the valence of the candidates changes the model and Ansolabehere and Snyder (2000) show that, if the difference of valence is significant enough, then there exists at least one Nash equilibrium. Furthermore, they show that this point is well-known in spatial voting games since it is the center of the Yolk. In this paper, we clearly improve Ansolabehere and Snyder’s result in different directions. In one hand, we determine different areas in which any point is a Nash equilibrium and not only the center of the Yolk. In particular, we show that there exists an open ball around the Yolk center such that any point within this ball is a Nash equilibrium. We also show that there exists a more complicated area where some points are Nash equilibria and some are not. However, we propose mathematical arguments which permit a classification of these points. In the other hand, we show that these results hold with games different from the restrictive majority game. For that, we propose a generalization of the notion of Yolk (based on Martin et al, 2018) which becomes an intersection of convex hulls.
As with all proportional list systems, the German system is afflicted by a fundamental inconsistency known as the More-Preferred-Less-Seats-Paradox. Although this has been known to be a theoretical possibility for a long time, it has never been demonstrated empirically for Germany. We follow a method previously applied to studies of elections in Denmark (1973-2005) and The Netherlands (1982-1994) that reconstructs these preference rankings from opinion polling data. We use flash polls that contain ‘thermometer data’ on party preferences conducted the week before polling day for the Federal Elections in 2005, 2009, 2013, and 2017. The main finding is that each of the elections has been afflicted by the paradox. Qualitatively, it is arguable that the occurrence of the paradox in 2005 and 2009 is relatively benign. But in 2013 and 2017 the paradox took on a different dimension. Firstly, in 2013 the liberal Freie Demokratische Partei (FDP) actually dropped out of parliament although being preferred over the leftwing party DIE LINKE, which was the so-called Condorcet-loser (or least-preferred party). DIE LINKE was the third largest faction in the Parliament and the official opposition. Then in 2017, the populist rightwing party, Alternative für Deutschland (AFD), received the third largest seat share although, as with DIE LINKE in the previous election, it was the Condorcet-loser and it too has become the official opposition. This suggests that the current system has the potential to distort the representation of voter preferences. We discuss the source of the paradox and the normative implications of these results by placing them in the context of representative and epistemic conceptions of democracy.
Claims problems with indivisible packages of different sizes

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In this paper we study the class of claims problems where the amount to divide is perfectly divisible and the claims consist of several indivisible packages of different sizes. We propose several properties that may be of interest for this particular framework. These properties represent common principles of fairness, efficiency, and non-manipulability. As we show, some combinations of the properties we consider are compatible, others are not. These findings contrast with the usual setting of claims problems (where both claims and amount to allot are divisible). We also investigate the possible decomposition of the general problem into two-step allocation procedures.

Sequential claims problem

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There are many situations where there is insufficient resource, and there are demands that must be fulfilled. In the literature, these kinds of problems are called claims problem. A claims problem is a situation where a group of agents has to distribute an insufficient resource to satisfy all their requests. The current paper analyzes this kind of situations from a sequential point of view, i.e., it considers that agents are linearly ordered. Two applications of sequential claims problems are: sharing the water of an international river (Ansink and Weikard, 2012a) and sharing rewards due to expedition in projects (Estévez-Fernández,2012a). Within this context, we propose three mechanisms to generalize well-known rules to our setting: the upwards, the downwards, and the two-step mechanisms. Besides, we analyze the constrained equal awards rule through some of the main well-known axioms used to characterize it.

A strategic justification of the Talmud rule based on lower and upper bounds in bankruptcy problems

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When a group of creditors has claims on a resource that is not enough to honor all claims, how should the resource be divided? This is the so-called bankruptcy problem. A well-known rule to solve this problem is the Talmud rule. We introduce a game that exploits standard consistency properties, as well as properties guaranteeing meaningful lower and upper bounds to all creditors. As we show, the game strategically justifies the rule. Our results are inspired by an axiomatic characterization of the Talmud rule in Moreno-Ternero and Villar (2004), who make use of the above meaningful lower and upper bounds together with consistency axiom to characterize the Talmud rule. The consistency axiom allows us to reduce n-person negotiation to 2-person negotiation, and then dramatically simplifies our analysis and allows us to focus on 2-person bargaining situation. We exploit the lower and upper bounds to design 2-person bargaining procedure. Our results and the above axiomatization for the Talmud rule not only complement each other, but also deepen our understanding of the Talmud rule.

Bargaining over Liabilities

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An insolvent firm has liabilities towards a group of creditors. We analyze the problem of how to distribute the asset value of the firm among the creditors and the firm itself, using a dynamic non-cooperative bargaining model. We specify a bargaining protocol where a randomly selected active player can propose a coalition and a feasible asset allocation. If the proposal is unanimously accepted by all members of the coalition at hand, then the related creditors leave the game. However, the firm has to stay in the game until all creditors are satisfied. We analyze the stationary subgame perfect equilibria of the game. We also relate the asset allocation outcomes of the game to bankruptcy rules.
Equilibria in large semi games
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A (noncooperative) game is a tuple of players, strategy sets of the players, and the players’ payoff functions defined on the product of the strategies of the players. For a reasonably large class of game (the mixed extension of finite games) it is well-known that each such game has a Nash equilibrium. A Nash equilibrium is a strategy profile such that no players can improve on by deviating unilaterally (from it). In this short talk we consider situations when a player’s payoff function is not measurable with respect to the field generated by the players strategy sets, hence the payoff of the player is not well-defined. We call this situations semi games. A semi game is large if there are only finite many players but the strategy sets are infinite. By means of an example we show that why it is problematic to extend the notion of Nash equilibrium onto large semi games. We introduce a new notion of equilibrium for these games, and we show that it is a generalization of the notion of Nash equilibrium. Moreover, we demonstrate that for any large semi game the proposed new equilibrium exists. This paper is intended to the GAMENET session.

Existence of justifiable equilibrium
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We present a general existence result for a type of equilibrium in normal-form games. We consider nonzero-sum normal-form games with an arbitrary number of players and arbitrary action spaces. We impose merely one condition: the payoff function of each player is bounded. We allow players to use finitely additive probability measures as mixed strategies. Since we do not assume any measurability conditions, for a given strategy profile the expected payoff is generally not uniquely defined, and integration theory only provides an upper bound, the upper integral, and a lower bound, the lower integral. A strategy profile is called a justifiable equilibrium if each player evaluates this profile by the upper integral, and each player evaluates all his possible deviations by the lower integral. We show that a justifiable equilibrium always exists. Our equilibrium concept and existence result are motivated by Vasquez (2017), who defines a conceptually related equilibrium notion, and shows its existence under the conditions of finitely many players, separable metric action spaces and bounded Borel measurable payoff functions. Our proof borrows several ideas from Vasquez (2017), but is more direct as it does not make use of countably additive representations of finitely additive measures by Yosida (1952).

The Value Functions of Constrained Markov Decision Processes
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We consider the value functions of a Markov decision problem with constraints, as a function of the discount factor $\lambda$. We prove that any piecewise-rational continuous function can be approximated. A necessary and sufficient condition to obtain the piece wise rational function accurately is proven. This condition is about the derivatives of any two consecutive rational functions. This paper is intended to the GAMENET session.

Stopping games played on finite directed graphs
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We consider multi-player dynamic games played on finite directed graphs. In such a game, each vertex of a directed graph is controlled by one of the players. The game starts in a given vertex. The player who controls this vertex has two options: he can terminate the game, or he can choose one of the outgoing arcs. In the former case, the game ends. In the latter case, the play moves to the vertex at the end of the chosen arc, and the controlling player of this vertex has two options: he can terminate the game, or he can choose one of the outgoing arcs. This is repeated until a player decides to terminate the game. The payoff of each player only depends on the vertex where the game is terminated. If no player ever terminates the game, each player receives payoff 0. We show that these games admit a subgame-perfect epsilon-equilibrium, for any epsilon > 0. Here, epsilon is an error-term. A subgame-perfect epsilon-equilibrium is thus a strategy profile in which no player can gain more than epsilon by a unilateral deviation, in any subgame. The proof of this existence result is constructive, and is based on a recursive algorithm that outputs a subgame-perfect epsilon-equilibrium, for any epsilon > 0, after a finite number of steps. This result generalizes several earlier existence results. As an additional feature, the constructed strategy profile is robust to discounting in the sense that the very same strategy profile is also a subgame-perfect epsilon-equilibrium when the payoffs are discounted, provided that the discount factor is sufficiently high (the players are patient).
Elector a committee with constraints

Egor Ianovski
Higher School of Economics

We consider the problem of electing a committee of k candidates, subject to some constraints as to what this committee is supposed to look like. In our framework, the pool of candidates is divided into tribes, and constraints of the form "at least p candidates must be elected from tribe X" and "there must be at least as many members of tribe X as of Y" are considered. While in general this problem would require us to rethink how we determine which election outcomes are good, in the case of a committee scoring rule this becomes a constrained optimisation problem – simply find a valid committee with the highest score. In the case of weakly separable rules we show the existence of a polynomial time solution in the case of tree-like constraints, and a fixed-parameter tractable algorithm for the general case, which is otherwise NP-hard.

The Italian Referendum: what can we get from Game Theory?

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In Italy, the referendum represents the main form of direct democracy. At the national level, only two forms of referendum exist: a popular referendum, in which the electorate is called to vote on whether they wish to abolish an existing law, and a constitutional referendum, which can be requested in some cases when a new constitutional law is approved by the Parliament. In the first case, the referendum has to meet a certain turnout requirement in order to be valid, namely, a "participation quorum" has to be reached. The rationale for such a requirement is that, to change the status quo, a large proportion of citizens should care about the issue at stake and take part in the decision. In our work, we provide a rigorous game theoretic analysis of a voting situation with a participation quorum requirement. In particular, in a simple game with abstention, we analyze how the decisiveness and the blocking power of the game, and of each player, change depending on the chosen quorum level. Then, we show how such a situation favours strategic voting behaviors.

Social Acceptability of Condorcet Committees

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We define and examine the concept of social acceptability of committees, in multi-winner elections context. We say that a committee is socially acceptable if each member in this committee is socially acceptable, i.e., the number of voters who rank her in their top half of the candidates is at least as large as the number of voters who rank her in the least preferred half, otherwise she is unacceptable. We focus on the social acceptability of Condorcet committees, where each committee member beats every non-member by a majority, and we show that a Condorcet committee may be completely unacceptable, i.e., all its members are unacceptable. However, if the preferences of the voters are single-peaked or single-caved and the committee size is not "too large" then a Condorcet committee must be socially acceptable, but if the preferences are single-crossing or group-separable, then a Condorcet committee may be socially acceptable but may not. Furthermore, we evaluate the probability for a Condorcet committee, when it exists, to be socially (un)acceptable under Impartial Anonymous Culture (IAC) assumption. It turns to be that, in general, Condorcet committees are significantly exposed to social unacceptability.
Does deliberation improve the reliability of epistemic democracy
Huihui Ding* and Marcus Pivato
*Université de Cergy-Pontoise

We study the effects of deliberation on epistemic social choice, in two settings. In the first setting, the group faces a binary epistemic decision analogous to the Condorcet Jury Theorem. In the second setting, group members have probabilistic beliefs arising from their private information, and the group wants to aggregate these beliefs in a way that makes optimal use of this information. We assume that each agent wants other agents to agree with her, and discloses her private information to persuade the other agents for this purpose; this is how we model deliberation. We find that deliberation is guaranteed to improve the performance of the group only under certain conditions; these involve the nature of the social decision rule, the group size, and also the presence of “neutral observers” whom the other agents try to persuade.

Strategic voting in grading systems
Daria Boratyn
Jagiellonian University, Center for Quantitative Research in Political Science

In the paper we study strategic voting in grading systems, i.e., systems based on grading the candidates instead of voting or ordering them. We consider strategic behavior in the context of assigning a collective grade to a fixed candidate. We put forward a new model of grading systems which generalizes the model constructed by Balinski & Laraki in 2010's. It is based on the assumption that for any given grades one should be able to determine how close they are. In our model the set of grades is endowed with an arbitrary linear order and metric. This structure restricts the domain of voters’ strategies, thus allowing the manipulability given by the well-known Gibbard-Satterthwaite theorem to be avoided. We will illustrate the existence of strategy-proof grading systems with the example of artificial majority utilized in Polish courts of criminal justice. We will propose a general condition of strategy-proofness of grading systems, based on the idea of preventing all judges from bringing about a result that is closer metrically to their favorite one by misrepresenting their preferences than by grading sincerely. Our main goal in this paper is to give a characterization of grade aggregation functions which resist strategic grading. On the basis of the proof by Balinski and Laraki, we will show that order statistics meet this criterion. We will present a new result regarding them being unique such functions.
Simultaneous-Offers Bargaining with a Mediator

Shunsuke Hanato
Tokyo Institute of Technology

In non-cooperative bargaining models, if negotiators cannot reach an agreement, the bargaining breaks down. To avoid such disagreement, an arbitrator is often introduced into bargaining. The role of an arbitrator is imposing some agreement as a final bargaining outcome when negotiators cannot reach an agreement by themselves. However, introducing an arbitrator carries a risk that a fair agreement for negotiators is eliminated from equilibrium outcomes if the arbitrator is biased. In our study, to avoid such a risk, we consider introducing a mediator instead of an arbitrator. While an arbitrator imposes an agreement, a mediator can only give advice. We analyze a simultaneous-offers bargaining model with a mediator and obtain the following desirable results. First, disagreement is not supported as an outcome of a stationary subgame perfect equilibrium (SSPE). This result implies that a mediator can resolve conflicts as with an arbitrator. Second, even if a mediator is biased, the fair agreement in the sense of the Nash bargaining solution (NBS) is guaranteed as an SSPE outcome. Therefore, the risk by a biased mediator does not appear. Finally, conversely, if a mediator is fair, the negotiators always reach an agreement with the NBS in SSPE when the discount factor is sufficiently large. That is, the fair mediator facilitates the reaching of a fair agreement.

Accounting for asymmetric bargaining power in automated negotiation processes - an procedural approach

Claus-Jochen Haake and Thomas Streck
Paderborn University

The main purpose of our research is to examine the effect of asymmetries in a modified Adjusted Winner procedure. We model it as a two person cooperative bargaining game with either variable disagreement point or variable utopia point. It is under observation to which extent the degree of asymmetry affects the outcome and whether the properties of a modified Adjusted Winner procedure alter its current properties.

