Rapid Model Building using Diagrams and Examples

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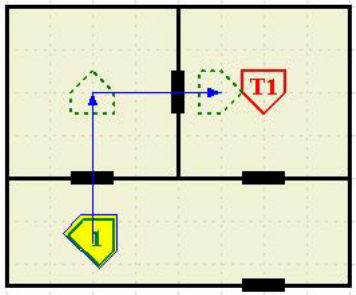
Supported by Office of Naval Research
Start Date: January 1, 2003

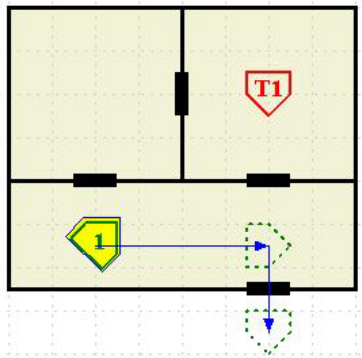
Why Building Models is Hard

Desired Behavior



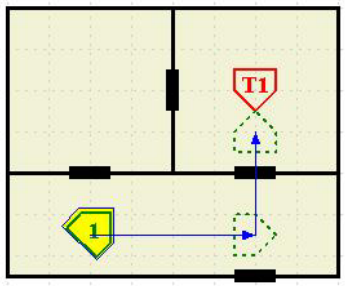
Errors and unvalidated behavior

Actual Behavior



Rules produce the behavior

Intended Behavior



SME

Slow, Difficult, Error prone

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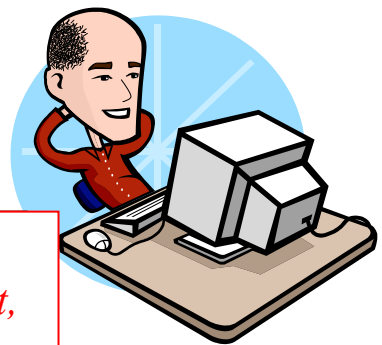

KE

Slow, Difficult, Error prone

A -> B
C -> D
E, J -> F
G, A, C -> H
E, G -> I
J, K -> L

Rules

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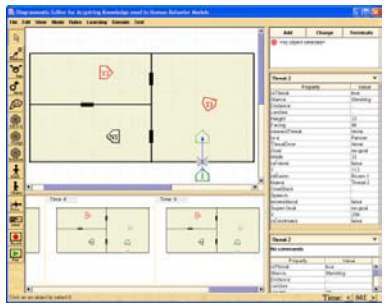
Diagram-based Example-driven Development Tool

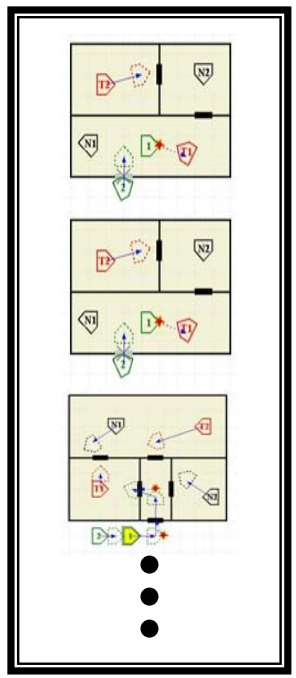
Define behavior with diagram-based examples

