Guiding Cooperative Stakeholders to Compromise Solutions Using an Interactive Tradespace Exploration Process

Matthew E Fitzgerald
Adam M Ross

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Outline

• Motivation for Compromise Techniques
• Types of Compromise
• Tradespace Exploration
• Structuring with Visual Analytics
• Expected Next Steps and Contributions
Large Sociotechnical Systems

• Complex systems often with multiple stakeholders
  – Satellites, infrastructure, etc.
  – Success may require agreement and satisfaction of multiple/all participants

• Need for negotiation between differing interests to generate compromise
  – Complexity drives need for additional help/guidance in negotiations
What’s the Problem?

• Without training, people often display counterproductive behavior, particularly positional bargaining
  – Ineffective at exploring options ("midpoint" resolutions)
  – Can fracture relationships
  – Exacerbated by many-party negotiation
  – Being accommodating is self-detrimental

• Negotiations are prone to breaking off or resulting in expensive "gold-plated" solutions
  – Potential projects with great mutual benefit are cancelled or completed ineffectively: largely because of poor negotiation

Ideally, we could have a process that resolves these common negotiation problems without requiring advanced training in negotiation technique
Additional Complications

• Disconnect between design variables and value-creating objectives (control vs. outcome)
  – Traditional negotiation techniques rely on control OF outcome space
  – Complexity can result in loss of situational awareness → risk-aversion prevents agreement

• Uncertainty in preference/utility statements
  – Changing of preferences when exposed to new data has been observed in complex problems
  – Utility elicitation is an “art”
Types of Compromise (1)

• Design Compromising
  – Selection of a design agreeable to all stakeholders, when no choices are optimal for all
  – One or more stakeholders must accept suboptimal value in the name of fostering agreement
  – Corollary to *distributive negotiation*, in which participants try to claim value

Preemptive claiming typically leads to positional bargaining and losses in total value: can we postpone this action?
• Preference Compromising
  – Modification of expressed utility function in order to promote agreement with other stakeholders
  – Not a stretch: stated preferences are observed to change when stakeholders are exposed to additional information
  – Corollary of *integrative negotiation*, in which the participants actively seek to work together to find mutual benefit

**Mutual value is what makes compromises attractive: can we support this process in order to increase stakeholder satisfaction?**
Tradespace Exploration

• System design paradigm with associated methods
• Multi-attribute Tradespace Exploration (MATE) maps system concepts into design variables and stated stakeholder preferences into performance attributes/utility functions

• Emphasis is placed on looking at a large set of alternatives and their outcomes
• Key goal: move away from point design analysis to better understand the problem via trends in outcomes (perceived value space)
Why will this work?

- Tradespace approaches (e.g. MATE) are a natural extension of many of the ideas central to “good” negotiation
  - Depersonalizes differing goals
  - Focuses on interests (preferences)
  - Uses objective metrics to evaluate choices
- Most importantly, it creates and explores many options: the key goal of integrative negotiation!

We propose that a process utilizing tradespace exploration can be created to help resolve the challenges of multi-stakeholder negotiation.
Structuring with Visual Analytics

- **Visual analytics** offers a useful structure to emulate in our process
- Well-suited for use in both negotiation and tradespace exploration
  - Iterative, with user feedback, similar to many negotiations
  - MATE generates large quantities of data for analysis, particularly requiring intelligent filtering to generate insights

**Visual Analytics Paradigm***

1. Analyze first
2. Show the important
3. Zoom/filter and analyze further
4. Data on demand

**PROPOSED Tradespace Compromise Process**

1. Find compromise dimension
2. Allow relevant stakeholder to select a compromise
3. Repeat 1 and 2 until termination
4. Final design compromise

**Goal:**

Guide stakeholders to a satisfactory, high mutual value solution (if one exists) by assisting them in compromising effectively according to principles of integrative and distributive negotiation

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1. Find Compromise Dimensions

• **Goal**: guide stakeholders to productive preference compromises
  – “productive” = conducive to agreement

• **Method**: identification of dimensions of utility functions that drive potentially reconcilable differences in stakeholders’ value

• **Need**: set of metrics/heuristics to find these dimensions

**Visual Analytics connection:** Analyze first
• Process data automatically in order to find useful information
2. Allow Relevant Stakeholder to Select Compromise

• With a compromise dimension found, suggest a compromise to the relevant stakeholder

Ex.

‘Player A, we’ve noticed that the your requirement for Attribute X is much higher than Player B, and it is eliminating 40% of potential compromises. If you are willing to lower your requirement to Z, the correlation between your utilities would improve by C and the joint Pareto set would grow by P.’

Visual Analytics connection: **Show the important**, Details on Demand

• Prevent “data overload” by showing relevant information only
• Allow for further interrogation, including results of selections, if requested
2. Allow Relevant Stakeholder to Select Compromise

• With a compromise dimension found, **suggest a compromise** to the relevant stakeholder

  ‘Player A, we’ve noticed that the your requirement for Attribute X is much higher than Player B, and it is **eliminating 40%** of potential compromises. If you are willing to lower your requirement to Z, the correlation between your utilities would improve by C and the joint Pareto set would grow by P.’

  – **Justify with objective metric** from step 1: lessens the negative association of “backing down”
  – **Determine ensuing effects** in advance
  – **Allowing opportunity to refuse** compromise is important: prevents pushing into realm of infeasibility

**Visual Analytics connection:** *Show the important, Details on Demand*

• Prevent “data overload” by showing relevant information only
• Allow for further interrogation, including results of selections, if requested
3. Repeat 1 and 2 until Termination

- Iteration allows for *gradual alignment of preferences*
- **When do we stop?**
  - Minimum / maximum number of compromises
  - Maximum number of refusals
  - Whenever the participants want to stop
  - Metrics for deviation from original preferences
- **Tradeoff between stakeholder satisfaction and other goals for process outcome**

Visual Analytics connection: Zoom/filter, and analyze further
- Gradually refine stated preferences, narrowing field of potential compromises, then run previous metrics again
4. Final Design Compromise and Selection

- Preference compromises complete → Proceed to distributive negotiation

What design in the tradespace do we select?

- Standard utility-distributing techniques are possible
  - Maximin, Nash Bargaining Solution, etc.
  - NOT DESIRABLE for stakeholders with “benefit at cost” or “ility”-informed definitions of value

- This phase likely to vary dramatically from case to case as appropriate
  - “Fair is fair” – let the stakeholders decide how to compromise and they are more likely to be happy with the result
  - 3rd party goals – do we want to influence solution?

Visual Analytics connection: Analyze first, Details on demand
- Although open-ended, will inevitably involve the analysis of post-preference-compromise data as interrogated in detail by stakeholders
Further Development of the Process

• **Experimentation** with many customizable aspects of the process likely to reveal benefits on a case-by-case basis
  – Limiting information shown to stakeholders
  – Ordering / priority of compromise dimensions

• **End goal:** reach a mutually agreeable solution with all stakeholders satisfied with the result
  – Satisfaction is a function not only of the solution but of the process
  – Potentially quantify satisfaction in the inverse with ‘regret’ using a Likert-type scale
Expected Next Steps and Contributions

• Normative control
  – Utilize mechanism design theory to tailor the process towards “proper” behavior or “fair” solutions

• Competitive stakeholders

• Coalition effects

• Authoritative mediator (arbitration)

• Budgeting (constrained utility maximization)

• Time-based uncertainty
  – Inclusion of multiple scenarios or lifecycles: how does this effect the ways people compromise?

Opportunity to include presumably any advanced concepts of negotiation or tradespace exploration: ideas are welcome!
Thank You!

Questions?