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# Enabling Trust with Behavior Metamodels

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# Challenges

- Software assistants are increasingly a part of everyday life
- What will constrain the use of these assistants?
  - Technology? Psychology?

# Technology as a Constraint

- The most obvious constraint on tomorrow's intelligent assistants
  - "we aren't doing that yet because we don't know how"
  - "…because we don't have computers/sensors/algorithms/etc that are precise/fast enough"
- Focus of most AI research

# Psychology as a Constraint

- Less obvious, less explored possibility
- Perhaps we aren't willing to turn all tasks over to computerized assistants...
  - How do engineers weigh the risks and benefits of the technology they develop?
  - How do end users determine when and what technology to adopt?

# Psychological Constraints

- Potential concerns:
  - Will this project/invention be safe for society?
  - Will it be a useful tool?
- Approach:
  - Validation / Testing
    - Did we make what we intended to?

# The end user…

- Potential concerns:
  - Will this project/invention be safe?
  - Will it be a useful to me?
- Needs:
  - Marketing?
  - **Trust**

# Thesis in a Nutshell

- Trust is a critical factor in developing human-human and human-computer relationships
- We can design systems so as to help facilitate trust
- Trust seems most important for end-users, especially early adopters, but the underlying components of trust will also benefit developers

# Trust

- Examined three models of trust
  - Recently cited / multi-disciplinary
  - Developed from models with longer history
- Based on this survey, four common properties can be identified
  - Understandability, predictability, similarity, liability

# Understandability/Predictability

- Based on reputation of other party
- Based on knowledge of other party's behavior
  - Knowledge based trust (Ratnasignham)
  - Cognitive Trust (Lewis & Weigert)
  - Habitus (Misztal via Fahrenholtz, Bartlet)

- Important for end-users and developers

# Between Humans & Computers

- An explanation of why software aids may make mistakes can increase trust
- Systems that can justify their actions engender greater trust

# Similarity

- Can the parties in the trust relationship find common ground?

- Empathy, common values (Lewis & Weigert)
- Solidarity, familial associations (Misztal via Fahrenholtz, Bartlet)

# Between Humans & Computers

- Users find programs more credible when they are considered part of same group as user (e.g., company).

- Agents that use a conversational strategy that is consistent with the users' behavior engender more trust.