Library of validated behavior examples

Analysis & generation tools

Executable Code





Detect inconsistency

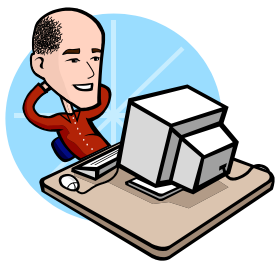
Generalize

Generate rules

Simulate execution

A -> B
C -> D
E, J -> F
G, A, C -> H
E, G -> I
J, K -> L

SME



KE

Simulation Environment

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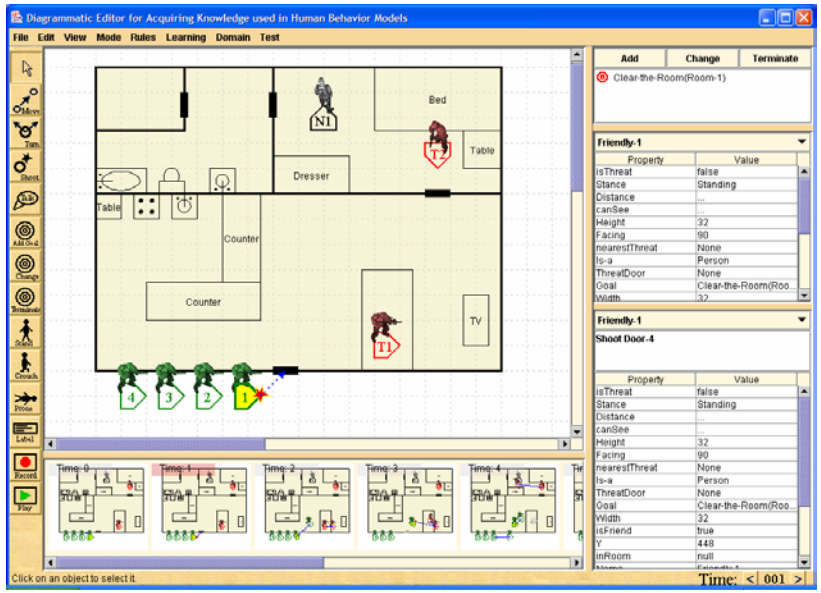
Tool demo

HBM Development Phases:

1. SME defines scenario
2. SME defines correct behavior
3. SME+KE indicate why behavior is chosen
4. Rules generated and automatically



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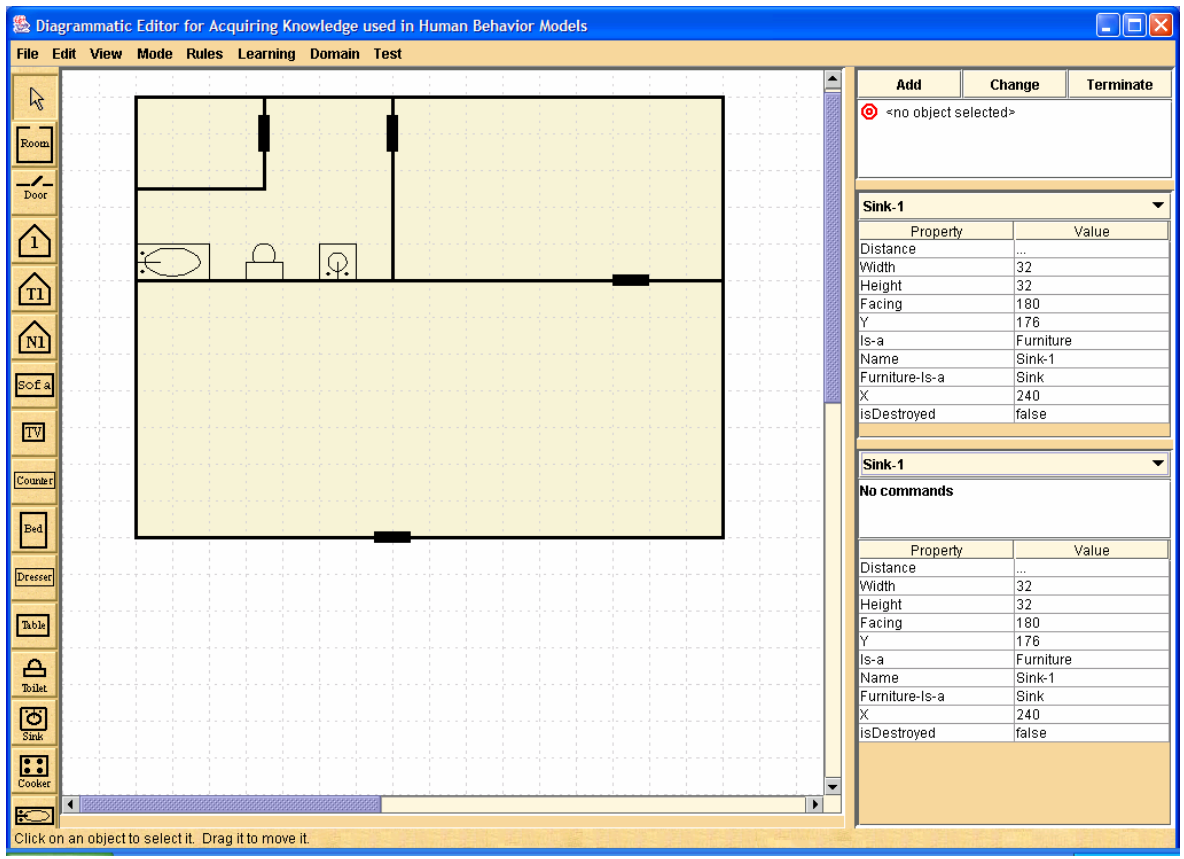
Demo Screenshots: Layout Rooms