A foundation of Nash bargaining solution from strategic uncertainty

Philippe Bich and Wael Saker
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The standard Bargaining problem can be summarized as follows: two players have to reach an agreement on the partition of a pie of size 1. John Nash [2] has proposed to axiomatize the desirable properties of such an agreement, in order to obtain one unique solution, called the Nash solution. Then, many researchers have tried to give a strategic (non cooperative) foundation of this concept (see, for example, Walter Trockel [4]), most of them using extensive form games (see Rubinstein [3]). In parallel, many concepts of solutions have been proposed to extend or modify Nash solution concept (e.g., Kalai-Smorodinsky solution concept). In this paper, we propose a new foundation for the Nash bargaining solution, using prudent games, introduced by Philippe Bich [1]. The idea is to introduce a new feature in the bargaining environment, strategic uncertainty, together with some "prudent" behavior of the players with respect to this strategic uncertainty. We prove that in the standard Nash demand game, this prudent behavior induces a unique equilibrium, which corresponds to different kind of cooperative solution concept (Nash's one or Kalai-Smorodinsky), depending on the kind of prudence introduced in the model. References[1] Philippe Bich, Prudent Equilibria and Strategic Uncertainty in Discontinuous Games, Preprint, halshs-01337293, 2016[2] John Nash, Two-Person Cooperative Games, Econometrica, 1953[3] Ariel Rubinstein, Perfect Equilibrium in a Bargaining Model, Econometrica, 1982[4] Walter Trockel, On the Nash Program for the Nash Bargaining Solution, Working paper 788 University of California, 1999

Bargaining over uncertain profit shares

Yigal Gerchak and Eugene Khmelnitky
Tel Aviv University

Suppose that several parties are contemplating establishing a partnership. But how will they divide the uncertain future profit? We assume that the division will be the result of bargaining, either Nash or Kalai-Smorodinsky type. We focus primarily on affine ("linear") contracts, which are often used in practice. We consider the implications of various examples of utility functions and beliefs. We also work out the division for asymmetric Nash and Kalai-Smorodinsky solutions.
The option of sequential alliances for cooperative investments

Fumi Kiyotaki* and Toshiji Miyakawa
*Kindai University

We examine whether the option of sequential bargaining alleviate free-rider problems. We consider the situation in which two players who need to invest bargain with a common third party. After the investment decision, the proposer of the coalition is randomly selected among the two players and decides whether to form a grand coalition immediately or bargain sequentially, considering externalities. We demonstrate that both players choose sequential bargaining and alleviate free-rider problems when the discount factor is sufficiently large. However, the option to bargain sequentially does not affect the incentives when the discount factor is sufficiently small. In addition, we show that an asymmetric equilibrium exists where one player who has invested chooses the sequential bargaining but another player who has not invested chooses the grand coalition and the incentives of investments are improved if positive externalities are not too large when the discount factor is intermediate.
Preference Reversal and Temporal Discounting by Optimizing Growth Rates

Diomides Mavroyiannis*, Alexander Adamou, Yonatan Berman and Ole Peters
*University of Paris, Dauphine

An important question in economics is how people evaluate payments in the future. The standard phrasing of the problem is in part psychological: the value we attach to a future payment is the dollar value of the payment discounted by a factor whose functional form is determined by our subjective psychology and whose (objective) argument is how long we have to wait for the payment. The functional form is called the “discounting function”, in practice commonly exponential or hyperbolic. Here we present an interpretation of these forms in terms of growth rates. A payment in the future, we posit, is often viewed as a growth rate of wealth averaged over the time until the payment. Choosing the greatest multiplicative growth rate is mathematically equivalent to exponential discounting, and the additive growth rate is equivalent to hyperbolic discounting. Multiplicative and additive processes are important models for wealth, corresponding approximately to non-earned and earned income. More complicated growth processes result in different discounting functions.

Bertrand-Edgeworth Competition with Capacity Uncertainty - Feasting on Leftovers

Robert Somogyi* and Wouter Vergote
*Budapest University of Technology and Economics

There is ample empirical evidence documenting that large firms set significantly lower prices than smaller, capacity-constrained, firms in procurement auctions. This is paradoxical in light of the standard theoretical result that large firms charge higher prices than small firms in models of price competition with capacity constraints. We argue that private information about the capacity constraints can account for this puzzle. We do so by studying duopoly pricing in which firms are privately informed whether they are capacity-constrained or not. We find that a capacity-constrained firm will price less aggressively than an unconstrained firm as it prefers to focus on any leftover demand in case her rival is also capacity-constrained and would rather not undercut the low prices charged by an unconstrained firm. Privately known capacity constraints thus provide a potential explanation for the empirically observed negative correlation between capacity constraints and prices charged by competitive firms.

Managing employee turnover

Saara Hämäläinen* and Vaiva Petrikaite
*University of Vaasa

We consider the effects of management practices on labor markets where employees are hit by shocks that might cause them to quit. Management can be either inattentive (“asleep”) or responsive (“awake”) to the idiosyncratic shocks affecting their employees. We show that employee turnover is excessive when management is asleep. This is because of a coordination failure that arises then and because employees receive information rents, which generate a wedge between what is optimal privately and socially. Instead, when management is awake, employee turnover is lower and average tenure is longer, because a firm can then compensate an employee for a bad shock by adjusting the wage (or fringe benefits, or working conditions) but extract leftover surplus. Unemployment rate also goes down. Generally, the paper finds that introducing private employee information – the shocks – alleviates search frictions whether managers are asleep or awake. However, the equilibrium we characterize is (constrained) efficient only when managers are awake. We find that improved management can intensify competition for labor, which could make also the average employee better off.

Endogenous lobbying with uncertainty

Yi Zheng* and Saara Hämäläinen
*University of Helsinki

This paper studies the welfare costs of competition for a monopoly position in a complex communication environment. Competition is modelled as a rent seeking game in which possible producers exercise effort to acquire the monopoly. Complexity is endogenous. Participants of the rent seeking game can use confusing communication strategies that decrease the commensurability of their effort choices. Welfare costs include the lower quantity and the rent seeking. We derive the equilibrium for sellers and buyers and discuss the welfare improvement.
This paper generalizes search theory considering searching as an economic good. Agents derive utility from the goods they have sampled and also from the act of searching itself. For both sequential and non-sequential search processes the notion of quasi-concavity guarantees the existence of an optimal search policy. In a non-sequential search process, the assumption of quasi-concave expected utility function reduces the set of solutions to some consecutive integers. Strict quasi-concavity further restricts the number of solutions to a maximum of two. In the case of a sequential search process, quasi-concavity of expected gains insures the existence of a simple search rule. We also investigate additive separable models, where the utility of searching is separable from the utility of the good that is purchased. We show that, with this assumption, the model is a particular case of quasi-concave expected utility function models. As a consequence, the existence of optimal search policies is guaranteed for both non-sequential and sequential search strategies. We then provide general first and second-order conditions towards the existence of a search rule when the utility of searching is not necessarily linear.
Outsource to or Compete with a More Efficient Input Supplier? Strategic Outsourcing in Vertical Markets.

Konstantinos Papadopoulos
Aristotle University of Thessaloniki

We analyze the outsourcing decision of two rivals to a common supplier of input. It has been shown in the literature that a vertically integrated firm may prefer to outsource the production of input to a common supplier, despite facing an input price higher than its internal cost of production. However, we show that a vertically integrated firm, instead of paying a premium on the input price, may profit from engaging in competition with its supplier for the supply of input to its downstream rival. If we allow for outsourcing among vertically integrated downstream competitors, the common supplier is no more capable of selling input at a price above the internal per unit production cost of downstream rivals, thus confirming conventional wisdom. At equilibrium all firms outsource to the common supplier, nevertheless at input prices lower than the ones where outsourcing among downstream rivals is not allowed.

Monopoly with uncertain demand

Klaus Kultti
University of Helsinki

We develop a formal framework to analyse a monopoly’s problem when demand is determined by a Poisson-distribution and the valuations of the buyers are draws from a common distribution. The buyers have unit demand, and the good in question is discrete. The monopoly has to make its quantity and pricing decisions before demand is realised. We determine sufficient conditions for the monopoly’s pricing decision to be unique, and we demonstrate the difference to the planner’s problem by numerical examples. We also study an economy with a fixed number of buyers assuming that the valuations are draws from the uniform distribution. When the economy grows in the limit one recovers the standard case of a monopoly with linear demand and constant marginal costs.

Who becomes the Quality Leader? A Dynamic Model of Vertical Differentiation.

Nima Jouchaghani
University of Duisburg-Essen

We analyze a dynamic duopoly model of vertical differentiation, where each firm sells a single product of a particular quality level to a mass of heterogeneous consumers in each period. Firms can improve their products quality in each period at some costs, which are private information and change in each period. However the firms know the distribution of the rival firms costs in each period. Each period consists of a three stage game. First, firms simultaneously choose their quality improvement, after learning their costs. Next, after observing the rivals quality level, firms simultaneously choose prices. Finally, consumers which are heterogeneous with respect to their marginal utility of quality, observe prices and qualities and exclusively decide from which firm to buy. In this paper we want to show that, depending on the models primitives, namely the cost distribution and the distribution of consumers willingness to pay for quality, different types of Markov perfect equilibria will arise. We find equilibria where both firms are increasing their products quality over time, possibly making the products more homogenous and ultimately reducing profits. The explanation for this finding is that uncertainty about the rivals costs translates into uncertainty of who will have access to the more profitable high quality market to serve consumers with the highest willingness to pay for quality. Compared to a situation of maximum quality differentiation, the average quality level is higher while prices are lower, which ultimately benefits consumers.
We investigate the impact of regulatory risk on vertical integration and upstream investment by a regulated firm that provides an essential input to downstream competitors. Regulatory risk reflects uncertainty about the regulator’s commitment to a regulatory policy that promotes unobservable investment effort. We show that, when the regulatory policy is set after the vertical industry structure has been established, some degree of regulatory risk is socially beneficial. Regulatory risk makes vertical integration profitable and stimulates upstream investment at a lower social cost. This occurs for moderate costs of investment effort and firm small risk aversion. Our analysis sheds new light on some relevant empirical patterns in vertically related markets.

This paper identifies the equilibrium quality choices in a vertically differentiated market with price competition, when the unit production costs are increasing with quality. Besides the partial coverage and full coverage equilibrium, we consider cases where the Nash equilibrium involves full market coverage but with a corner solution in the price game. We identify when each of the market coverage configurations holds. This article completes and corrects previous results on vertically differentiated models.
Selecting a pooling equilibrium in a signaling game with a bounded set of signals

Miguel Ángel Ropero
University of Malaga

In a general class of signaling games, in which the support of the signal is limited or the cost of the signal is sufficiently low, there may be multiple pooling equilibria. In those games, the typical restrictions on the out-of-equilibrium beliefs suggested by previous literature cannot discard any of the sequential equilibria obtained. For this reason, we develop a new refinement, which is called the most profitable deviator. We show that this refinement is useful to select a unique equilibrium in those games. Additionally, we prove that those sequential equilibria which pass our criterion of the most profitable deviator will also pass the refinements developed by previous literature in monotonic signaling games. Thus, we guarantee that our criterion does not select implausible equilibria in the class of games usually studied in economics.

Directed search with multi-unit demands

Mats Godenhielm
HY / PTT

We study the sellers' choice of mechanisms in a large frictional economy where buyers have multi-unit demands and decreasing marginal utilities. We derive the equilibrium mechanisms with capacity constrained sellers and local demand uncertainty. We show that all equilibrium mechanisms are payoff-equivalent to multi-unit Vickrey auctions and that they are constrained efficient. Fixed prices or auctions with reserve prices are not equilibrium mechanisms.

Bayesian Elicitation

Mark Whitmeyer
Department of Economics, University of Texas at Austin

"How can a receiver design an information structure in order to elicit information from a sender? Prior to participating in a standard sender-receiver game (in which messages are possibly costly à la Spence), the receiver may commit to any information structure—any degree of transparency. Commigning to a less informative signal about the sender's choice affects the endogenous information generation process such that the receiver thereby secures himself more information. We establish broad conditions under which the problem of designing a receiver-optimal information structure can be reduced to a much simpler problem, commigng optimally to a distribution of actions as a function of the sender's message. Moreover, we relate the choice of information structure to inadvent and establish conditions under which the optimal degree of inattention is equivalent to the optimal degree of transparency. We apply these results to various situations including those in which the sender has an incentive to feint, as well as a political scenario."

Signalling Expertise

Alexandros Rigos, Maria Kozlovskaya and Matteo Foschi

Aston University, Birmingham

This paper models strategic information transmission between buyers in need of a service and an expert seller who can provide it. Buyers are heterogeneously informed about their needs and so the seller can try to offer them unnecessary services. We assume better-informed buyer types can differentiate themselves from worse-informed types by providing verifiable evidence of their expertise. We show that, in equilibrium, there can be strong incentives to hide one's expertise. By selectively withholding their information, partially-informed buyers can even completely protect themselves from seller fraud. Additionally, more-informed buyers can actively protect less-informed buyers by pooling with them through hiding expertise.
Games on hierarchies

Rene van den Brink
VU Amsterdam

Various restrictions on coalition formation in cooperative games are studied in the literature. Famous restrictions arise from restricted communication and hierarchies. In this presentation, I will review several models of cooperative transferable utility games with a hierarchical structure on the player set. A central model is that of games with a permission structure where players in a cooperative transferable utility game are part of a permission structure (directed graph), where some players need permission from other players before they are allowed to cooperate. Besides this model, we will discuss several generalizations, such as games on antimatroids, games on union closed systems and games with a local permission structures. Also, we mention some applications of games with a permission structure, such as auction games, polluted river games, joint liability games, digraph games and hierarchically structured firms.
Day 2 - July 3rd

Parallel Sessions 4

Session: Dynamic Games II - Room: Ls07 - July 3rd, 9:00–10:40

Descriptive Set-Theoretic Properties of Bayesian Updating

Yehuda Levy* and Ziv Hellman

*University of Glasgow

When one of finitely many states of Nature is unknown to agents who receive public signals about the state (possibly conditional on actions), agents update their beliefs in a Bayesian way. An equivalence relation is thus induced on the simplex of beliefs; two beliefs are in the same class if one can lead to the other after observing some sequence of signals. The complexity of this equivalence relation is crucial; for example, Hellman & Levy (forthcoming) show that when the process is associated with a state-dependent payoff function for the agents, if this equivalence relation is sufficiently tame, equilibrium which is measurable and stationary in beliefs exists. We show, however, that for generic signalling structure, the orbits of this relation are dense and do not admit Borel cross-sections. We establish these results and others by better understanding the group of actions the signals induce on the simplex of beliefs, and in particular use techniques from Diophantine approximation.