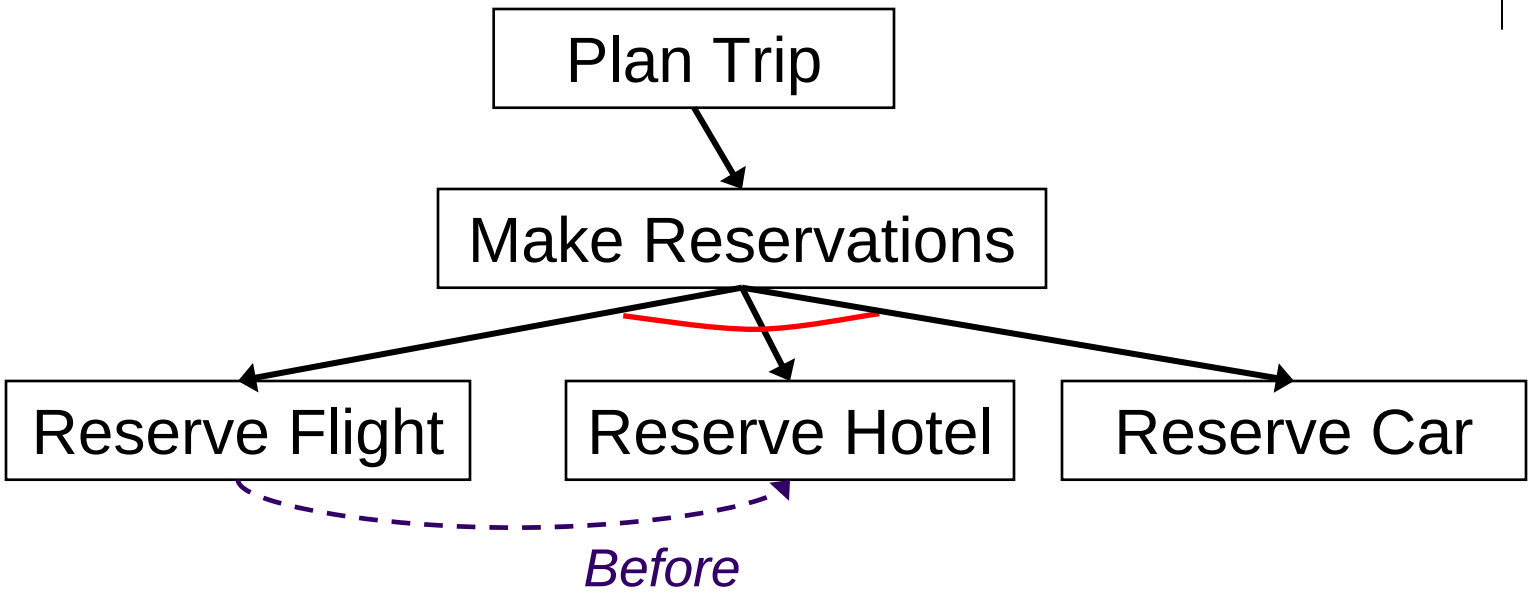
# Liability

- Deterrence based trust (Ratnasignham)
  - Early form of trust
  - Supported by threat of punishment
- Emotional trust (Lewis & Weigert)
  - Entering trust relationship causes bond
  - Breaking bond causes pain/wrath

# Metamodels: Enabling Trust

- Metamodels are high-level descriptions of the agent's behavior
  - They are easy to create
  - "Easy" to understand
  - Consistent with agent's behavior

# A Hierarchical Representation




- Similar to Finite State Machine, AND/OR Tree
- Describes potential sequences of behavior

# How Metamodels May Aid Trust

- Understandability
  - Illustrates reasoning path leading to a state
- Predictability
  - Illustrates reasoning path extending from a state
- Similarity
  - Agent’s reasoning process may map to user’s
- Liability
  - ???

# Exploring Understandability…

- How can we see if metamodels improve understandability?
  - By watching developers find bugs in a program.

- Begin with an existing Soar agent performing a simple goal-directed task: "*Correct Behavior*".
  - Create two more agents based on this original: "*A*", "*B*".
  - New agent's behave somewhat differently.
  - Participants observe correct and flawed behavior
  - Do metamodels help find behavioral differences?

