From Nego to Invite

20 years of developing software to support negotiators

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First experiments

• Man-machine interactive approach
  • Moskowitz, Wallenius, Korhonen & Zionts (1981)
  • Multi-criteria discrete optimization
  • Bilateral, intra- and inter-group negotiations
  • Experiments in the US and Finland
  • Comparison of supported and unsupported groups
    • No significant difference in the ease of understanding, and ease of use
    • Significant difference (at 1%) in the usefulness of the information and quality of the approach
    • Unsupported groups ended in a deadlock more often than supported groups
Nego

- Developed to train members of the Polish Solidarity union.
- Multilateral negotiations (7 parties).
- Used in training 1981-87, (Kersten, 1985).
- Linear optimization problems; goal programming
- Interactive; graphical user interface

First application

- MIT deep ocean mining model
- RAINS
  - Construction and analysis of transboundary air pollution scenarios; used to develop strategies for the reduction of emissions of various pollutants in Europe (Hordijk, 1991).
1990s …

- Linear and discrete optimization
  - SmartSettle
- Multiattribute utility
  - Negotiators Assistant, Inspire, Virtual property agency
- Logic-based and argumentation support
  - Negoplan, Negoisst
- Communication
  - Email, WebNS, SimpleNS
- Negotiation software agents
  - Kasbah, Tête-à-Tête, eAgora,
- On-line auctions

E-negotiation

- Process that involves people and an ENS.

- A *socio-technical system*
  - comprising people and technological solutions - both actively
    involved in the processes-rather than a social system that is
    facilitated with technology (Ropohl, 1999).
  - People, practices, technologies and values interact in a given
    setting (Nardi, 1999).

- How are values and practices embedded in ENSs and
  how do ENSs interact with people?
E-negotiation foundations

• Negotiation process models
  • Two-phase model (Ghee-Soon Lim, 1994); three (Holmes, 1992); eight-phase model (Gulliver, 1979).
  • Media reference model; four phases of user-system interactions: knowledge, intention, agreement and settlement (Schmid, 1999)
• London and Montreal taxonomies
  • First comprehensive taxonomy providing foundation for e-negotiation processes (Ströbel and Weinhardt, 2003).
  • Based on the media reference model (Schmid, 1999); focus on intention and agreement.
• Software platforms
  • Complementary auction mechanisms communication modes
  • Real-time customization
  • SilkRoad (Ströbel, 2001); GNP (Benyoucef, 2001)

E-negotiation foundations

• Phase model
  • Six-phase model
• Taxonomy
  • Extended Montreal taxonomy
• Ontology
  • Taxonomy ↔ ontology
• Protocols
Negotiation phase model

- Six phases; five based on Gulliver’s model and the post-negotiation activities phase

Extended Montreal Taxonomy

- From two phases to six phases
- Aggregate constructs, atomic constructs and values

Phases and top-level constructs
Negotiation constructs

Negotiation:

<table>
<thead>
<tr>
<th>Construct</th>
<th>Value or second-level construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict</td>
<td>Interests, power, values, mixed</td>
</tr>
<tr>
<td>Type</td>
<td>Bilateral, multi-bilateral, multilateral, mediation, arbitration, mixed</td>
</tr>
<tr>
<td>Admission</td>
<td>Open, restricted, closed</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Prohibited, limited, allowed</td>
</tr>
</tbody>
</table>

Problem constructs and examples of negotiation problems

- Type: Structured, Semi-structured, Structured
- Structure: Closed, Open, Semi-closed
- Issues: Single, Few, Many
- Objectives: Joint, Separate, Mixed
- Levels: Reservation, Aspiration, Ownership
- Ownership: Single, External, Divided
- Price negotiation: Closed, Structured, Single issue, Single variable, Divided
- Bargaining: Semi-closed, Structured, Few issues, Issue function, Discrete variable, Divided
- Decision-making: Non-closed, Semi-structured, Many issues, Issues and functions, Continuous and categorical variables, Single
- Trade negotiation: Open, Semi-structured, Many issues, Issues and functions, Continuous and discrete variables, Divided
E-negotiation

• Socio-technical system
  • Negotiators: cognitive abilities, practices, values and interests
  • ENSs: practices, prescriptions, norms implemented as models and procedures
  • Division of labor between the negotiators and the ENS

ENS design issues

• Specification of constructs formulated solely by the system, those formulated jointly by the system and users, and those that are the sole responsibility of the users;
• Selection of models and procedures used for construct formulation;
• Design of ENS and its components together with the assignment of constructs to components; and
• Communication rules among components, between the components and the ENS users, and with other systems.
Protocols

- Roots: automated negotiations
  - Software agents’ behavior is controlled by a negotiation protocol (Cranor, 2000; Jennings, 2001; Zlotkin, 1996).
  - A model that guides processing and communication tasks of software and its users, and imposes—explicitly or implicitly—restrictions on their activities through the specification of permissible inputs.

Protocols: types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>All rules are defined a priori; no rule can be added or modified</td>
</tr>
<tr>
<td>Open</td>
<td>Rules may be constructed and added during the negotiation</td>
</tr>
<tr>
<td>Private</td>
<td>Guides the user’s activities and defines her valid actions</td>
</tr>
<tr>
<td>Public</td>
<td>Defines the rules of interactions between the negotiators</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Can be used for different types of negotiations</td>
</tr>
<tr>
<td>Specialized</td>
<td>Applicable to one or a few negotiation types</td>
</tr>
</tbody>
</table>
Protocol properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input consistency</td>
<td>All available information is considered for processing</td>
</tr>
<tr>
<td>Transparency</td>
<td>Users can observe and understand ENS behavior and actions</td>
</tr>
<tr>
<td>Explicability</td>
<td>Reasons for action selection are justifiable</td>
</tr>
<tr>
<td>Tractability</td>
<td>The purpose of every potential activity can be justified</td>
</tr>
<tr>
<td>Completeness</td>
<td>Users-ENS interactions are sufficient to achieve the goal of the negotiation.</td>
</tr>
</tbody>
</table>

Phases, activities and constructs

- A phase is decomposed into states.
- In every state one or more activities are undertaken.
  - Activity’s result is an output which specifies one or more values of a construct, but
  - Some activities may not contribute to the construct specification.
States and sequences

- States: initial, optional, and mandatory
- Exits

Rule-based representation

- Within a sequence

\[ v(s_i) \Rightarrow v(s_{i1}) \vee v(s_{i2}) \vee \ldots \vee v(s_{ik}) \vee v(s_j) \]

- Between sequences

\[ v(s_j) \Rightarrow v(s_{1}) \vee v(s_{2}) \vee \ldots \vee v(s_{L}) \]

- Levels of reasoning about protocols
  - **Protocol level**: only sequences and the relationships among them are considered; the sequence composition is ignored; and
  - **Sequence level**: only the internal states of a sequence and their relationships are considered; states that are not elements of the sequence are ignored
Protocol level

- Protocol completeness:
  - Using the resolution theorem first formulated by Herbrand in 1930 we can prove that protocol is consistent.
  - Protocol that is consistent for every possible path is complete.

- Example of a complete protocol

Intervening states

- The result of the negotiators’ interactions

- Functions of the intervening states
Invite

• Based on the six phase model
• Implements extended Montreal taxonomy
• Allows for multiple protocols using the outlined theory

• Invite:
  • Presented by Ka Pong Law and Stefan Strecker, and
  • You have a warm *invite* to their presentation