Optimal stopping in a principal-agent model with hidden information and no monetary transfers

Eugen Kovac*, Daniel Krähmer and Tymon Tatur

*University of Duisburg-Essen

This paper studies optimal stopping rules in a simple stopping problem when the decision maker lacks relevant information but can consult an informed yet self-interested agent, while the exchange of contingent monetary transfers is infeasible. A leading example is the search for new employees where the employer has to decide whether to hire a current applicant or hope for a better candidate to arrive in the future. In each period, the agent observes the current state of the world, which determines the payoff from taking an irreversible action (“stopping”) today. We consider the simplest setting in which the state evolves independently across time and can be either “high” or “low”, corresponding to a high or low payoff from stopping. We adopt a mechanism design approach where, at the outset, the principal can commit to a dynamic stopping rule that specifies for each period the probability to stop depending on information communicated by the agent. To capture the conflict of interest between the parties, we assume that, while both parties agree that the high state is better than the low state, they face “intertemporal conflict of preferences” by having different preferences about when to stop. Under the optimal stopping rule the principal sets a deadline. Within the deadline, the agent can make exactly one proposal to stop. If he makes a proposal, it is accepted with some probability (which increases over time). With the complementary probability, the proposal is rejected and, in fact, no action is ever taken in the future so that stopping never occurs. If the agent does not make a proposal until the deadline, he is delegated the decision right immediately after the deadline (which is in our simple setup equivalent to stopping immediately after the deadline).
Sender-receiver stopping games

Aditya Aradhye*, János Flesch, Mathias Staudigl and Dries Vermeulen
Maastricht University

We introduce a model of sender-receiver stopping games, where the state of the world follows an iid-process throughout the game. At each period, the sender observes the current state, and sends a message to the receiver, suggesting either to stop or to continue. The receiver, only seeing the message but not the state, decides either to stop the game, or to continue which takes the game to the next period. The payoff to each player is a function of the state when the receiver quits, with higher states leading to better payoffs. The horizon of the game can be finite or infinite. We characterize the set of Perfect Bayesian Equilibria (PBE) of these games when the players are sufficiently patient; the payoffs are either undiscounted or discounted with a large discount factor. We also derive existence and unicity results for PBE. As we show, in all our results the central role is played by a specific strategy profile in which the sender uses a threshold strategy whereas the receiver blindly follows the recommendations of the sender. This implies that in PBE the sender plays the decisive role, and surprisingly, regardless of the payoff function of the receiver, the sender obtains the best possible payoff for himself. We also consider the extension in which there are multiple senders and just one receiver.

Social Learning with Endogenous Order of Moves

Daniel Hauser, Pauli Murto* and Juuso Välimäki
Aalto University

We extend the canonical social learning model to allow for free timing of actions. Previous literature has understated the role of endogenous timing in facilitating information aggregation, suggesting that with bounded signals agents learn very little and quickly herd on a potentially inefficient action. We demonstrate that even in environments with bounded private signals the most informative symmetric equilibrium fully aggregates information as the number of players becomes large, but with delays. Moreover, in the limit as the number of players goes to infinity, we can fully characterize the rate of learning, welfare, and the waiting dynamics.
On the Shapley value of constant-sum games
Tamás Solymosi
Corvinus University of Budapest

We show that on the space of (non-negative) constant-sum transferable utility cooperative games, the Shapley value is the only linear value that satisfies efficiency, the equal treatment property, and the null-player property. To this end, we identify a basis among the (non-negative) "constant-sum average unanimity games" used by Khmelnitskaya (IJGT, 2003) to show that Young’s (IJGT, 1985) axiomatization of the Shapley-value by marginalism, efficiency, and anonymity also holds for the class of (non-negative) constant-sum games. From the inverse basis, we derive a "sharing matrix" that depends only on the number of players and the Shapley-value probabilities of a player joining a coalition. The Shapley payoff vector of a (non-negative) constant-sum game is then obtained by multiplying this sharing matrix with the game vector. We also discuss the relations between the properties of the sharing matrices of efficient linear values and the equal treatment and the null-player axioms imposed on the values.

Marginality, dividends, and the value in games with externalities
Frank Huettner* and Andre Casajus
ESMT Berlin

In the absence of externalities, marginality is equivalent to an independence property that rests on Harsanyi’s dividends. We introduce notions of marginality and independence for games with externalities. They rest on the idea that a player’s contribution in an embedded coalition is measured by the change that results when the player is removed from the game. We provide characterization results using efficiency, anonymity, and independence or marginality, which generalizes Young’s characterization of the Shapley value. An application of our result yields a new characterization of the solution put forth by Macho-Stadler et al. (J Econ Theor, 135, 2007, 339-356) without linearity.

The canonical extension of the Shapley value for cooperative games with externalities
André Casajus* and Frank Huettner
HHL gemeinnützige GmbH

We identify one extension of the Shapley value to games with externalities from the literature (Macho-Stadler, Pérez-Castrillo, Wettstein: J Econ Theor, 135, 2007, 339-356) as the canonical one. Other attempts for extensions via generalizations of unanimity games, null players, monotonicity properties, or average games lead into ambiguities and technical problems. Our extension is based (i) on the potential approach to solutions for games with externalities (Dutta, Ehlers, Kar: J Econ Theor, 145, 2010, 2389–2411) and (ii) on a natural extension of the potential of the Shapley value (Hart, Mas-Colell: Econometrica, 57, 1989, 589–614) to games with externalities and a corresponding restriction operator both based on the interpretation of the potential as the worth of a random partition (Casajus: Econ Lett, 126 (2), 2014, 164–166).
Voting paradoxes in restricted domains

Hannu Nurmi
University of Turku

That a little bit of consensus helps in finding acceptable social outcomes should come as no surprise. In late 1940's Black demonstrated this in the context of pairwise voting by majority principle. What he came up with is a sufficient condition for the majority rule to result in a complete and transitive social preference ranking and, hence, a seemingly stable outcome. It soon turned out, however, that the crucial sufficient condition, single-peakedness of individual preferences, is quite stringent in multi-dimensional policy spaces. The focus of the present paper is to look at some apparently stable outcomes and see whether they have an impact of the incidence of voting paradoxes. In other words, we ask if the stability of outcomes has implications regarding the vulnerability of various voting rules to voting paradoxes. In particular, we examine the vulnerability of various voting procedures to monotonicity-related paradoxes. The background of this work is Moulin's theorem establishing the incompatibility of Condorcet's winner intuition and the condition known as participation. Our results pertain to the validity of this result in restricted domains. Of these the most important is the Condorcet domain, i.e. a class of profiles where a Condorcet winner exists. We restrict this domain further by requiring that the Condorcet winner be elected in the initial profiles (which is automatically the case in Condorcet extensions). We also consider additional restrictions such as the coincidence of Borda and Condorcet winners as well as the presence of an absolute winner in the initial profiles. It turns out that quite a few voting rules fail on participation even in these essentially restricted domains.

Double Majority and Generalized Brexit: Explaining Counterintuitive Results

Werner Kirsch, Wojciech Słomczyński, Dariusz Stolicki* and Karol Życzkowski
Jagiellonian University, Center for Quantitative Research in Political Science

It has been already noted that the effects of Brexit on the voting power in the Council of the European Union (which employs a double-majority weighted voting system) are nontrivial, as the voting power of some member states increases, while the voting power of others decreases. In addition, the ratio of post-Brexit to pre-Brexit voting power is nonmonotonic with respect to voting weights. Similar effect appears for a hypothetical “generalized Brexit,” i.e., an exit of another member states (from a 28-member Union), although the exact patterns depend on the size of the leaving state. Using both numerical simulations and analytic approximations, we seek to explain the effects in question, particularly the nonmonotonicities. We conclude that some degree of nonmonotonicity is a generic feature of weighted voting systems, that the introduction of the double-majority requirement is conducive to greater nonmonotonicity of exist effects, and that said nonmonotonicity is further exacerbated by the peculiar distribution of large countries’ voting weights in the EU.

Scoring Run-off Rules, Single-peaked Preferences and Paradoxes of Variable Electorate

Eric Kamwa*, Vincent Merlin and Faty Mbaye Top
*Université des Antilles

In three-candidate elections with single-peaked preferences, this paper analyzes the vulnerability of scoring run-off rules to abstention and participation paradoxes. These paradoxes occur when the size of the electorate varies (grows or diminishes). In particular, the Abstention or No-show paradox occurs when a voter is better off by not casting his ballot in the election. First, using the fact that a Condorcet winner always exists on the single-peaked domain, we show that these paradoxes never occur for all the scoring run-off rules located between the Borda run-off and the Antiplurality run-off. Secondly, when these paradoxes are still possible, we compute their likelihood under the Impartial Anonymous Culture assumption. We conclude that considering the single-peaked domain drastically reduces, and even sometimes eliminates the impact of No-show paradoxes, for scoring run-off rules.
We introduce the following generalization of the plurality and the reverse-plurality rules (the latter introduced in Bednay, Moskalenko and Tasnádi, 2017): For a given preference profile order the alternatives decreasingly based on the numbers of voters ranking the alternatives on top, and we refer to the rule selecting the kth ranked alternative based on the obtained ordering as the kth group rule. Any voting rule can be decomposed by partitioning the universal domain of preference profiles into at most as many subsets of preferences as many alternatives we have, and then assigning exactly one of the kth group rules to each partition member. By investigating the proposed decomposition we arrive to preference domains which are maximal with respect to manipulation. In order to arrive to our results we analyze the relation between the kth group rules.
The set of Pareto optimal simple outcomes: A natural solution concept for the one-sided assignment game

David Pérez-Castrillo* and Marilda Sotomayor
*Universitat Autònoma de Barcelona

In the one-sided assignment game any two agents can form a partnership and decide on the sharing of the surplus created. Thus, an outcome involves a matching and a vector of payoffs. In this market, stable outcomes often fail to exist. We introduce the idea of simple outcomes: they are individually rational outcomes where no matched agent can form a blocking pair with any other agent, neither matched nor unmatched. We propose the set of Pareto optimal (PO) simple outcomes, which are the maximal elements of the set of simple outcomes, as a natural solution concept for this game. We prove several properties of the simple outcomes and the PO simple outcomes. In particular, each element in the set of PO simple payoffs provides the maximum surplus out of the set of simple payoffs, the set is always non-empty, and it coincides with the core when the core is non-empty. Moreover, we suggest a dynamic process of coalition formation that leads to these outcomes. In this process, two agents only reach an agreement if both believe that more favorable terms will not be obtained in any future negotiations. That is, once a transaction is done at a given stage, the agents involved will keep their payoffs at the subsequent stages.

Strategy-proofness in experimental matching markets

Pablo Guillén and Róbert Veszteg*
*Waseda University

We introduce two novel matching mechanisms, Bottom Trading Cycles (BTC) and Reversed Deferred Acceptance (RDA) with the purpose of challenging the idea that strategy-proof mechanisms induce high rates of truth-telling in economic experiments. BTC and RDA are identical to the celebrated TTC and DA mechanisms, respectively, in all their properties but their dominant-strategy equilibrium is to report one’s preferences in the order opposite to the way they were induced. If participants still report their preferences in the order induced by the experimenter, we have a clear proof for them not understanding the structure of the game played under BTC and RDA. We find that roughly half of the observed truth-telling under TTC and DA is the result of naive (non-strategic) behavior and only 15-25% of participants seem to act in a sophisticated (strategic) manner. Surprisingly, even they tend to lack full understanding of the game. We argue that confusion and other mistakes account for the vast majority of truthful play in both TTC and DA. We can conclude that high truth-telling rates in TTC and DA in laboratory experiments are not a result of strategy-proofness but an artifact of the experimental design.

Assignment markets with middlemen

Saadia El Obadi*, Silvia Miquel and Marina Nuñez*
*University of Lleida

In a two sided markets there are two disjoint finite sets of buyers and sellers that want to trade indivisible units of some good. With the aim of being closer to real situations, we consider a three sided market. We assume that there is a third side in the market formed by finite set of middlemen (disjoint with the set of buyers and sellers). In this market, each buyer-seller pair can attain a profit only if there is a middleman that connects them. This profit does not depend on the identity of the middleman, and each buyer and seller can take part in at most one partnership while middlemen can establish multiple partnerships. This situation may represent a real estate market in which value is generated by the matching of of a buyer and a seller but typically real state agencies act as intermediaries. Moreover, a same house can be advertised in the website of several agencies, and each buyer also searches in several of these sites. We show that assignment games with middlemen, where the profit of a buyer-seller pair does not depend on who is the middleman that connects them, have a non-empty core when the number of middlemen in the market is enough to connect the maximum possible number of buyer-seller pairs. Otherwise, we show by means of an example that the core may be empty and we provide a sufficient condition to guarantee the non-emptiness of the core. After the analysis of the core, we define competitive prices and competitive equilibrium payoff vectors and study the relationship between this set and the core. We show that whenever the core is non-empty, the set of competitive equilibrium payoff vectors coincides with the set of solutions of the dual assignment problem.
In this paper, we consider von Neumann-Morgenstern (vNM) farsightedly stable sets of assignment games. Assignment games can be seen as a two-sided matching problem where transfers are allowed. Although the game is often cast as a transferable utility (TU) game in characteristic function form, we use an alternate formulation of the assignment game that is closer to the two-sided matching problems to circumvent issues involving coalitional sovereignty for TU games. That is, for TU games, when a coalition of agents deviates, it can also dictate the payoffs and matchings of the agents outside the coalition. Another reason we do not use the TU game framework is that any formulation involving a characteristic function implicitly assumes an optimal matching, which restricts the type of deviations allowed by a coalition. We show that a matching outcome in the core and its payoff-equivalent outcomes constitute an essentially singleton vNM farsightedly stable set defined by a farsighted version of weak domination where only a pair of agents or a single agent can deviate at a time. Moreover, these are the only such types of essentially singleton vNM farsightedly stable sets. Next, we consider a modified farsighted domination relation that restricts the number of times an agent can break a matching and re-match with another agent. While imposing this restriction does not change the results for two-sided matching and roommate problems, we can show that with this modification, there can exist other types of (non-singelton) vNM farsightedly stable sets, and unlike roommate problems, such a stable set can consist of two distinct matching outcomes.
A measurement of linkages power in corporate networks

Cesarino Bertini, Jacek Mercik and Izabella Stach

AGH University of Science and Technology

Some game-theoretical methods that measure indirect control in complex corporate shareholding structures are discussed. These methods used power indices and measure the direct and indirect control power of all firms involved in shareholding networks (which means investors and stock companies). However, neither takes measuring the importance of mutual linkages (arcs in networks) into consideration. Thus, we focus particularly on an extension of these methods in our research in order to measure not only the control-power of firms involved in complex shareholding structures (represented by nodes in networks) but also the importance (power) of linkages between the firms as elements of a whole corporate shareholding network. Moreover, we continued the considerations started in Mercik and Stach (2018) about the reasonable properties for indirect control measurement.

Network games with heterogeneous preferences

Olena Orlova

Université Paris I Panthéon-Sorbonne

We consider two-stage network games in which players first propose links to each other and then, when the network is formed, choose actions. Players have individual preferences over available actions. We investigate the consequences of preference heterogeneity for a wide range of games and characterize the corresponding sets of subgame perfect Nash equilibria. We derive the necessary and sufficient conditions for existence of an equilibrium in which every player satisfies her action preference. We find that social welfare is maximized in the other equilibrium, however: in the complete network with everyone conforming to the action preferred by the majority. Finally, our framework allows for new types of equilibria with partial integration and action diversity that were absent in earlier literature.