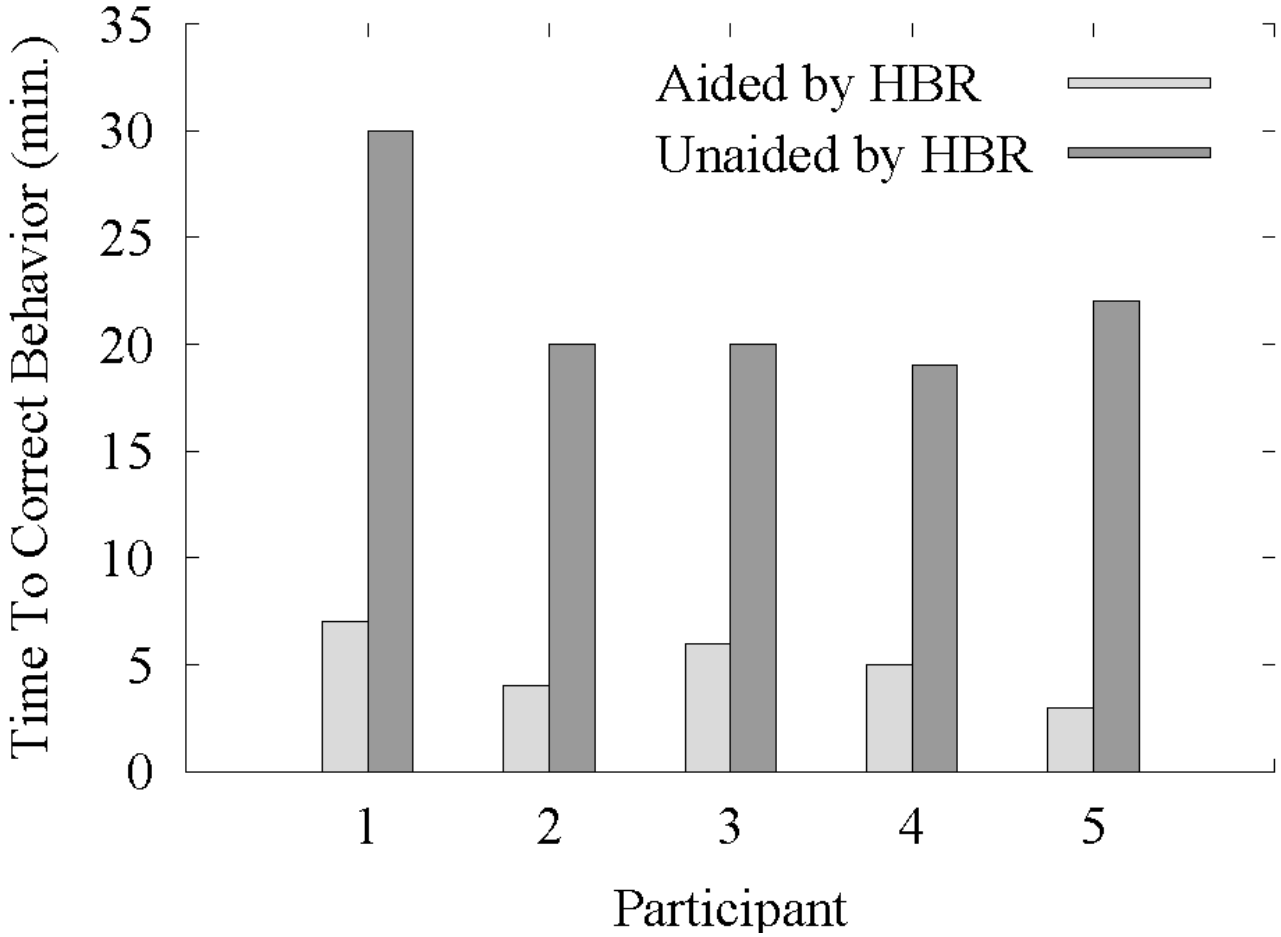
# Three Agent Programs

- Original Agent ("Correct Behavior")
  - This is the specification of how to behave
  - Serves identical role to a human expert we may want to emulate
  - 4 distinct behaviors
- Flawed agent *"A"*
  - Occasionally pursues inappropriate goals
  - 12 distinct behaviors, 4 are consistent with specification
- Flawed agent *"B"*
  - Occasionally replaces one goal for another (inappropriately)
  - 8 distinct behaviors, 4 are consistent with specification