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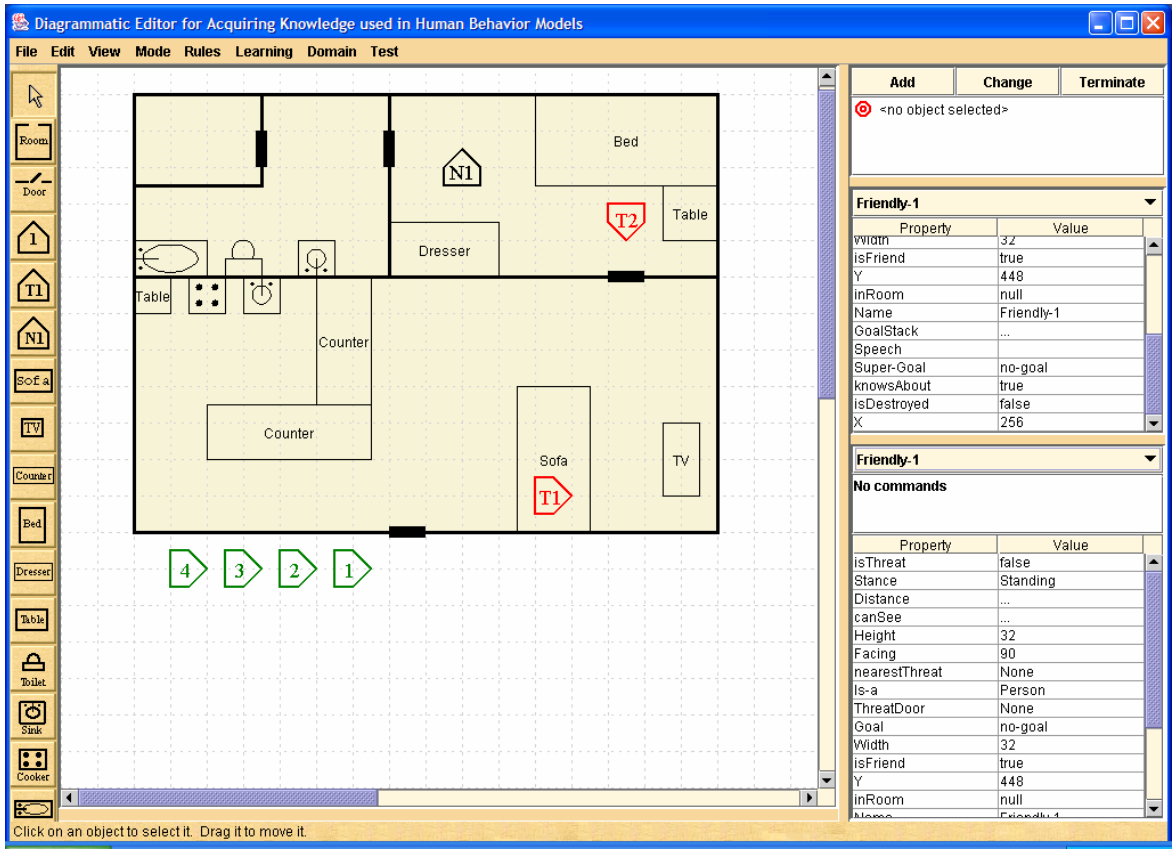
Demo Screenshots: Populate Rooms