Stronger bonds with less connected agents in stable resource sharing networks

Anastas Tenev

Maastricht University

This is a model of network formation in which agents create links following a simple heuristic: they invest their limited resources proportionally more in neighbours that have fewer links. This decision rule captures the notion that when considering social value more connected agents are on average less beneficial as neighbours. It also illustrates an externalities effect, whereby an agent’s actions also influence his neighbours’ neighbours. Besides complete networks and fragmented networks with complete components, the pairwise stable networks produced by this model include many non-standard ones with structures observed in real-life networks. Multiple stable states are possible starting from the same structure—the stable networks could have cliques linked by intermediary agents while sometimes they have a core-periphery structure. While the complete networks are the most efficient, all pairwise stable networks have close to optimal welfare.

Core stability in information graph games

Marina Nunez and Juan Vidal-Puga

University of Barcelona

In an information graph situation, some agents that are connected by an undirected graph can share with no cost some information or technology obtained from a source. If an agent is not connected to an informed player, this agent pays a unitary cost to obtain this technology. A coalitional cost game can be defined from this situation and the core of this game is known to be non-empty. We prove that the core of an information graph game is a von Neumann-Morgenstern stable set if and only if the graph is cycle-complete, or equivalently, if the information graph game is concave. When the graph is not cycle-complete, whether there always exists a stable set is an open question. In this regard, some examples are shown.
Considering moral hazard problems in a matching market may affect the predictions of the classical principal-agent model and it provides new insights for understanding the attributes of the partners that match and the characteristics of the incentive contracts.

From the point of view of the agency theory, the interest of this extension is easy to understand. The partial equilibrium approach characterizes the optimal incentive scheme for a given principal-agent partnership. In this approach, the bargaining power is exogenously given to principals or agents, which implies that an exogenous reservation utility condition for the agent (or for the principal) determines the distribution of surplus and the form of the contract. However, when one considers explicitly the existence of several heterogeneous principals and several heterogeneous agents, some of the properties obtained in the simple version of the agency problem do not necessarily hold.

From the point of view of matching theory, the consideration of incentives between partners is a natural extension of the assignment game, where the outcome is not only a matching and a vector of prices but a matching and a vector of incentive contracts, one for each partnership.
Parallel Sessions 5  
Session: Applications II - Room: Ls010 - July 3rd, 14:00–15:40

Cooperative approach to a plant location problem with positive externalities

Adriana Navarro-Ramos* and Gustavo Bergantinos  
*Universidade de Vigo

We consider that a firm 0 is planning to open a new plant in certain country. This country is divided into r different regions where the plant could be installed. On these regions are located a finite set of firms, denoted by N. These firms obtain some benefit from this new incorporation. If an existing firm is outside the region where the new plant locates, this firm does not obtain any benefit. In a decentralized mechanism, firm 0 would be located at the region where it optimizes its individual benefit. Instead, we assume that a planner should decide where to locate firm 0 maximizing the global benefit and providing a compensating scheme such that firm 0 gets more than in the decentralized mechanism and the other firms are not worst off. In order to do this, we associate to any problem a utility transferable cooperative game. We consider that cooperation on a region exists if and only if all firms already installed on that region belong to the coalition. We study the core of the game and propose two solutions belonging to the core. We also provide characterizations for these solutions.

Sequencing situations under learning and deterioration effects

Alejandro Saavedra-Nieves*, M. Gloria Fiestras-Janeiro and Manuel A. Mosquera Rodríguez  
*University of Vigo

Sequencing problems describe those situations where several jobs have to be processed on a set of machines. This class of problems are formally defined by the following elements: an initial order for the jobs and, for each of them, a cost function associated to its processing. In this sense, different factors influence in determining these costs as, among others, the processing time of each job or its position in the queue. For instance, learning and deterioration effects on the machine may influence under the mentioned approach. Cooperation in sequencing problems was widely treated in literature. Several papers analyse sequencing situations with a single machine and different cost functions. In order to analyze them two common issues have to be addressed: (a) identify the optimal sequence for the jobs, and (b) distribute the corresponding cost savings with respect to the initial order among the agents. To this aim, cooperative game theory is useful. In this work, we analyze sequencing problems with learning and deterioration effects. Under these assumptions, we obtain some results about the optimal order and analyse the cooperation through the saving games associated to these situations.

Gain-sharing in Urban Consolidation Centers

Behzad Hezarkhani*, Marco Slikker and Tom Van Woensel  
*Brunel University London

Urban consolidation centers provide the logistical infrastructure for cooperation among less-than-truckload carriers with contiguous destinations. We introduce and study cooperative situations comprising a set of carriers with time sensitive deliveries who can consolidate their cargo to obtain savings. We introduce the class of Dispatch Consolidation (DC) games and search for ways to fairly allocate the obtained savings among the participating carriers. When delivery capacities are not restrictive we show that stable allocations in the core always exist and can, in their entirety, be found by solving a compact linear program. With restrictive capacities, however, the core of a DC game may become empty. We introduce the notion of component-wise core for DC games to preserve stability first and foremost among the carriers whose deliveries are dispatched together in the chosen optimal solutions. We characterize the component-wise cores of DC games, prove their non-emptiness, and suggest proportionally calculated allocations therein.
On How to Allocate the Fixed Cost of Transport Systems

Teresa Estañ, Natividad Llorca*, Ricardo Martínez and Joaquín Sánchez-Soriano
Miguel Hernández University of Elche

In this study, we consider different cities located along a tram line. Each city may have one or several stations and information is available about the flow of passengers between any pair of stations. A fixed cost (salaries of the executive staff, repair facilities, or fixed taxes) must be divided among the cities. This cost is independent of the number of passengers and the length of the line. We propose a mathematical model to identify suitable mechanisms for sharing the fixed cost. In the proposed model, we propose, and characterize axiomatically, three rules, which include the uniform split, the proportional allocation and a intermediate situation. The analyzed axioms represent the basic requirements for fairness and elemental properties of stability.

Equilibrium arrivals to a queue under Last-Come First-Serve Preemptive-Resume

Jesper Breinbjerg, Trine Tornæs Platz* and Lars Peter Østerdal
Copenhagen Business School

We consider a queueing environment where a finite number of customers independently choose when to arrive at a queueing system that opens at a specific time and serves customers on a last-come first-serve preemptive-resume (LCFS-PR) basis. Each customer has a service time requirement that is identically and independently distributed, and customers want to complete service as early as possible while minimizing the time spent in the queue. We establish the existence of a symmetric (mixed) Nash equilibrium and show that there is at most one symmetric equilibrium. We provide a numerical method to compute this equilibrium and demonstrate by an example in which the social efficiency is lower than that induced by a similar queueing system that serves customers on a first-come first-serve (FCFS) basis.
On the core of many-to-many matching markets with transferable utility

Ata Atay*, Marina Núñez and Tamás Solymosi

*Hungarian Academy of Sciences

We study transportation games that model many-to-many matching markets with transferable utility. This model has been considered by Sánchez-Soriano et al (2001) and Sotomayor (2002). We investigate to which extent the known results on the assignment game (one-to-one matching markets with transferable utility) can be carried over to the transportation games. First, we show that, unlike the assignment game, transportation games are neither INTO-lemaral nor ONTO-lemaral. Sotomayor (2002) showed that there is no opposition of interest between the two sides of the market and the core is not a lattice. We conjecture that, for a given non-degenerate transportation game, there is (at least one) core vertex where all sellers get their core maximum payoffs; and there is (at least one) core vertex where all buyers get their core maximum payoffs. Secondly, we study the relationship between the set-wise solution concepts. We show that the kernel need not be a subset of the core of a transportation game, and hence the classical bargaining set and the core do not coincide. Finally, for transportation games, we see that single-valued solution the tau-value need not be a core allocation.

The R Package CoopGame for cooperative game theory, further software for cooperative games with partitions and communication structures and some new results

Jochen Staudacher* and Johannes Anwander

*Hochschule Kempten

The main subject of the talk is the software package CoopGame, a comprehensive package for cooperative games with transferable utility written in R. The package CoopGame currently provides- 10 different functions for generating TU games with special structures, like e.g. bankruptcy games and weighted voting games- functions for checking 17 different game properties, like e.g. superadditivity and convexity- functions for computing 5 different set-valued solution concepts for TU games, including the core- more than 30 point-valued solution concepts and power indices- routines for drawing both set- and point-valued solution concepts for the 3- and 4-player cases- some general functionality useful in the context of TU games, like e.g. computing the unanimity coefficients of a game vector. The talk will give both an overview and a practical introduction to CoopGame, including live demonstrations in R. CoopGame itself allows for neither partitions of the player set nor for communication structures in the form of an undirected graph connecting the players. Additional R packages by the names of PartitionGames and CommunicationGames are in their final stages. These two packages make use of CoopGame and provide a large number of solution concepts, including the Owen value for partition games and the Myerson value for communication games. Currently, the package CoopGame is under review by CRAN, the Comprehensive R Archive Network. Its manual comprises more than 200 pages. Anyway, release versions of all three packages will be made available to the public via CRAN or github before the start of the conference. Along the way, new theoretical results will be presented, including new findings on the computation of the Gately point [1] and some yet unpublished ideas for point-solution concepts. References:[1] Staudacher, J., and Anwander, J.: (2019). Conditions for the uniqueness of the Gately point for cooperative games. 10 pages. arXiv preprint, arXiv:1901.01485.

Primal and dual algorithms, and the number of iterations needed to compute the nucleolus

Marton Benedek*, Tri-Dung Nguyen and Joerg Fliege

*Hungarian Academy of Sciences

The nucleolus of a cooperative game with transferable utilities given in characteristic function form can be computed by solving a sequence of linear programs (LPs). This sequence can be formulated using mainly primal or mainly dual LPs. By the nature of the problem, primal formulations typically rely on a dual based subroutine, but offer minimal number of iterations among the sequential methods. While in a purely dual setting, the large LPs needed to be solved are computationally easier to handle, however, might require more iterations to find the nucleolus, creating a trade-off between the primal and the dual approach. Even though the effect of the subroutines is, in most cases, negligible in terms of computation time, the dual formulation is regarded more favourable in general. We offer a comprehensive categorisation of major milestone methods in the past five decades of nucleolus computation in the general case, and introduce variants of existing methods that dissolve the previously mentioned trade-off. However, we argue there is another side of the trade-off favouring the primal, that is, warm starting. Primal methods can effectively exploit warm start due to the sequential setting, while this is not the case for the dual. Finally, we offer a concept that, in practice, while increases the number of iterations needed, can still lead to a decrease in computation time.
Consistency of the equal split-off set
Bas Dietzenbacher* and Elena Yanovskaya
HSE University

A well-known egalitarian solution for convex games was defined in the seminal paper of Dutta and Ray (1989). Inspired by the computational algorithm of this solution, Branzei et al. (2006) introduced the equal split-off set as an extension to arbitrary cooperative games. The equal split-off set recursively assigns the maximal average worth to the members of one of the corresponding coalitions, and subsequently considers a reduced game for the other players. This presentation axiomatically studies this extension on multiple classes of non-convex games. We obtain several characterizations by exploring the relation of the equal split-off set with various consistency notions in different forms.

Monotonicity and weighted prenucleoli: A characterization without consistency
Pedro Calleja*, Francesc Llerena and Peter Sudhölter
University of Barcelona

A solution on a set of transferable utility (TU) games satisfies strong aggregate monotonicity (SAM) if every player can improve when the grand coalition becomes richer. It satisfies equal surplus division (ESD) if the solution allows the players to improve equally. We show that the set of weight systems generating weighted prenucleoli that satisfy SAM is open which implies that for weight systems close enough to any regular system the weighted prenucleolus satisfies SAM. We also provide a necessary condition for SAM for symmetrically weighted nucleoli. Moreover, we show that the per capita nucleolus on balanced games is characterized by single-valuedness (SIVA), translation and scale covariance (COV), and equal adjusted surplus division (EASD), a property that is comparable but stronger than ESD. These properties together with ESD characterize the per capita prenucleolus on larger sets of TU games. EASD and ESD can be transformed to independence of (adjusted) proportional shifting and these properties may be generalized for arbitrary weight systems $p$ to $I(A)Sp$. We show that the $p$-weighted prenucleolus on the set of balanced TU games is characterized by SIVA, COV, and $IAsp$; and on larger sets by additionally requiring $Sp$. 
Competing Travelling Salespersons with Multi-payoffs

Erella Eisenstadt and Amiram Moshaiov

"Tel-Aviv University

Recently, a novel non-cooperative multi-payoff game has been introduced in which two travelling salespersons are competing, where each of them has two self-conflicting objectives [1]. Here, the payoffs’ model is revised to make it more realistic. In particular, each player has a dilemma between increasing her own revenue and inflicting a reduction on the opponent’s revenue. The considered game, which is a zero-sum game with respect to each of the payoff components, is of a normal form and involves pure strategies. The game is also of incomplete information since players are undecided about their objective preferences. Following the game definition, the recently introduced solution concept of mutual rationalizability to payoff-vector games [2], is described. As argued in [3], such an approach allows the players to examine performance tradeoffs to support rationalizing strategy selection out of the exposed sets of rationalizable strategies. Finally, several case studies are used to demonstrate the pro-posed game model and its solution concept. References 1. Eisenstadt, E., Moshaiov, A. and Avigad G., The Competing Travelling Sales-persons Problem under Multi-criteria, Proceedings of the International Conference on Parallel Problem Solving from Nature, PPSN 2016. 2. Eisenstadt, E. and Moshaiov, A., Mutual Rationalizability in Vector-payoff Games, Proc. of the Int. Conf. on Evolutionary Multi-Criterion Optimization, 2019.3. Eisenstadt, E. and Moshaiov, A., Decision-making in Non-cooperative Games with Conflicting Self-objectives, Journal of Multi-Criteria Decision Analysis, 2018.

Beyond the self-interest. Maxmin preferences in strategic models

Mª Ángeles Caraballo*, Asunción Zapata, Luisa Monroy and Amparo Mármlol

*University of Seville

There are many situations where the motivation of individuals goes beyond the self-interest. In fact, people often care for the well-being of others and this behavior may have economic consequences. In order to model this concern, utilitarianism has been widely used. However, when attitudes like inequity aversion are relevant, the egalitarianism proposed by Rawls seem to be more adequate to capture the social nature of individuals’ preferences. Within this setting, agents care about the best interest of the worst-off agent. The methodological framework considered to analyse this situation is the theory of non-cooperative vector-valued games. To deal with these games, the agents seek to maximize the minimum of the weighted component of their vector-valued utility functions, that is, their preferences are represented by a weighted maxmin function. Taking into account the parameters of this representation, we present results which permit the description of different agents, according to the attitude exhibited by them with respect to the results of the others. Moreover, necessary conditions and sufficient conditions on the weights, which enable the identification of equilibria, are provided. Finally, it is also shown that the existence of non-trivial equilibria depends on the attitudes of the agents.

