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Cognitive Assistance for Problem Formulation in Tradespace Exploration

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Motivation

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- Problem formulation and Tradespace exploration in systems engineering is vital to designing a successful system from multiple perspectives
  - Lifecycle cost
  - Stakeholder satisfaction
  - Risk management
- Human-AI collaboration has been shown to be useful in tradespace exploration
  - Cognitive assistants for tradespace exploration [source, Antoni's paper]
- However, relatively little work has been done investigating cognitive assistants for problem formulation

Problem Formulation Challenges

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- Complex black-box evaluation functions can make design variable selection difficult
  - Identifying high sensitivity design variables
- Deciding which objectives to consider / prioritize within a set of competing objectives is not always straightforward
  - Competing stakeholder satisfaction
  - Cost and Risk metrics

Contribution

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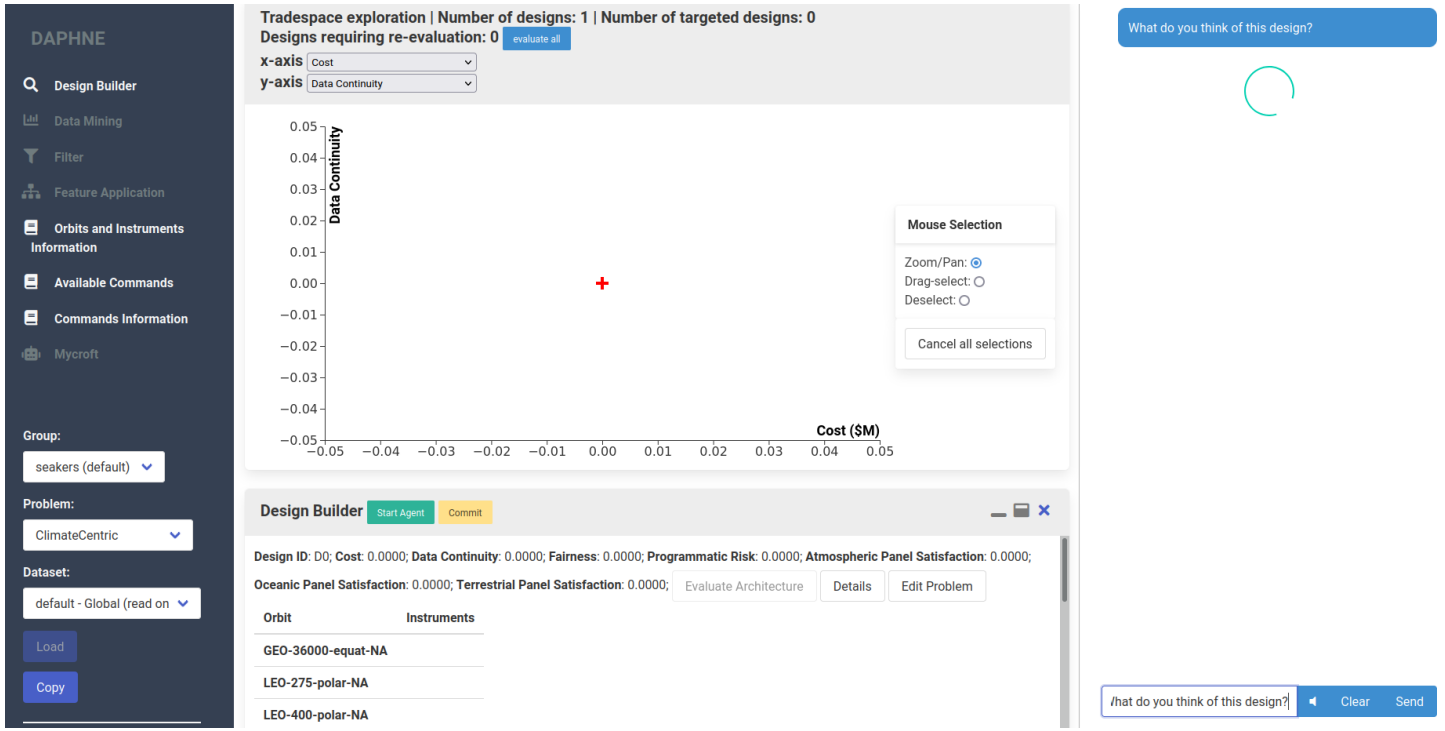
- A cognitive assistant capable of assisting in system architecture problem formulation in the following ways
  1. Recommending design variables with low sensitivity for removal
  2. Recommending non-architecturally distinguishing objectives for removal
  3. Identifying high sensitivity design variables not in the current problem formulation

- A pilot study is conducted to evaluate the effectiveness of the assistance from both a design performance and human leaning perspective
  - Within-subjects study
  - 11 Texas A&M aerospace engineering graduate students

Cognitive Assistant

- Based on a pre-existing cognitive assistant for designing earth observing satellite systems (Daphne)
- Interfaces with users both proactively and reactively via a built-in chat box
- Runs a genetic algorithm for exploring a problem's solution space



Demo

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- Daphne demo

Pilot Study Design

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- Experiment Specifications
  - Within-subjects
  - N = 11 Subjects (Texas A&M Aerospace Engineering graduate students)
- Each subject solves a climate centered earth observing satellite system design task in two conditions
  1. With the cognitive assistant for problem formulation
  2. Without any cognitive assistance
- Task ordering is randomly assigned to subjects to minimize learning effects between tasks
- Subjects are administered a short exam at the end of each task to measure human learning on problem formulation

Figures…

Pilot Results

- Results here…

Conclusion

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- Purpose of this work
  - Investigate the usefulness of cognitive assistants for Human-AI collaboration in problem formulation
- Conclusion based on results…

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END