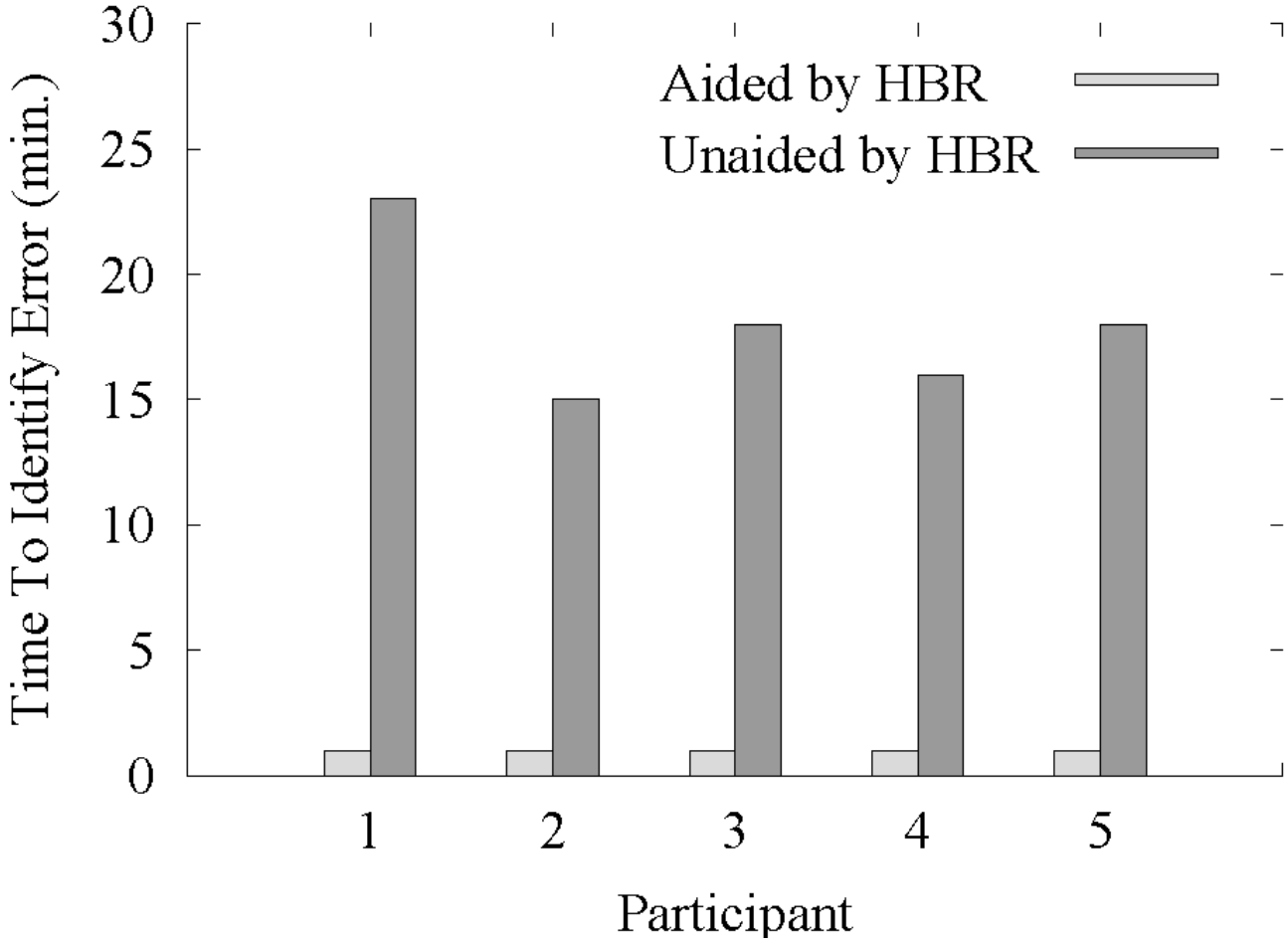
# Participants' Task

- Five participants – all experienced with Soar
- Each participant looks for bugs in "A" and "*B*"
  - On one agent users were **aided** by metamodels
  - On other agent users were **unaided**
- In **aided** task, users get metamodel of specification, and metamodel of flawed agent
- In **unaided** task, users get behavior sequences (observations) from specification
- In **both** tasks, users must identify error verbally, then proceed to fix it

