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

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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

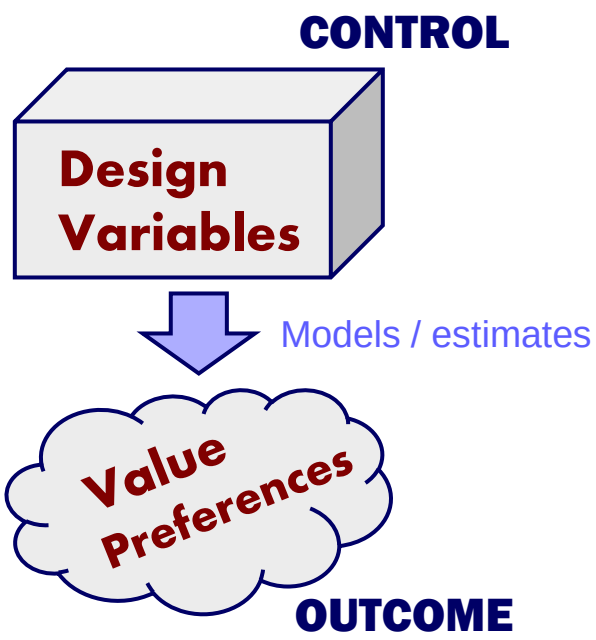
What's the Problem?

- 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

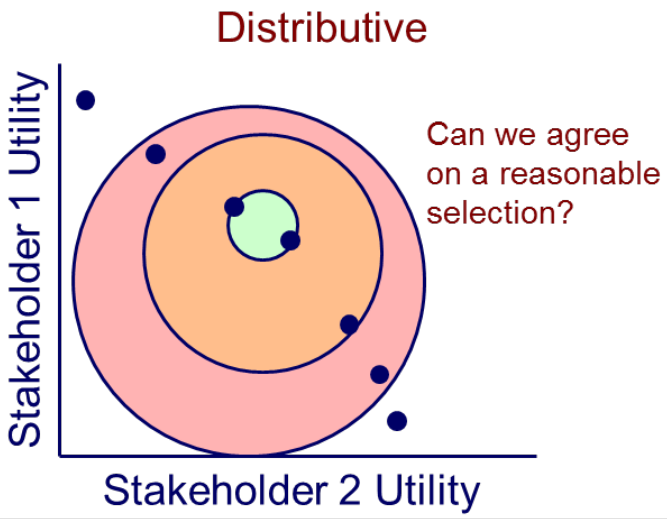


- Uncertainty in preference/utility statements
  - Changing of preferences when exposed to new data has been observed in complex problems
  - Utility elicitation is an "art"

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

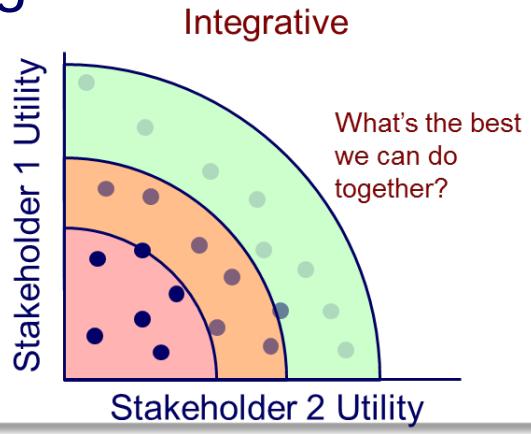
Preemptive claiming typically leads to positional bargaining and losses in total value: can we postpone this action?



Types of Compromise (2)

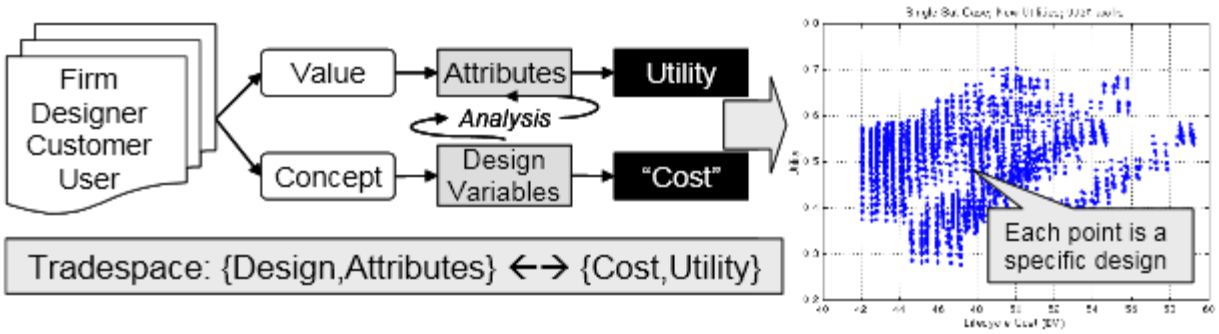
- Preference Compromising
  - Modification of expressed utility function in order to promote agreement with other stakeholders
  - Not a stretch: stated preferences are observed to change when stakeholders are exposed to additional information
  - Corollary of *integrative negotiation*, in which the 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!

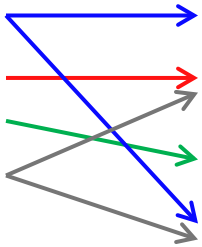
We propose that a process utilizing tradespace exploration can be created to help resolve the challenges of multi-stakeholder negotiation

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 may 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

* D.A. Keim, F. Mansmann, J. Schneidewind, J. Thomas, H. Ziegler, Visual Analytics: Scope and Challenges, Visual Data Mining, 2008.

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

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  - 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?