Nash Blocks

Peter Wikman

Toulouse School of Economics

There are many situations where the motivation of individuals goes beyond the self-interest. In fact, people often care for the well-being of others and this behavior may have economic consequences. In order to model this concern, utilitarianism has been widely used. However, when attitudes like inequity aversion are relevant, the egalitarianism proposed by Rawls seem to be more adequate to capture the social nature of individuals’ preferences. Within this setting, agents care about the best interest of the worst-off agent. The methodological framework considered to analyse this situation is the theory of non-cooperative vector-valued games. To deal with these games, the agents seek to maximize the minimum of the weighted component of their vector-valued utility functions, that is, their preferences are represented by a weighted maxmin function. Taking into account the parameters of this representation, we present results which permit the description of different agents, according to the attitude exhibited by them with respect to the results of the others. Moreover, necessary conditions and sufficient conditions on the weights, which enable the identification of equilibria, are provided. Finally, it is also shown that the existence of non-trivial equilibria depends on the attitudes of the agents.
Emergent Collaboration in Social Purpose Games

Robert Gilles*, Lina Mallozzi and Roberta Messalli
Queen’s University Belfast

We study a class of non-cooperative games where the payoffs depend separately on a player’s own strategy (individual benefit) and on a function of the strategy profile which is common to all players (social benefit) weighted by an individual benefit parameter. This structure allows for an asymmetric assessment of the social benefit across players. We show that these games have a potential and we investigate its properties. We show existence results for the Nash equilibrium and the social optimum and, following the literature of partial cooperation, we investigate the leadership of a single coalition of cooperators while the rest of players act as non-cooperative followers. In particular, we show that social purpose games admit the stable emergence of a single coalition of cooperation for a wide range of parameter values. We apply our analytical framework to study the standard formulation of a tragedy of the commons game in which a common resource is exploited by the players. We show that in this social purpose game, there emerges a single coalition of cooperators to curb the overuse of the resource, as is the case in Nash equilibrium based on standard best response rationality.

Partially exclusive contests

Samuli Leppälä
Cardiff University

This study presents a contest model in which the players compete for partially exclusive prizes and the number of winners is stochastic. In rent-seeking context, for example, the prizes may be limited in number but need not be mutually exclusive. The results demonstrate that while partial exclusivity leads to lower prize dissipation, it also increases aggregate effort. The contest design that maximises the aggregate effort sets the maximum number of prizes equal to half of that of the players. Contrary to sequential multiple prize contests, in partially exclusive contests the maximum aggregate effort is generally the same between a grand contest and multiple sub-contests.
Optimal Lying and Lie-Detection in Bayesian Persuasion Games with Costly Information Acquisition and Truth-Proportional Beliefs

Mantas Radzvilas* and Todd Stambaugh
*Munich Center for Mathematical Philosophy, LMU

If the aim of pharmaceutical regulators is to prevent dangerous and ineffective drugs from entering the market, the procedures they implement for approval of drugs ought to incentivize the acquisition and accurate reporting of research on the questions of safety and effectiveness. These interactions take the form of Sender-Receiver games, in which Pharmaceutical companies seeking approval of a drug conduct the research themselves, and report the results to the regulators. Of course, the companies may be inclined to falsify these reports, despite the potential costs. The main aim of this work is to give a formal model for this kind of interaction and to identify the mechanism that is optimal for the regulatory body, and by proxy, the public, when the costs of information, lying, and the detection of lies are nontrivial.

In this model, the Sender incurs costs via noisy acquisition of information by sequential testing, falsification of reports of individual tests, and punitive measures upon detection of falsified reports. Further, the model has an epistemic facet, in which the Sender believes that the likelihood of being caught lying is increasing in the number of falsified reports.

The Receiver is cautious in the sense that she doesn’t rule out the possibility that falsification is a viable strategy for the Sender’s type, and she makes probabilistic inferences about the Sender’s type and strategy from the messages she receives. The ability of the Receiver to detect lies is limited by the costs of her verification procedure. We identify sequential equilibria of the game under multiple constraints on the payoffs, costs (testing, falsification, and verification), and type structures of the players. Additionally, we identify the report verification strategy that is optimal - if known to the Sender, the strategy minimizes the incentives to falsify reports.

Strategic Information Release on a Communication Network

Aidan Smith
University of Oxford

We analyse a game in which a sender chooses a point of release for information on a communication network. The information then travels through the network to receivers, acquiring noise. We show with quadratic loss preferences the sender wants to provide information to the most central receiver if preferences are sufficiently aligned, else they want to provide information to the least central receiver, on a centrality measure we define. In contrast we show with heterogeneous receiver preferences it may remain optimal for the sender to link to the most central receiver even when all receivers on the network are very misaligned with the sender. In a setting with two competing senders, we show that a sender whose preferences are misaligned with receivers may find it optimal to copy the link formation decision of the other sender, even if this implies linking to the most central receiver.

Cheap Talk with Multiple Experts and Uncertain Biases

Gülen Karakoç
University of Naples Federico II, Department of Economics and Statistics

A decision maker solicits information from two partially informed experts and makes a choice under uncertainty. The experts can be either moderately or extremely biased relative to the decision maker which is their own private information. I investigate the incentives of the experts to share their private information with the decision maker and analyze the resulting effects on the information transmission. Interestingly, I show that it may be optimal to consult a single expert rather than two experts if the decision maker is sufficiently concerned about taking advice from extremely biased experts. In contrast to what may be expected, this result suggests that getting a second opinion may not be always helpful for decision making.
Learning to agree over large state spaces
Michele Crescenzi
University of Helsinki

We study how a consensus emerges in a finite population of like-minded individuals who are asymmetrically informed about the realization of the true state of the world. Agents observe a private signal about the state and then start exchanging messages. Generalizing the classical model of rational dialogues of Geanakoplos and Polemarchakis (1982), we only require that the set of states be a non-empty set. In particular, we dispense with the standard assumption that the state space is either finite or a probability space. We show that a class of rational dialogues can be found that always lead to consensus provided that three main conditions are met. First, everybody must be able to send messages to everybody else, either directly or indirectly. Second, communication must be reciprocal. Finally, agents need to have the opportunity to participate in dialogues of transfinite length.

Two-sided Strategic Information Transmission
Saori Chiba and Kazumi Hori*
*Ritsumeikan University

We study a cheap talk model in which a decision maker and an expert are both privately informed. Both players observe independent signals that jointly determine ideal actions for the players. Furthermore, in our model, the decision maker can send a cheap talk message to the expert, which is followed by the expert’s cheap talk and then the decision maker’s decision making. We show that the informed decision maker’s talk cannot affect the quality of the expert’s information transmission in the decision maker’s preferred equilibria in models in which optimal actions are only additively or multiplicatively separable in the two players’ information, and their preferences are represented by quadratic loss functions. We also apply our finding to a decision maker’s information acquisition problem.
Stability in Weighted College Admissions Problems

Britta Hoyer* and Nadja Stroh-Maraun
Paderborn University

There are a number of matching or college admissions problems in which participants are heterogeneous according to the space they occupy at the institution they are allocated to. E.g. when matching kids to kindergartens, depending on their age there is a different staff-to-student ratio. To deal with this source of heterogeneity we propose a weighted college admissions problems by assigning each student a so-called weight. We show that the existence of stable matchings is not ensured anymore when these different weights are taken into account. To find a stable matching, if it exists, we propose a new algorithm, the deferred acceptance algorithm with waiting lists (DAWL). It results in stable matchings if existing and does not terminate otherwise. Moreover, we show how to restore stability by increasing or decreasing the colleges’ quotas by at most the highest weight.

Incentives in a Job Market Clearinghouse

Ryan Tierney
University of Southern Denmark

We characterize the set of pairwise strategy-proof and non-discriminatory rules for allocating heterogeneous objects or positions, and monetary transfers, when there is unit-demand. We name the resulting class Endogenous Null Min-Price rules. Unlike previous studies, we do not require full distribution of the objects or any restriction on the transfer associated with the null. We thus provide novel solutions to the one-to-one matching with transfers problem: Endogenous Null Min-Price rules allow firms to demand reservation profits, and allow for unemployed workers to receive subsidies. Moreover, these subsidies can increase in the number of agents allocated jobs (not all need be filled). The Endogenous Null Min-Price rules are a finite dimensional family of lattice-extremal rules. Each is given by a list of reserve prices, one for each real object, and possibly several for the null object. For each economy, the rule then selects a minimal price equilibrium allocation that respects these reserves, with the effective reserve of the null depending on the number of agents who get real objects. The family includes both min-price Walras and (for the one-object case) Sprumont’s (2013) maxmed family. We also extend some existing results, from one to multidimensional preferences, for the case when full-distribution of the objects is required. Here we provide a characterization of Min-price Walras in terms of strategy-proofness, no-discrimination, and respect of the outside option.

Decentralized Two-Period Matching

Sergei Balakin
The Ohio State University

We consider a two-period decentralized matching in a two-sided market of employers and employees (universities and students). Because of dynamics, potential employees often face a tough decision of whether to accept a underwhelming offer in the first period or to reject it hoping to be matched with a desirable employer in the second round. In a simple case of two agents from each side, we obtained necessary and sufficient conditions for different strategies to be in equilibrium. Also, the paradox called “threat of reject” is discovered: under some values of parameters, the higher number of options for employees may surprisingly lead to worse payoffs. This problem may be solved by signaling which turns a dynamic problem into a static one, makes the matching optimal, and increases total welfare.
Family Ties: School Assignment With Siblings

Umut Dur, Thayer Morrill and William Phan
North Carolina State University

We introduce a new school choice problem motivated by the following observations: students are assigned to grades within schools, many students have siblings who are applying as well, and many school districts require siblings to attend the same school. The latter disqualifies the standard approach of considering grades independently as doing so separates siblings. We argue that the central criterion in school choice elimination of justified envy is now inappropriate as it does not consider siblings. We propose a new solution concept that addresses the issues. Moreover, we introduce a strategy-proof mechanism that satisfies it. Using data from the Wake County magnet school assignment, we demonstrate the impact on families of our proposed mechanism versus the "naive" assignment wherein sibling constraints are not taken into account. Interestingly, the problem can be equivalently modeled within the many-to-many matching with contracts framework, and our results have novel implications in this literature. Despite the fact that neither families' nor schools' choice functions are substitutable (even bilaterally), we show that there always exists a stable assignment.

Efficiency in Weighted School Choice Problems

Nadja Stroh-Maraun
Paderborn University

There are a number of school choice problems in which students are heterogeneous according to the number of seats they occupy at the school they are assigned to. We propose a weighted school choice problem by assigning each student a so-called weight. Under this extension of the classical model several desirable properties of matchings cannot be guaranteed anymore. Nevertheless, we show that the top trading cycles algorithm works well under this extension and call the new mechanism the weighted TTC. We show that this mechanism is strategy-proof and results into a Pareto efficient matching.
Quitting games are a subclass of both stopping games and stochastic games. In these two classes of games, the existence of equilibrium is known only when few players are involved (three in the case of stopping games, two in the case of stochastic games) or under severe restrictions on the payoffs and/or transitions. In this talk, I will explain the difficulty in studying this problem, survey known results, and present techniques that are used to prove them.
Price and Treatment Strategic Decisions in Epidemics

Andrea Di Liddo
University of Foggia

An interesting issue in the study of epidemic models is the identification of therapeutic strategies that minimize the relevant negative features of the disease at a minimum cost. A social planner wishes to minimize the infected part of the population by the administration of a therapy to the highest possible number of patients. A specific problem is given by extremely expensive therapies in the presence of a very high number of patients to be healed. To treat all infected patients would mean sometimes spending all or a very large part of the national budget allocated to health. This is the case, for example, for the treatment of hepatitis C virus (HCV) by a costly drug, such as sofosbuvir. Such a choice is impractical or, in other words, should have a cost (in terms of utility) that is infinite. We consider a pharmaceutical company that sells a drug that is useful in the treatment of an infectious disease, determining its price. A public authority buys the drug to heal a portion of the infected population, choosing a suitable quantity. The authority has an overall budget for all health care costs in the country and can only allocate a (small) part of the budget to the purchase of the drug. Two different games are proposed and their solutions are discussed: a cooperative game in which the two players bargain for the price of the drug and a competitive game in which the seller announces a price strategy to the buyer and binds to it; the buyer reacts by choosing the quantity to be purchased. In the case of linear or quadratic costs, it may happen that the government has to spend the entire budget to purchase the drug. This drawback does not occur when the blow-up cost function is used.

On optimal extraction under asymmetric information over reclamation costs

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Exhaustible resource extraction ends with costly reclamation and the producers often have private information regarding the parameters of the extraction operation including for example extraction costs (Gaudet et al. 1995; Osmundsen 1995) and initial resource stock (Osmundsen 1998; Martimort et al. 2018). Currently a problematic feature of many extraction operations is that the monies intended for the reclamation of the site after shut-down are not sufficient to return the site into a productive alternative use. A plausible reason for the failure to cover the costs is that the regulator does not know the reclamation costs and is forced to ask the better informed producer for a cost report before giving a permit to commence extraction. The producer, who cares about its profits, has incentives to misreport. The regulatory design of a polluting exhaustible resources must take this asymmetric information into account. This paper applies principal-agent framework to a polluting resource extraction problem and analyzes the second-best optimal reclamation contract between the firm and the regulator, the optimal pollution tax and the shut-down date. The model has two stages: resource extraction is followed by costly reclamation. It is shown that the two-stage structure and timing of the model dictate a contract that extracts all the profit from the highest-cost type firm, but leaves profits for the more efficient types. The second-best reclamation effort is lower compared to the first-best for a given shut-down date pollution stock, and the deviation is greater for more expensive types. It is further shown, that asymmetric information regarding the costs also affects the optimal pollution tax and the shut-down date, but the tax and the date are nevertheless identical across different firm types. Optimal tax can be lower or higher than the tax under complete information.
When limited to heterosexual marriage, agents of different genders are not guaranteed to harvest the same payoff even conditional on having the same type, and even if all other factors, such as search costs or the distribution of partner types, are the same across genders. If same-sex marriage is legalized and there is a positive mass of agents who find marriage with both sexes acceptable, then only symmetric equilibria survive in symmetric environments.
Relationally equal treatment of equals and affine combinations of values for TU games

Yukihiko Funaki
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"We axiomatize the set of affine combinations between the Shapley value, the equal surplus division value, and the equal division value in cooperative games with transferable utilities. The set is characterized by efficiency, linearity, the balanced contributions property for equal contributors and outsiders, and the differential null player out property. The balanced contributions property for equal contributors and outsiders requires the balance of contributions between two players who contribute the same amount to the grand coalition and whose singleton coalitions earn the same worth. The differential null player out property requires that an elimination of a null player affects the other players identically. These two relational axioms are obtained by investigating Myerson’s (Int J Game Theory 9:169-182, 1980) balanced contributions property and Derks and Haller’s (Int Game Theory Rev 1:301-314, 1999) null player out property, respectively, from the perspective of a principle of Aristotle’s distributive justice, whereby "equals should be treated equally"."
Unanimous and strategy-proof probabilistic rules for single-peaked preference profiles on graphs

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Finitely many agents have single-peaked preferences on a finite set of alternatives structured by a connected graph. First, all unanimous and strategy-proof probabilistic rules are characterized when the graph is a tree. These rules are uniquely determined by the values they assign to preference profiles where all peaks are on leafs of the tree, and thus extend the known case of a line graph. Second, it is shown that every unanimous and strategy-proof rule is random dictatorial if and only if the graph has no leaf. Finally, the two results are combined to obtain a general characterization for every connected graph.