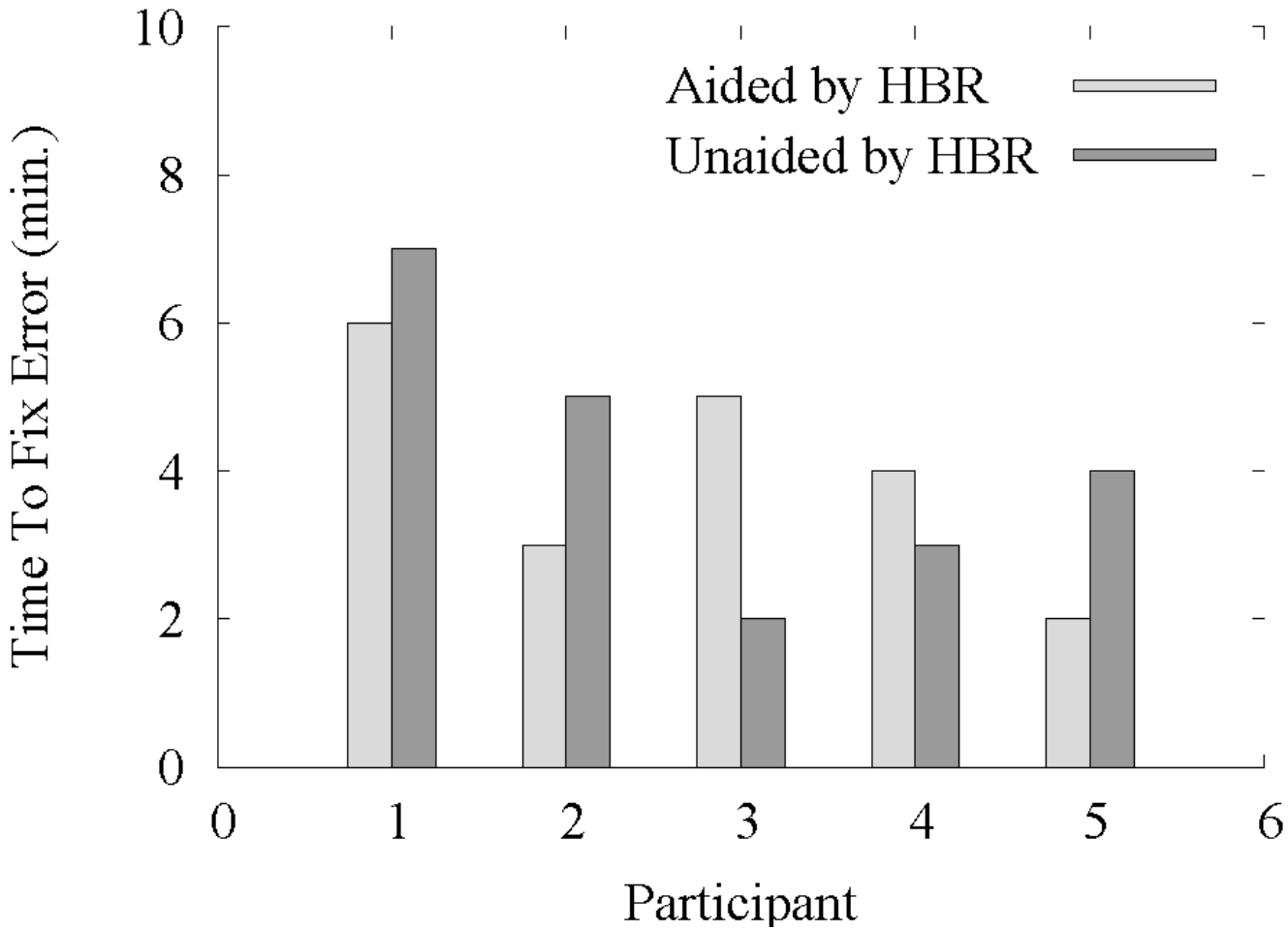
# Finding & Fixing Error



# Finding Error



# Fixing


Aided by HBR
Unaided by HBR
Time To Fix Error (min.)
10
8
6
4
2
0
0
1
2
3
4
5
6
Participant

# Conclusions

- Multi-resolution models of behavior may be valuable tools for helping both developers and end users
- A key challenge is to abstract away the correct features
- As we vary the level of abstraction there should be a cost benefit curve associated with interpreting the model can we quantify this?