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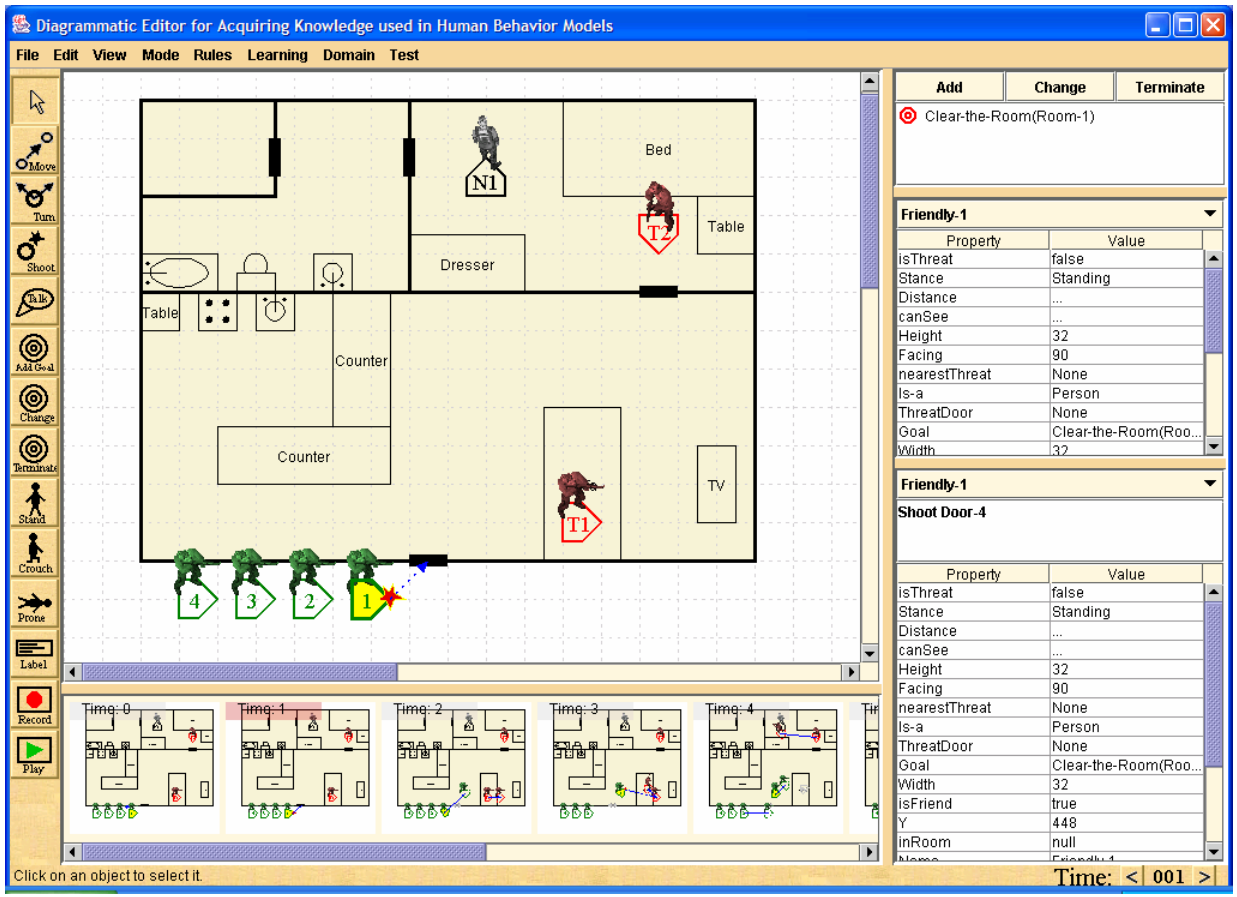
Demo Screenshots: Define Scenario