Informativity vs. Conformity: Opinion Sharing In Social Networks

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We study opinion formation processes on acyclic graphs. Individuals sequentially express their opinion, and care both about expressing their true opinion as well as about being similar to their graph neighbors. We define and analyze the informativity of the resulting game, which is the proportion of voters who express (in equilibrium) their true opinion. Our main interest is in understanding how the informativity depends on the voting order. We show that the natural “diffusion” order in which a node votes (only) after at least one of its neighbors votes has poor informativity when the number of leaves in the graph is large. We then show a slight but careful modification of this order that in many cases significantly improves informativity. A key technical building block in our analysis is the case of star graphs. This case turns out more complicated than one would initially expect, with some surprising results.

Union Formation in Network Spill-over Games

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In this paper we study a model of spill-over effects in a fixed network. Players choose effort levels and receive utility according to their own effort and the effort of the other players. There exists a global spill-over effect between all players and an additional local spill-over effect between neighbors. Moreover, neighbors suffer disutility when their efforts are different. We find the unique Nash equilibrium of the game and discuss policies to increase the total effort of all players. We find the positive keyplayer, i.e. the player that contributes most to the total effort. Additionally, we allow players to form unions where the members choose their efforts by maximizing the joint utility. We analyze how the union formation in the network affects the total effort in the population of players. We prove that unions always increase the total effort. Furthermore, we compare different partitions of players into unions and find the optimal partition. We study how the structure of these unions influences the total effort in the population.
Inheritance of convexity for some partition-restricted games

Alexandre Skoda
Université Paris 1

Given a finite set \( N \), we consider a correspondence \( P \) which associates to every subset \( A \subseteq N \) a partition \( P(A) \) of \( A \). Then, for every game \((N,v)\), the \( P \)-restricted game \((N,v_P)\) is defined by \( v_P(A) = \sum_{F \in P(A)} v(F) \), for all \( A \subseteq N \). A founding example is the correspondence \( PM \) associating to each subset of nodes of a graph its partition into connected components. Then, the PM-restricted game corresponds to Myerson’s restricted game. In the present work, we consider some different correspondences associated with weighted graphs and study the inheritance of convexity. We consider cooperative games associated with a weighted graph. For any coalition \( A \subseteq N \), we denote by \( P_{\min}(A) \) the partition of \( A \) obtained by the removal of all minimum weight edges in the subgraph induced by \( A \). In a previous paper, we obtained a characterization of graphs satisfying inheritance of convexity for the correspondence \( P_{\min} \). We also investigated inheritance of a relaxed-convexity notion obtained by restricting convexity to connected subsets. We established necessary and sufficient conditions on the edge-weights of paths, cycles and pans. In the present work, we consider at first the correspondence \( P^*_{\min} \), which is a slightly different version of the correspondence \( P_{\min} \), obtained by deleting the minimum weight edges in each connected component. The conditions established for \( P_{\min} \) are still necessary for \( P^*_{\min} \) but no longer sufficient. We have to reinforce the conditions on cycles and pans to get a characterization of inheritance of convexity for \( P^*_{\min} \). Finally, we consider a correspondence which partitions any coalition into blocks such that the ratio between the number of edges removed and the number of blocks created is minimized. This last correspondence coincides with \( P_{\min} \) when the underlying graph is cycle-free. For arbitrary graphs, we introduce some new necessary conditions.
Weighted representative democracy

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We propose a new system of democratic representation. Any voter can choose any legislator as her representative; thus, different legislators can represent different numbers of voters. Decisions in the legislature are made by weighted majority voting, where the weight of each legislator is determined both by the number of voters she represents, and the level of confidence each of these voters expresses in her judgment. We show that, if the size of the electorate is very large, then with very high probability, the decisions obtained in the legislature agree with those which would have been reached by a popular referendum decided by simple majority vote. Full paper is available at https://sites.google.com/site/marcuspivato/chronological-list/weighted_representative_democracy.pdf?attredirects=0&d=1

Multiple international unions

Gero Henseler
University of Hamburg

In many fields of politics, countries form international unions to coordinate their provision of local public goods. In this paper, we explore stability and efficiency of multiple international unions. Countries can form unions to coordinate their national politics, internalizing externalities but losing independence in contribution decisions. After unions are formed, countries vote on a common contribution level. Our model extends Alesina, Angeloni, and Etro (2005) where countries are restricted to form at most one international union, while the remaining countries do independent national politics. By allowing for multiple international unions, we can investigate how their formation is interrelated. We study individually stable cooperation structures (ISCS) and establish that there always exists an ISCS. We then show that a cooperation structure with multiple international unions is stable if preferences are sufficiently similar within and sufficiently different across unions. However, in general even countries with the same preferences may be part of different unions in an ISCS. Furthermore, welfare comparisons reveal that if both the grand coalition and several international unions are stable, then several international unions may yield higher welfare than the grand coalition.

Work Productivity and Income Redistribution in a Voting Experiment

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In the midst of the recent debt crisis, income inequality, income redistribution and tax compliance has been a hot issue in many parliaments of developed countries. In this paper, we analyze theoretically and experimentally which proportional tax scheme is selected by voters in an election when those voters differ on productivity (high skilled and low skilled workers). In particular, we provide a basic model of redistributive politics. We design a laboratory experiment to test the results of the model, i.e. the tax rate chosen by majority voting and the labor supply of each type of voter in equilibrium. We obtain that low-skilled workers vote for the low tax rate more frequently than the model predicts. On the other hand, and according to the model, high-skilled workers increase their production when the tax rate chosen by the majority is low. We compare our theoretical predictions with the experimental results and provide some extensions of the model to explain the divergence between theoretical and experimental results.

Successful Leadership and Political Compromise

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The model considered in this paper is introduced by Shenoy (On committee decision making : A game theoretical approach, Management Sci. 26 (1980), no4, 387–400). It comprises a human society endowed with a constitution and a collection of alternative policies. At any time, each member of the society might be become leader and promotes a different view on how the society should be run. The society aims at choosing one option from a set of policies, possibly after lengthy deliberations. The leader who introduces a proposal for adoption by means of vote before his peers does not cooperate in any effort to defeat his proposal. To be successful, the proposal should belong to the optimal compromise set (known as One-core). We construct a stability index with which we establish a necessary and sufficient condition for a compromise to be always attainable under any qualified majority rule, no matter the size of the society and individual preferences, provided that they are weak orderings. The result helps to identify credible leaders and best compromises. Besides, we show that political rules affect the will of a leader to negotiate a compromise. Indeed, rules that are close to unanimity lead to a dictatorial leadership.
Equilibrium and Conjectures in Dynamic Differentiated Duopoly Games

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Nihon University

This paper examines conjectures and equilibrium in dynamic differentiated duopoly games. We explore relationships between open-loop equilibrium and Markov perfect equilibrium in both a model of quantity adjustment and that of price adjustment. Dynamic conjectures are endogenously determined and identified at Markov perfect equilibrium for both the quantity adjustment and the price adjustment models. We show that open-loop equilibrium in the quantity adjustment model corresponds to static Cournot equilibrium when time goes to infinity and that open-loop equilibrium in a price adjustment model corresponds to static Bertrand equilibrium when time goes to infinity. We also show that Markov perfect equilibrium in the quantity adjustment model is more competitive than static Cournot equilibrium. The paper also examines equilibrium and dynamic conjectures in a dynamic setting in which products may obsolete. The models in the paper encompass the previous models in the literature on dynamic duopoly.

The route to chaos in congestion games. Population increase leads to chaos with Price of Anarchy equal to one.

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We study a simple learning dynamic model of congestion games to explore the effects of increasing the total demand on system performance. We focus on the most benign setting, non-atomic routing games with two parallel edges of linear cost, where all agents evolve using Multiplicative Weights Updates with a fixed learning rate. Previous game-theoretic analysis suggests that system performance is improved in the large population limit, as seen by the reduction in the Price of Anarchy. We show that Price of Anarchy reduction comes at the cost of destabilizing the system. With increasing the total demand the system eventually becomes chaotic, invalidating the Price of Anarchy predictions of near-optimal system performance.

Stochastic Stability of Mixed Equilibria

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We consider a setting similar to the well-studied model of adaptive play and conventions introduced in Young (1993). A finite game is recurrently played in a large population, with one distinct player population for each player role in the game. In each period, one individual is randomly drawn from each player population to play the game. These individuals independently sample previous action profiles from a finite history of past play, and either play a myopic best reply to the empirical distribution of the sample or, with a small positive probability instead play at random. This defines an ergodic Markov chain. Young (1998) shows that it spends almost all time in some collection of minimal CURB sets. However, this process does not easily lend itself to analysis of the behavior inside minimal CURB sets. Furthermore, in simulation, it exhibits large and regular cycles around mixed equilibria, even in simple games such as matching pennies. Arguably such cycles are not plausible predictions for real-life play. We here propose an alternative model in which the history of play is infinite and more recent interactions are more likely to be sampled. This results in a continuum-state Markov process that can be conveniently represented in terms of sampling probabilities. We replicate important results from Young (1993,1998), such as the existence of an invariant measure, and convergence to a collection of minimal CURB sets, and we obtain results for its behavior inside minimal CURB sets.
In this paper, we investigate the long-run outcomes of the reinforcement learning of Roth and Erev (1995) and Erev and Roth (1998) with foregone payoff information in normal form games. That is, players observe payoffs from not only chosen actions but also unchosen actions. This paper provides conditions under which the reinforcement learning process converges to a mixed action profile at which each action is chosen with a probability proportional to the expected payoff of the action. In particular, in symmetric 2x2 partnership games without a Pareto-dominant Nash equilibrium and matching-pennies games, the action profile corresponds to the mixed Nash equilibrium. However, the action profile does not correspond to a Nash equilibrium unless for each player, all the actions are chosen with equal probability at the equilibrium. Instead, we show that the mixed action profile corresponds to a regular quantal response equilibrium (Goeree et al., 2005) when there is no distortion on the foregone payoff information. Therefore, under these conditions, the reinforcement learning process almost surely converges to the equilibrium in normal form games.
Bi-Proportional Apportionments
Mirko Bezzi, Gianfranco Gambarelli and Giuliana Angela Zibetti

An apportionment method is proposed that generalizes Hamilton’s method for matrices, optimizing proportionality in both directions, both for rows and columns. The resulting matrix respects fixed totals for rows and columns even when such totals in the original matrix do not satisfy standard criteria (monotonicity, maximum or minimum Hare, Power Indices): for example, following the allocation of majority bonuses to parties or coalitions. The algorithm may easily be expressed for legislative norms.

Keywords: bi-proportional apportionment, electoral system, algorithm.

References:

New Characterizations of Single-Peaked and Single-Caved Preferences
Mostapha Diss and Muhammad Mahajne

We present new characterizations of the well-known single-peaked domain based on two main properties of preference profiles, called mirror-counter property and the last-counter property. The mirror-counter property states that for every subset of four alternatives there is a matching which assigns to every alternative another one, its 'mirror-counter', such that for each individual, the first alternative is placed by him in the top half of the alternatives if and only if its counter is placed by him in the last half of the alternatives. The last-counter property states that for every subset of four alternatives there is a matching which assigns to every alternative another one, its 'last-counter', such that it cannot be that both an alternative and its counter are placed last in some two preference relations in the same preference profile. We call the set of profiles satisfying the two properties with respect to some (same) matching as the mirror-last counter domain, and we prove first that this domain is exactly the single-peaked domain. We provide another version of this result based on other versions of these two properties. We present similar characterizations for the single-caved domain. These characterizations may shed some new light on the nature of the single-peaked preferences and the single-caved preferences.

Fair Division Procedures for Goods with Market Value
Marco Dall’aglio

We will discuss new fair division procedures specifically designed to propose an equitable distribution between parties involved in family law disputes (heredities and divorces), and to reach an out-of-court agreement among them. Typically, fair division procedures require agents to express their personal preference on the disputed assets. Those preferences can differ from the goods’ market values but cannot be totally disconnected from them. The algorithms that we propose express agents’ utilities as distortion of the market prices and return allocations that maximize the social welfare of the allocation, while maintaining equal or proportional market values of the proposed shares. Those algorithms are being applied in the context of the Conflict Resolution through Equititative Algorithms (CREA) project funded by the European Union’s Horizon 2020 research and innovation programme, aiming at introducing new mechanisms of dispute resolution in legal contexts. The proposed solutions also ignite new research questions on the optimality properties of the proposed solution. Disclaimer: This contribution has been produced with the financial support of the Justice Programme of the European Union. The contents of this contribution are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Commission.
A set of related majority rule-based social choice correspondences are considered: the union of minimal P-dominating sets D (Duggan 2011, Subochev 2017) the union of weakly stable sets WS (Aleskerov & Kurbanov 1999), the union of minimal P-externally stable sets PES (Wufl et al. 1989, Subochev 2008) and the union of minimal R-externally stable sets RES (Aleskerov & Subochev 2009, 2013). It has been found that PES and RES both satisfy the following axioms: monotonicity with respect to changes in social preferences (P-monotonicity), the generalized Nash independence of irrelevant alternatives, the independence of social preferences for irrelevant alternatives (the independence of losers), but they do not satisfy the extension axiom (Sen’s property gamma). It has also been demonstrated that D satisfies neither of these axioms, and WS satisfies P-monotonicity only. It has been also found that PES and RES both satisfy the Sanver monotonicity (Özkal-Sanver & Sanver, 2010). Thus, despite they are not Maskin monotonic, these social choice correspondences can be implemented in a nonstandard setting, where actors have (extended) preferences for sets of alternatives. It has also been demonstrated that D and WS do not satisfy the Sanver monotonicity and consequently are not implementable.
Fairness and efficiency for probabilistic allocations with endowments

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We propose to use endowments as a policy instrument in market design. Endowments give agents the right to enjoy certain resources. For example in school choice, one can ensure that low-income families have a shot at high-quality schools by endowing them with a chance of admission. Common policy objectives, such as walk-zone or sibling placement can be achieved through endowments (arguably more transparently than via priorities).

