Differentiating ‘Human in the Loop’ Decision Strategies

Sarah Walsh and Dr. Karen Feigh
Research Questions

1. Can we infer decision strategies from dynamic behavioral data?
2. Can we detect when people diverge in their decision making approach?
3. Can we classify these inferred decision strategies based solely on behavioral data?
Human-AI Decision Making

- **Inventive** (more adaptive, less precise)
  - Human Strengths
  - Al-Aided Medical Diagnosis
- **Methodical** (more precise, less adaptive)
  - Heuristic (faster, less comprehensive)
  - Analytic (more comprehensive, slower)
  - E.g., Al-Aided Quality Control

Colors:
- Yellow: Human Strengths
- Blue: AI Strengths
- Green: AI-Human Team Strengths
Limitations in Human-AI Shared Mental Models

Team Model

Task Model

01100
10110
11110

Task Model

Team Model
Improving Human-AI Teaming:

- Explainable AI (Shin 2020, Preece 2021, Arya 2019)
- Improving human mental models of AI error boundaries (Bansal, 2020)
- AI systems create Shared Mental Model with human teammates (Scheutz 2017)
- Bridging gaps between the AI and human's relative policies (Bastani, 2021)
AI in human-AI teams often operate with little or no model of the human’s cognitive state.

We need ‘learning human mental models' that are easy of an AI system to train and can support planning/decision-making (Chakraborti et al., 2017).
Approach to Learning Human Mental Models of Decision Making

1. Design an experiment to capture real-world decision making
2. Capture and classify decision strategies
Experiment with Geospatial, Sequential Task

- Participants will be assuming the role of a disaster relief planner making decisions about how to allocate resources prior to and during a storm.
- The participants will have several heat maps that will aid in the decision making process overlaid on a US city.
- The heat maps show gradients of better and worse locations to place resources.
- Participants can only observe one resource at a time.
Experiment in a Sequential Environment

Storm tracks change through time. Each time a storm track changes the participant is asked to update their decision (resource location).

Experiment Features
- 10 timesteps / decision events
- 6 data sources (3-dynamic and 3-static)
- 1 resource placements

Example Storm Track through 10 Times Steps
User-Interface

Experiment Demo

CEC CDM Experiment

Data sources
- Population
- SocioEco Status
- No-go zones
- Power Outages
- Flooding
- Current Storm
- Clear

Decision Surface

Tools
Staging site marker
Drag the marker to your desired location.
Submit

Better
Worse
Administration of Experiment

Experiment Design

- Start
- Consent
  - Instructions
  - Training
  - Randomizer
    - A
    - B
    - Task-Chicago
    - Task-Houston
    - Task-Houston
    - Task-Chicago
  - Post Experiment Questionnaire
  - Debrief
- Finish

Task Break-down

- Single Task
  - Time Step 1
  - Time Step 2
  - ... (Ellipses)
  - Time Step 10

Attributes

- Population
- SE Static
- No Go Zone
- Storm
- Power Outages
- Flooding

Decision Space

Performance Data

Output to Experimenter

- Behavioral Data
- Click Count per Attribute
- Elapsed Time per Attribute
- Utility of Decision Choice
Approach to Identifying DM Strategies

**Part 1:** Label data using Partial Least Square Regression

**Goal:**
- Use behavior to classify decision strategies and predict decision strategies/mental models of participants

**Part 2:** Reverse analysis to classify using Random Forrest

**Goal:**
- Classify DM strategy
- The output of the random forest is the class selected by most trees
Results

1. Can we infer decision strategies from dynamic behavioral data?
2. Can we detect when people diverge in their decision making approach?
3. Can we classify these inferred decision strategies based solely on behavioral data?
Diagram of Possible Decision Strategies

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Abbrev.</th>
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<tbody>
<tr>
<td>Power Outages</td>
<td>P</td>
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<tr>
<td>Population Density</td>
<td>D</td>
</tr>
<tr>
<td>Storm</td>
<td>S</td>
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<tr>
<td>No Go Zones</td>
<td>N</td>
</tr>
<tr>
<td>Flooding</td>
<td>F</td>
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<tr>
<td>SocioEconomic Status</td>
<td>E</td>
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</tbody>
</table>

6-attribute       5-attribute       4-attribute       3-attribute       2-attribute       1-attribute
Results: Can we infer decision strategies from dynamic behavioral data?
Results: How stable are people's decision strategies?
Results: Can we classify individuals into these inferred decision strategies based solely on observable behavioral data?

<table>
<thead>
<tr>
<th>Chicago</th>
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<tbody>
<tr>
<td>Number of Trees:</td>
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<tr>
<td>No. of splitting vars.:</td>
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<tr>
<td>OOB estimate of error rate:</td>
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<tr>
<td>Confusion Matrix:</td>
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<td>Analytic</td>
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Implications and Next Steps

- Infer Human Mental Model
- Provide Proactive Support
- AI-Decision Aid

Human
Differentiating ‘Human in the Loop’ Decision Processes

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