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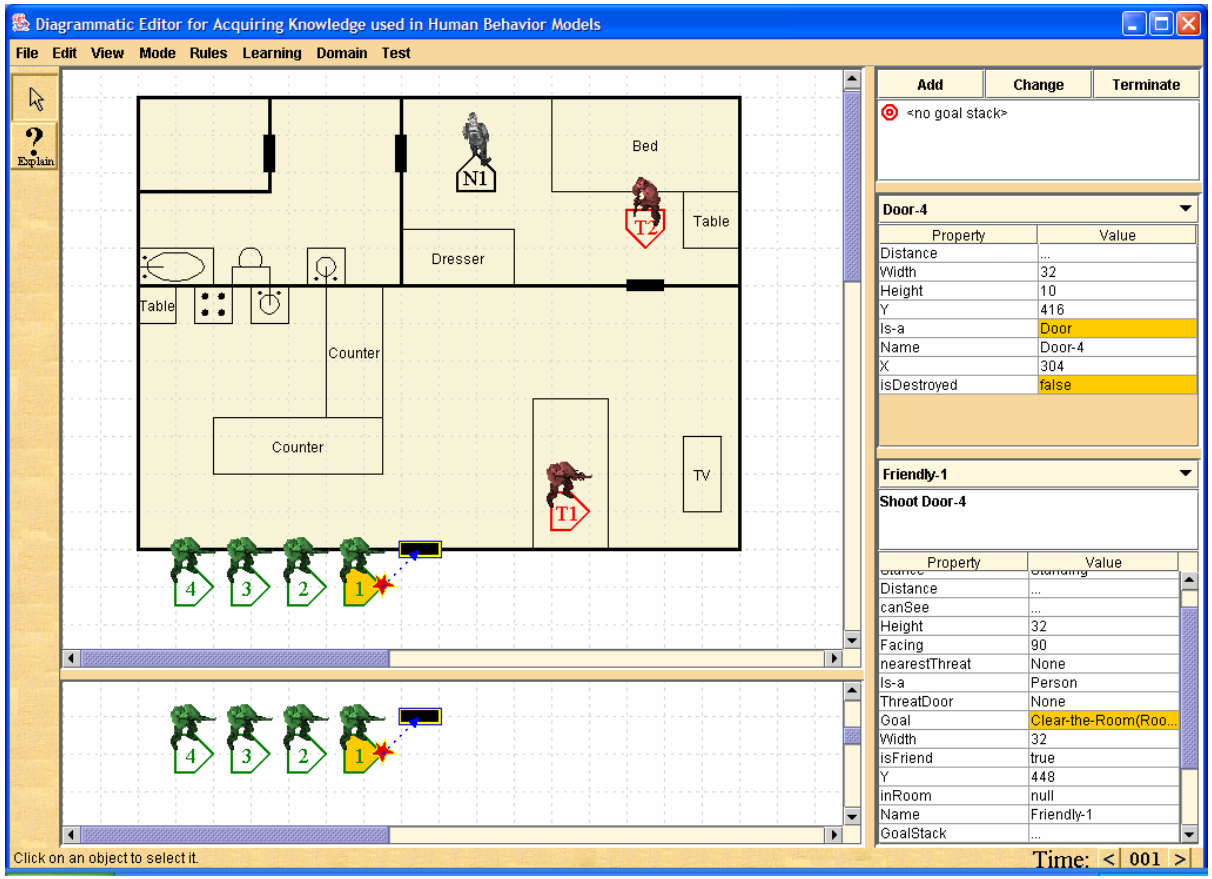
Demo Screenshots: Define Behavior