We introduce two new criteria in resource allocation problems with endowments. The first adapts the notion of justified envy to a model with endowments, while the second is based on market equilibrium. Using either criteria, we show that fairness (understood as the absence of justified envy) can be obtained together with efficiency and individual rationality.
Do Arabian babblers play mixed strategies in a "volunteer's dilemma"?

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The Arabian babbler is a cooperatively-breeding songbird, researched for more than 45 years in Shezaf nature reserve, southern Israel. Arabian babblers live in groups of 2-20 individuals with complex social structure and interactions. In particular, when group members forage on the ground, often one group member sentinel on a high branch and utters characteristic alarm calls when it spots a raptor. Upon hearing these alarm calls, the foragers typically either run to shelter or join the sentinel on tall branches in crying out alarm calls, presumably in order to dissuade the raptor from attacking. Archetti (“The volunteer’s dilemma and the optimal size of a social group,” Journal of Theoretical Biology 2009) suggested that following the sentinel alarm call, foragers may be engaging in a "volunteer’s dilemma" game, in which if a large enough fraction of the group manifests to the raptor that it has been revealed, the raptor will forego the attack. The symmetric Nash equilibrium of this game is in mixed strategies, where foragers join the sentinel in calling with a positive probability smaller than 1, independently across foragers. We set out to test this independence assumption in two datasets on groups of 5-6 individuals – one documenting foragers’ reactions in natural events in which a sentinel uttered alarm calls towards a raptor, and the other documenting foragers’ reactions in a playback experiment in which recordings of sentinel alarm calls were sounded to the group. To test for independence we employed a resampling method, adapted to the fact that the subgroup of foragers is different across events. The null hypothesis of independent behavior was rejected in the dataset of natural observations, and not rejected in the dataset from the experiment.

Static stability in games
Igal Milchtaich
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Static stability in games differs from dynamic stability in only considering the players’ incentives to change their strategies. It does not rely on any assumptions about the players’ reactions to these incentives, so it is not necessarily linked with any particular dynamics. This paper introduces a general notion of static stability of strategy profiles, which is applicable to any asymmetric N-player game, and static stability of strategies, which is applicable to any symmetric game and population game. It examines several important, large classes of games, with strategy spaces or payoff functions that have special structures (such as unidimensional strategy spaces or multilinear payoff functions), where this general notion takes a simple, concrete form. In particular, evolutionarily stable strategy (ESS) and continuously stable strategy (CSS) are shown to be essentially special cases of the general static stability concept for symmetric games. As an application, the paper identifies a connection between static stability and comparative statics of altruism. In general, increasing internalization by all players of the aggregate payoff or some other kind of social payoff may paradoxically result in a decrease of that payoff. But this is never so if static stability holds for the equilibria involved.

Heterogeneity in Cognition and Equilibrium Switching in Coordination Games
Jianxun Lyu
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We investigate how a population could switch from an inefficient social norm to an efficient one in a two-strategy coordination context. Experimental studies (e.g., Smerdon et al. (2016), Andreoni et al. (2017), Duffy and Lalky (2018)) find that the disclosure of information about preference distributions and low conformity pressure are crucial for the occurrence of transitions. However, it is unclear why these factors could facilitate such transitions since both social norms are strict Nash equilibria. In this paper, we proposed a dynamic forward-looking level-k model, which generalizes ideas of strategic teaching and level-k/cognitive hierarchy model. We identified a set of distributions of cognitive types under which more sophisticated players can manipulate the plays of less sophisticated ones, thereby lead the population to a step-wise transition from the payoff-dominated equilibrium to the payoff-dominant one. In addition, we found that when there are two parties and neither of them constitutes the majority, an alternation equilibrium, where the population continuously switch between two pure Nash equilibria, could emerge if both parties consist of enough sophisticated players. Finally, we investigate equilibrium switching in the local information environment where players can only observe histories of play of their matched opponents. We found that a single sophisticated player can switch the equilibrium within a finite span if and only if the number of players in stage games does not exceed three, and the length of players’ memory of plays is bounded above. Our theoretical predictions coincide with several seemingly contradictive experimental results, hence provide a unified explanation for the equilibrium switchings in coordination games.
Sequential games with distributions as strategies

Steve Alpern and John Howard

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If a two-player sports contest is played over a number of rounds, there has to be some rule for determining the overall winner. If in each round the players achieve a "score" sampled from a given set of distributions, two simple rules would be either to choose the player with the highest maximum score, or else to take the player with the highest total score. Also, in each round the players might play sequentially or simultaneously. We look at two examples which illustrate the possibilities. In our version of weight-lifting (or high-jumping), the players alternately nominate a weight to attempt, and the score is the weight successfully lifted (or zero). The winner is the sportsman having the maximum score at the end. In our version of a cycling race, during each stage the two cyclists attempt the same course at different times, and neither knows the other's time until she finishes. The winner has the lowest total time over all the stages. We look at games with two rounds, and solve the first problem for equally matched sportsmen. We also report progress with the second problem, but more work remains to be done.
A General Derivation of Axiomatizations for Allocation Rules: Duality and Anti-Duality Approach

Takayuki Oishi
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Recently, Oishi et al. (2016, J. Math. Econ) proposed a general approach for axiomatizations of solutions in TU games, referred to as the "(anti-)duality approach." The (anti-)duality approach allows us to relate some existing axiomatizations of solutions in TU games, and find new ones. We develop the (anti-)duality approach in TU games toward axiomatic analysis of allocation rules for economic problems. Given a rule on a domain of allocation problems, its (anti-)dual can be defined. A rule is self-(anti-) dual if it is own (anti-)dual. Given an axiom, its (anti-)dual can be defined: Two axioms are (anti-)dual to each other if whenever a rule satisfies one of them, its (anti-)dual satisfies the other. First, we verify that an axiom for the (anti-)dual of a rule can be derived from taking the (anti-)dual of an axiom for the original rule. We also verify that the (anti-)dual of a rule can be axiomatized by taking the (anti-)dual of the axioms involved in an axiomatization of the original rule. Next, we apply the notion of (anti-)duality approach to "airport problems" and "bidding ring problems" in a single-object English auction. As an illustration, we derive a new axiomatization of the Shapley value for bidding ring problems from using the notion of duality and axioms involved in axiomatizations of the Shapley value for airport problems. As another illustration, we derive a new axiomatization of the nucleolus for bidding ring problems from using the notion of anti-duality and axioms involved in axiomatizations of the nucleolus for airport problems.

The risk-based core for cooperative games with uncertainty

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In coalitional games with uncertain payoffs, a deviating coalition can only form expectations regarding its post-deviation payoff. Classical approaches address the problem from the side of conservatism, expecting the worst, or by explicit assumptions of the emerging state of the world. We borrow the idea of risk from the finance literature and compare the payoff of staying with the original outcome with the risk of deviating. Employing this idea to the core leads to a new concept that we call the risk-based core. We introduce this concept and discuss its properties. We find an inclusion relation between cores of games with increasingly conservative players. The model is also suitable to study cooperative games in partition function form where the value of a coalition depends on the entire partition. For the cores of such games our main result yields many of the familiar inclusion relations as corollaries, while the inclusion of the optimistic core in the optimistic recursive core turns out to be non-robust.

A Unique Core allocation and Competitive Equilibrium in General Coalition Formation Games

Satoshi Nakada* and Ryo Shirakawa
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This paper considers a unique core allocation in general coalition formation games, which subsume many novel applications such as marriage problems, roommate problems, housing market problems and hedonic games. First, we show that the set of core allocation coincides with the set of fixed points of a certain mapping regardless of feasibility constraints about allocations. This set is sometimes empty, but under certain condition, it can be nonempty and singleton. We provide that a sufficient condition, iterative top coalition property, to ensure the existence of the unique core allocation, which generalizes and unifies some existing sufficient conditions in the literature. Second, we define a notion of competitive equilibrium and investigate the relationship with the core allocation. We show that, under certain feasibility constraints about allocations, a competitive equilibrium exists if and only if it coincides with the feasible allocation induced by a modified TTC algorithm. Moreover, if it exists, the core allocation is unique and it can be obtained via a fixed-point algorithm based on the monotone mapping.
Do coalitions matter in designing institutions?

Michele Lombardi*, Ville Korpela and Hannu Vartiainen
*University of Glasgow

In this paper, we re-examine the classical questions of implementation theory under complete information in a setting where coalitions are the fundamental behavioral units and the outcomes of their interactions are predicted by applying the solution concept of the core. The planner’s exercise consists of designing a code of rights, which specifies the collection of coalitions that have the right to block one outcome by moving to another. A code of individual rights is a code of rights in which only unit coalitions may have blocking powers. We provide necessary and sufficient conditions for implementation (under core equilibria) by codes of rights as well as by codes of individual rights. We show that these two modes of implementation are not equivalent. This result is proven robust and extends to alternative notions of core, such as that of an externally stable core. Therefore, coalitions are shown to bring value added to institutional design. The characterization results address the limitations that restrict the relevance of existing implementation theory.
Imagine yourself driving a car, stuck in traffic on your way out of the city for a weekend holiday outdoors. Just ahead of you someone is trying to join the traffic from a side road. Will you stop and let them in or push on, hoping that someone else will let them in behind you? Will you do the same if the other is a driverless car? We will soon have to switch from being mere users of machines (think, for instance, of Google Translate) to being their co-players in strategic social settings with artificial agents increasingly endowed with their own autonomous decision-making capacities. The impact of this on people’s choice behaviour and the desirability of outcomes of human-AI interactions is yet unknown. We investigate whether and how patterns of cooperation and coordination between humans and AI systems will emerge in our day-to-day interactions with one another. Using the methods of behavioural game theory, we are conducting a series of pilot studies to see whether people are as likely to trust, take risks, and cooperate with AI systems as they do with other humans. We focus on four well-known games: Prisoner’s Dilemma, Stag Hunt, Chicken, and Trust. Initial results suggest that people are less likely to cooperate with AI than with humans and that this is mostly due to being “less nice” towards expected cooperation by AI than by a human. To gain a deeper insight into behavioural differences that we find, we are collecting data on a number of parameters: participants’ choices, response times, predictions of co-players’ choices, confidence in these predictions, and emotional responses to resulting outcomes. Our studies will be concluded over the course of the coming few months, in time for a discussion of the full set of results at the conference in July.

A School Choice Experiment: Cognitive Ability and Information

Naoki Watanabe*, Tetsuya Kawamura and Kazuhito Ogawa

Keio University

We study how cognitive ability subjects innately have and information they are given affect their behavior and the allocative efficiency under the Boston mechanism (Bos) and the deferred acceptance mechanism (DA) in a school choice experiment with district schools. Cognitive ability of subjects was measured by scores of the Raven APM test. Main observations are as follows. (1) A dominant strategy (truth-telling) chosen by students in the low score group under DA is sensitive to both unclear provision of information on schools’ priority orders for students and incomplete information on the other students’ preferences over schools, while a dominant strategy (choosing district schools at the top choice) under Bos is not sensitive to those factors in subjects in the high score group. (2) For the high score group, the normalized efficiency rates under DA were significantly higher than those rates under Bos in the case of (complete but) unclear information, while for the low score group those rates under DA is significantly higher in both cases of (complete and) clear and (complete but) unclear information. (3) In the case of complete but unclear information, the normalized efficiency rates under both Bos and DA for the high score group were significantly higher than those rates for the low score group. We also consider what allocations were observed as the equilibria of the games corresponding to Bos and DA.

Revealed fairness

Yasushi Agatsuma

Tokyo Metropolitan University

We investigate testable implications of fair allocations via the revealed preference approach. For an observed data which consists of finitely many allocations for a given group of agents, we seek what conditions must be satisfied by the data in order to rationalise that the data is consistent with fair allocations. Specifically, we focus on two fairness criterion on allocations, the envy-freeness and the equal division lower boundness (EDLB). The rationalisability of an allocation data is characterised in terms of the solvability of a system of linear inequalities, which is easily executed. We conduct experiments of slightly modified version of the ultimatum game and the dictator game to generate allocation data to which our results can be applied, and report how extent the subjects’ giving behaviour, which is frequently observed in the lab experiments of the ultimatum game and the dictator game, can be captured as they select fair allocations.
Rational Altruism? On Preference Estimation and Dictator Game Experiments

Philip Grech* and Heinrich Nax
*ETH Zurich

Experimental implementations of dictator games are found to differ in terms of their underlying strategic incentives. We explore this discovery in two separate directions. Theoretically, assuming identical other-regarding preferences, we show that the two most widely used protocols can generate strongly contrasting rational-choice predictions, from which different interpretations of dictator giving arise. Experimentally, a tailor-made experiment moreover reveals significant differences between the two protocols but rejects full-rationality as a satisfactory explanatory theory. Our findings indicate that several previously drawn conclusions regarding other-regarding preferences among humans distinguished by social class, gender, generation, nationality, etc. may be more ambiguous than hitherto believed.
Judgement Aggregation and Rational Inattention

Atahan Afsar
Stockholm School of Economics

Condorcet (1785) posits that majority rule is asymptotically efficient if all individuals agree on state-dependent actions, and they all exogenously receive conditionally independent informative signal about the true state, and if each individual votes according to her private information (votes informatively). However, Austen-Smith and Banks (1996) showed that informative voting does not always constitute a Nash equilibrium under the same assumptions about the information structure. This paper investigates judgement aggregation under majority rule for committees consisting of rationally inattentive agents. We first analyze a setting with a two-state world and ex-ante identical agents, and we focus on symmetric Nash equilibria. Our preliminary results show that while the agents, in line with Down’s rational ignorance, acquire less information in larger committees, the aggregate information also decreases with the committee size. For uniform priors and equal cost of mistakes of type-I and type-II, the aggregate information converges to a level above one half. Yet in asymmetric settings there exists no informative symmetric equilibrium for large enough committees under the majority rule. Moreover, for sufficiently large committees there exists an equilibrium where no one acquires information and everyone votes according to their common prior. We also investigate the effect of heterogeneous information acquisition costs, transparency as in certain central banks where individual votes are revealed ex-post, and moral motivation behind the information acquisition and subsequent voting behavior.

Gamson’s Law in Dynamic Legislative Bargaining

Duozhe Li* and Quan Wen
*Chinese University of Hong Kong

Gamson (1961) argues that in coalition formation games, each party’s payoff share in the majority coalition should be proportional to its contribution to that coalition. In the context of legislative bargaining, a winning coalition is usually formed via majority voting and the policy supported by this winning coalition is then enforced. Therefore, a party in the winning coalition obtains its payoff from the enforced policy, while its contribution to this coalition is measured by the number of effective votes under its control. We study a tractable model of dynamic legislative bargaining. Our primary goal is to develop a dynamic version of Gamson’s Law and provide a game theoretic foundation for it. In a baseline model, we consider the dynamic majoritarian bargaining among three legislators on a renewable surplus of fixed size. We characterize a stationary Markov equilibrium with three absorbing states. In each absorbing state, two parties form a minimal winning coalition and they share the entire surplus equally. The equilibrium outcome is clearly consistent with Gamson’s Law. Then we extend the model to allow for general distribution of votes among multiple political parties. This general formulation allows us to examine the comparative static predictions of Gamson’s Law in dynamic settings. For robustness, we further consider the bargaining environment with noise, that is, the status quo policy may be exogenously shifted at any time with a small probability, leading to the formation of a new winning coalition. We also consider a dynamic bargaining process with endogenously determined proposers.

Analysis of the composition of the Spanish Congress of Deputies

Julio Rodrigo Fernández García, Inés Magdalena Gallego Sánchez* and Andrés Jiménez Losada
*University of Seville

The main objective of this work is to study, from a Game Theory perspective, the composition of the Spanish Congress of Deputies, taking into account the provisions of Article 68 in the Spanish Constitution of 1978. Power indices will be used and possible distributions of Deputies among the circumscriptions will be analyzed, modifying the maximum composition of the Congress of Deputies and considering different initial minima for the number of deputies of the provinces. Finally, two proposals are made to modify the composition of the Congress of Deputies, considering in both cases the rule of the cubic root of the de jure population.
We extend the Baron-Ferejohn model of legislative or multilateral bargaining by allowing the players to attempt tying their hands, as in the bilateral models of Ellingsen and Miettinen (2008, 2014), to pre-commit not to accept any share of the pie below one’s commitment. We compare the unanimity rule against any majority rule and find, first, that inefficiencies and delay are present only under the unanimity rule but not under any supermajority rule. There are potentially many symmetric stationary Markov equilibria that are inefficient under unanimity rule. These can be ordered from the least to the most aggressive according to how large a share of the pie the individual commitment demands, or how many uncommitted players are needed for an agreement to arise. With more aggressive commitments, the delay is longer and a greater number of uncommitted players are required. As the number of negotiating players is exogenously increased, the equilibrium with the most aggressive commitment always exists. Yet, for symmetric commitment profile, which requires a given number of uncommitted players before the deal is struck, this commitment profile does not constitute an equilibrium if the number of players in the game is sufficiently large. The delay and inefficiency at the most aggressive equilibrium profile increase as the number of players increases. Thus, the loss of surplus increases under the unanimity rule as the number of negotiating parties increases. This suggests that unanimity rule is particularly damaging if the number of legislators is large.
Multimarket Contact under Imperfect Observability and Impatience
Tadashi Sekiguchi
Kyoto University

We study a model of infinitely repeated games where two or more identical prisoners’ dilemmas with imperfect public monitoring, whose monitoring structures are mutually independent, are simultaneously played every period. Our central question is whether the most cooperative public strategy equilibrium per-game payoff is greater than that of an individual repeated game. This question translates into a debate in industrial organization as to whether multimarket contact facilitates collusion. While existing results are concerned with limit results on either the number of markets or patience, we allow any number of games and any level of discounting. We show that adding one more game never reduces the most cooperative equilibrium per-game payoff. Further, except the case where the players cannot cooperate at all in any equilibrium, adding one more game almost always increases the most cooperative equilibrium per-game payoff, and adding two or more games always increases it. Finally, we ask to what extent an added game can have an impact on the most cooperative equilibrium payoff and show the following “critical mass result.” Namely, for any given number of games m, there exist a stage game and a discount factor such that (i) if the number of games is m or less, the only equilibrium is repeated play of the static equilibrium, and (ii) if the number of games is m+1, this forms a critical mass and the most cooperative equilibrium payoff is arbitrarily close to the payoff of full cooperation in all games. This result is a caution to antitrust authorities.

Cooperation Between Emotional Players
Lina Andersson
University of Gothenburg

This paper uses the framework of stochastic games to propose a model of emotions in repeated interactions. An emotional player, who transitions between different states of mind as a response to observed actions taken by the other player, can be in either a friendly, a neutral, or a hostile state of mind. The state of mind determines the player’s psychological payoff that together with a material payoff constitutes his utility. In the friendly (hostile) state of mind the player has a positive (negative) concern for the other player’s material payoffs. Emotions can both facilitate and obstruct cooperation in the repeated prisoners’ dilemma game. If finitely repeated, then a traditional player (who cares only for own material payoffs) can have an incentive to manipulate an emotional player into a friendly state of mind for future gains. If infinitely repeated, then two emotional players may require less patience to sustain cooperation. However, emotions can also obstruct cooperation if the players are either unwilling to punish each other, or become revengeful when punished.

Nash Equilibria in One-Memory Strategies
Artem Baklanov
Higher School of Economics SPB

We study the Nash equilibrium in infinitely repeated 2x2 games where limit-of-means payoffs are determined by reactive or by 1-memory strategies. Reactive strategies are stochastic 1-memory strategies such that a probability of players’ actions depends only on the opponent’s preceding move. We provide a characterization of all Nash equilibria in the class of reactive strategies and suggest a very intuitive geometric interpretation of them. We then derive a characterization for all symmetric stage games admitting Nash equilibria in the class of reactive strategies. We show that all (1-memory) strong mixed equilibria in a discounted game are generated by equalizer zero-determinant strategies. This allows us to compare our results with existing results for 1-memory strategies. Namely, we show that payoff relevant indeterminacy holds true and there is no folk theorem. Then we obtain a probability for an arbitrary symmetric game to have a Nash equilibrium in the class of reactive strategies. In contrast to existing results for 1-memory strategies, we demonstrate that the reverse dominance condition does not influence the existence of Nash equilibria.
We consider a price competition model in which a few large firms acting as a cartel, share the market with a fringe of many small suppliers in an infinite-horizon setting. In each period the cartel sets the price and small firms, incumbents or future entrants, observe it and decide if stay or out of the market. We study the sustainability of collusive agreements for large firms using trigger strategies. The main result is that, under certain conditions, a punishment price less aggressive than Bertrand price makes the agreement more sustainable, in the sense of it can be sustained by a smaller discount factor. The economic intuition behind this result is that, if a member of the cartel deviates from the collusive agreement, it can get profit from the others member of the cartel and also from the competitive fringe which decide to leave the market anticipating the even lower price in the future.
Author Index

Życzkowski
Karol, 32

Østerdal
Lars Peter, 39

Adamou
Alexander, 22

Afsar
Atahan, 66

Agatsuma
Yasushi, 64

Algaba
Encarnación, 9

Alpern
Steve, 61

Andersson
Lina, 68

Anwander
Johannes, 40

Aradhye
Aditya, 39

Arieli
Itai, 22

Ashkenazi-Golan
Galit, 17

Atay
Ata, 40

Aurell
Alexander, 55

Béal
Sylvain, 9

Bahrami
Bahador, 64

Baklanov
Artem, 68

Balakin
Sergei, 46

Basallote
Manuela, 51

Bednay
Dezső, 33

Benedek
Marton, 30

Bergantilhos
Gustavo, 35

Berman
Yonatan, 22

Bertini
Cesario, 46

Bezzi
Mirko, 57

Bich

Philippe, 20

Blasco
Joan, 9

Boratyn
Daria, 19

Borm
Peter, 5

Braham
Matthew, 15

Breinhjerg
Jesper, 39

Calleja
Pedro, 44

Canales
Andrea, 69

Caraballo
Mª Angeles, 12

Casajus
André, 31

Catalão-Lopes
Margarida, 28

Chessa
Michela, 18

Chiba
Saori, 15

Ciardiello
Francesco, 4

Crescenzi
Michele, 45

Csóka
Péter, 16

Dall’aglio
Marco, 57

Deroy
Ophelia, 64

Devhchoudhury
Kangkan, 14

Dietzenbacher
Bas, 5 8 11

Dinettan
Lee, 65

Ding
Huihui, 19

Diss
Mostapha, 15 18 57

Dur
Umut, 37

Echenique
Federico, 59

Eisenstadt
Erella, 42
Elise Flore
Tchouante Ngamo, 14
Estévez-Fernández
Arantzta, 16
Estañ
Mª Teresa, 16
Teresa, 39
Falniowski
Fryderyk, 56
Favory
Thomas, 23
Fernández García
Julio Rodríguez, 66
Fiestras-Janeiro
M. Gloria, 58
Fiocco
Raffaele, 26
Fiorini
Luciana, 23
Flesch
János, 17, 30
Fliege
Joerg, 40
Foley
Angèle M., 14
Foschi
Matteo, 26
Fragnelli
Vito, 18
Freixas
Josep, 9, 10
Funai
Naoki, 56
Funaki
Yukihiko, 51
Gallardo Morilla
José Manuel, 54
Gallego Sánchez
Inés Magdalena, 66
Gambarelli
Gianfranco, 57
García-Martínez
José A., 2
Garcés
Pedro, 25
Gerchak
Yigal, 20
Germano
Fabrizio, 2
Gilles
Robert, 45
Giménez-Gómez
José-Manuel, 19
Gladysz
Barbara, 5
Godenhelme
Mats, 26
Grégoire
Jean-Charles, 14
Grech
Philip, 65
Gromova
Ekaterina, 6
Guillén
Pablo, 34
Guo
Dongyu, 25
Gladysz
Barbara, 31
Hämäläinen
Saara, 22
Haake
Claus-Jochen, 20
Hanato
Shunsuke, 20
Hauser
Daniel, 30
Heifetz
Aviad, 60
Heller
Ruth, 60
Hellman
Ziv, 29
Henseler
Gero, 54
Herings
P. Jean-Jacques, 11, 16
Hernández-Mancera
Carmen, 51
Hezarkhani
Behzad, 98
Hillas
John, 6
Hoerl
Roger, 10
Hori
Kazumi, 45
Howard
John, 61
Hoyer
Britta, 46
Huetter
Frank, 54
Ianovski
Egor, 15
Izabella
Stach, 5
Jiménez-Jiménez
Natalia, 54
Jiménez-Losada
Andrés, 51
Jorge
Silvia Ferreira, 25
Jouchaghani
Nima, 24
Kóczy
László Á., 62
Kalinin
Nikita, 12
Kamwa
Eric, 32
Kang
Liying, 5
Karakoç
Gülen, 14
Karos
<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominik</td>
<td>1</td>
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<tr>
<td>Karpus</td>
<td>64</td>
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<td>Karreskog</td>
<td>65</td>
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<tr>
<td>Kawamura</td>
<td>64</td>
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<tr>
<td>Kawasaki</td>
<td>64</td>
<td></td>
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<td>35</td>
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<td>Khmelnitskaya Anna</td>
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<td>Kilgour D. Marc</td>
<td>14</td>
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<tr>
<td>Kirsch Werner</td>
<td>32</td>
<td></td>
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<tr>
<td>Kiyotaki Fumi</td>
<td>21</td>
<td></td>
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<tr>
<td>Kobayashi Shinjii</td>
<td>55</td>
<td></td>
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<td>Kondratzev Aleksei</td>
<td>10</td>
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<tr>
<td>Korpela Ville</td>
<td>63</td>
<td></td>
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<tr>
<td>Kovac Eugen</td>
<td>29</td>
<td></td>
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<td>Kozlovskaya Maria</td>
<td>26</td>
<td></td>
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<tr>
<td>Krämer Daniel</td>
<td>29</td>
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<td>Krüger Adrian</td>
<td>64</td>
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<td>Kramm Michael</td>
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<td>24</td>
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<td>Kurz Sascha</td>
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<td>Kuzyutin Denis</td>
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<tr>
<td>Kvasov Dmitriy</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Lappi Pauli</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Lavi</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Leppälä Samuli</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Levy Yehuda</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Li Duoaze</td>
<td>66</td>
<td></td>
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<tr>
<td>Liddo Andrea Di</td>
<td>19</td>
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<tr>
<td>Llerena</td>
<td>8</td>
<td>41</td>
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<tr>
<td>Llorca Natividad</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Lombardi Michele</td>
<td>63</td>
<td></td>
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<tr>
<td>Losada Andrés Jiménez</td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td>Lyu Jianxun</td>
<td>60</td>
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<tr>
<td>Mágó Manuel László</td>
<td>10</td>
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<tr>
<td>Mármol Amparo</td>
<td>43</td>
<td></td>
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<tr>
<td>Losada Andrés Jiménez</td>
<td>61</td>
<td>60</td>
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<tr>
<td>Mathieu</td>
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<td>Martinez Ricardo</td>
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<td>Martin Mathieu</td>
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<tr>
<td>Martinez Ricardo</td>
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<td>Matsuse Tomohiro</td>
<td>89</td>
<td></td>
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<td>Mavroyiannis Diomides</td>
<td>22</td>
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<tr>
<td>Mayer Alexander</td>
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<td>9</td>
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<td>Mayor-Serra Antonio J</td>
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<td>Meca Ana</td>
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<td>Mercik Jacek</td>
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<td>Merlin Vincent</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Messallí Roberta</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Miettinen Topi</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Milchtaich Igal</td>
<td>60</td>
<td></td>
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<tr>
<td>Minchuk Yizhaq</td>
<td>13</td>
<td></td>
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<tr>
<td>Miquel Silvia</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Miyakawa Toshiji</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Molinero Xavier</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Molis Elena</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Momo Kenfack Joseph</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Monroy Luisa</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Moreno-Ternero Juan D</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Morrill Thayer</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Moshaiov</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Amiram
Mosquera Rodríguez
Manuel A.,
Murto
Pauli,
Núñez
Marina,
Nakada
Satoshi,
Nanumyan
Mariam,
Napel
Stefan,
Naumova
Natalia,
Navarro-Ramos
Adriana,
Nax
Heinrich,
Nesterov
Alexander,
Nguyen
Tri-Dung,
Nuñez
Marina,
Nunez
Marina,
Nurmi
Hannu,
Obadi
Saadia El,
Ogawa
Kazuhito,
Oishi
Takayuki,
Orlova
Olena,
Ostreiher
Roni,
Pérez-Castrillo
David,
Papadopoulos
Konstantinos,
Parakhonyak
Alexei,
Peters
Hans,
Petrikaitė
Vaiva,
Petrosian
Ovanes,
Petrosyan
Leon,
Phan
William,
Pinter
Miklos,
Pires
Cesaltina Pacheco,
Pivato
Marcus,
Platz
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- Cooperative games and their applications;
- Mechanism design;
- Networks;
- Dynamic games;
- Evolutionary games;
- Stochastic games;
- Voting and power indices;
- Auctions;
- Bargaining;
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