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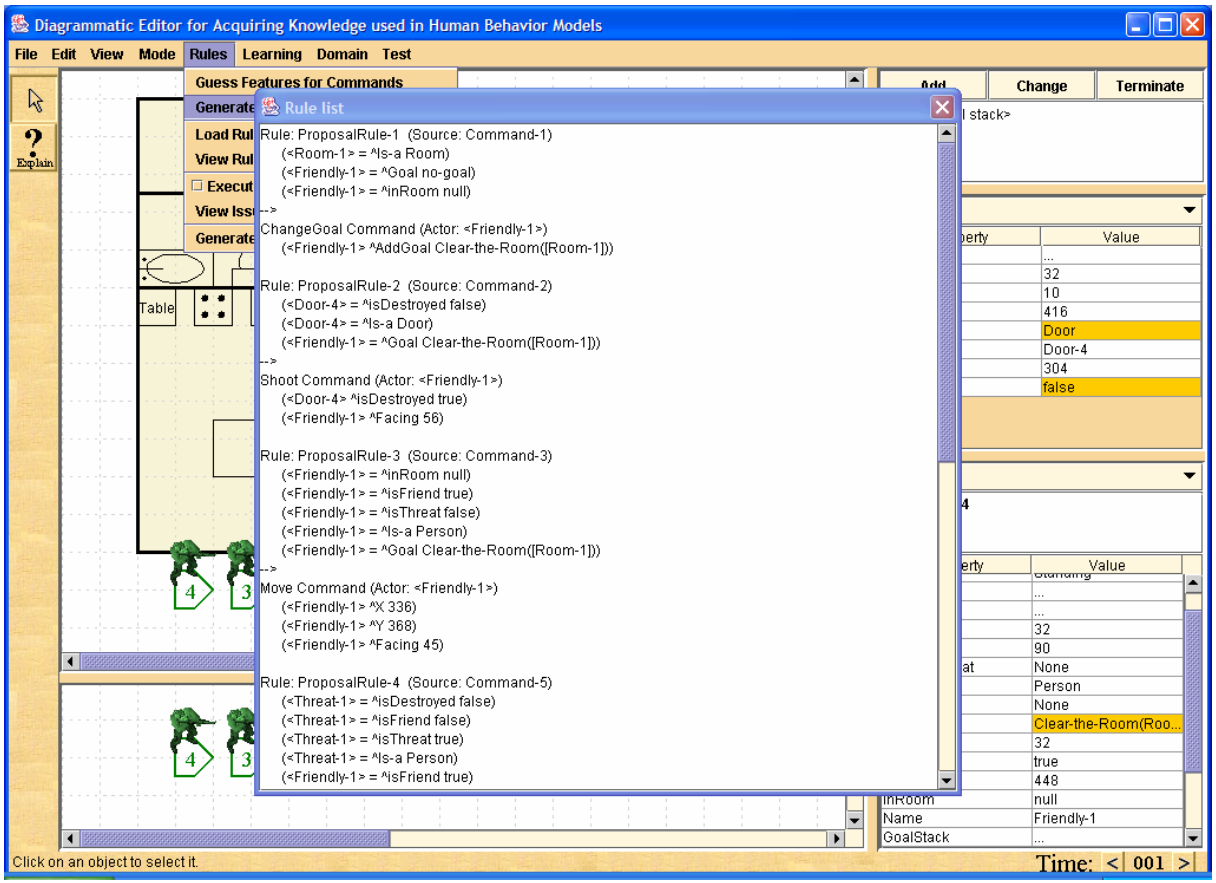
Demo Screenshots: Generate Rules



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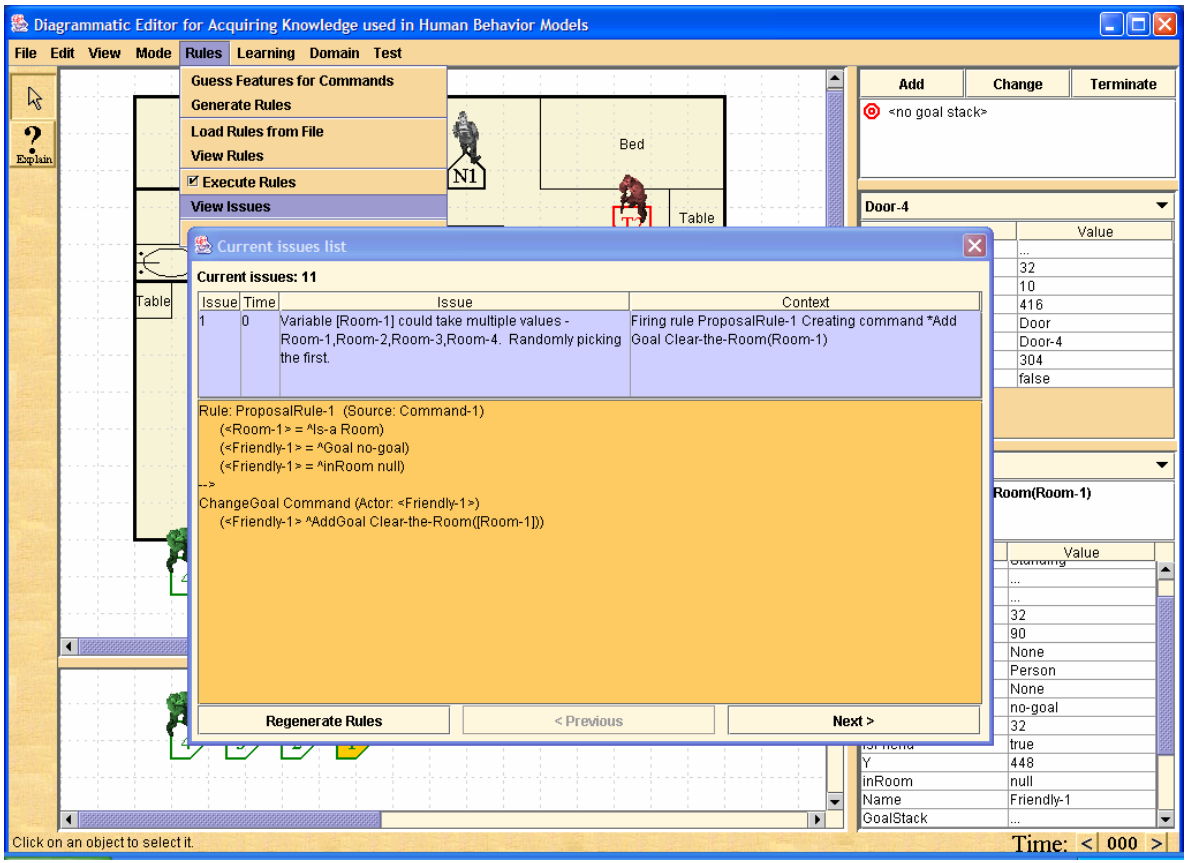
Demo Screenshots: Detect Errors



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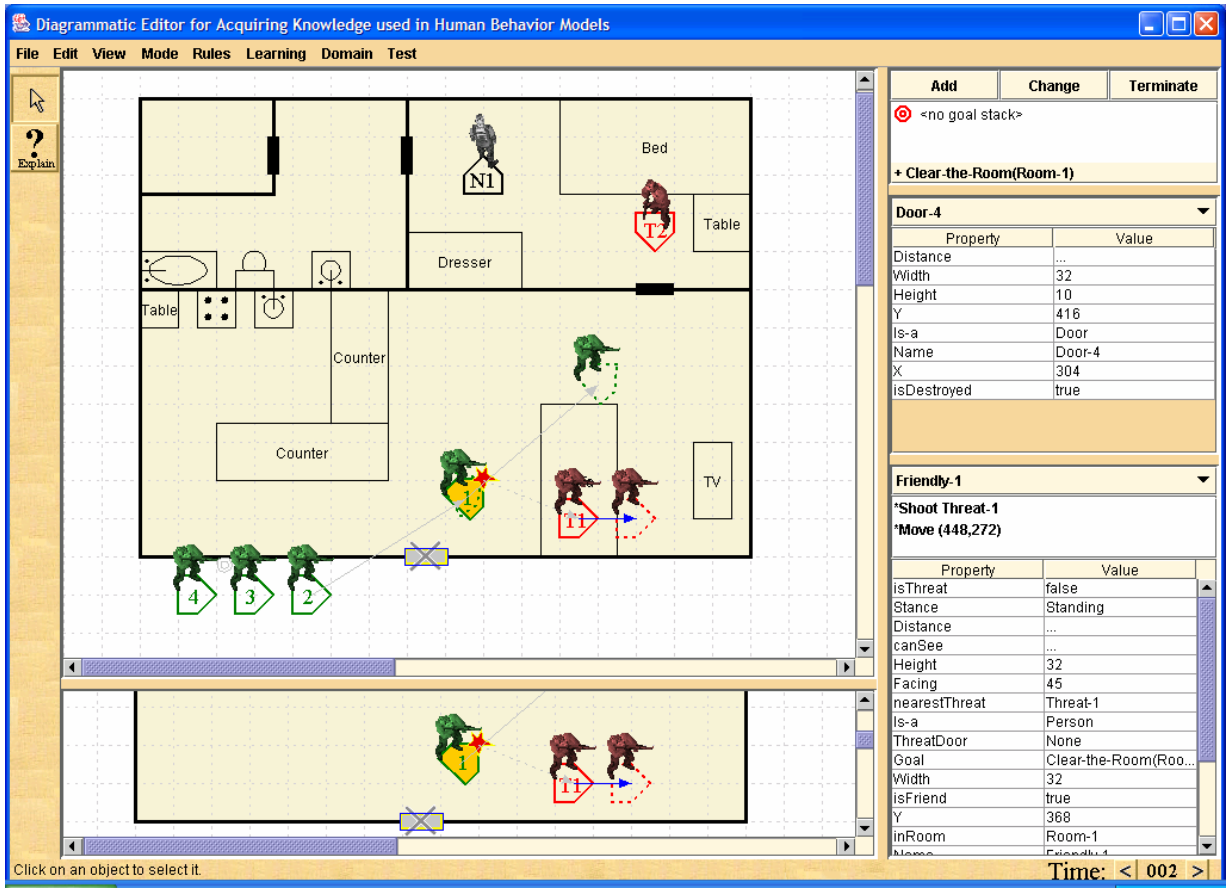
Demo Screenshots: Simulate Behavior



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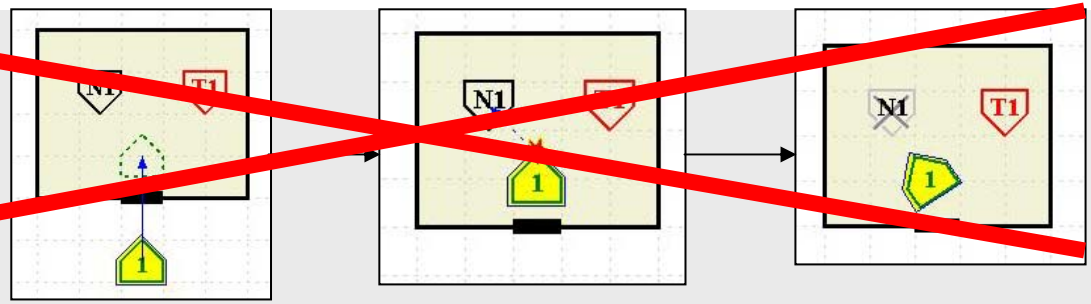
Improved HBM Development

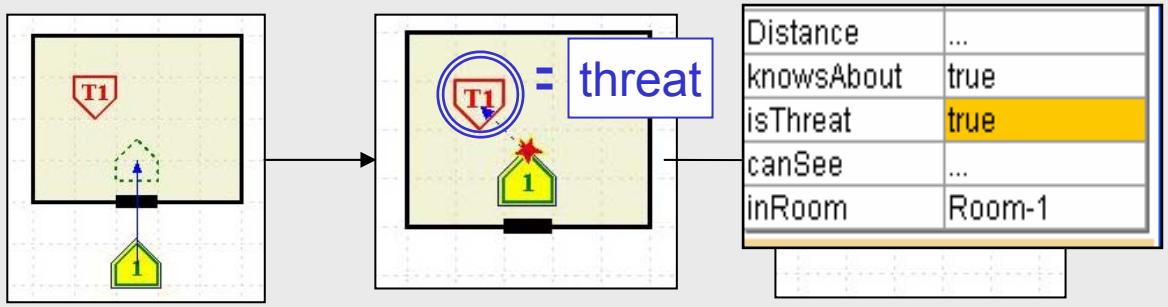
- Minimize HBM Development Cost
  - Extract maximal knowledge from examples
- Ensure Correctness of Behavior
  - Immediate verification on current example
  - *Consistency analysis across example library*
- Minimize HBM Maintenance Cost
  - Maintain validated examples, not code
  - Greatly decrease need for KE
- Minimize Cost of Tool Development & Use
  - Use same tool for multiple domains
  - *Use same tool for multiple target architectures*

Define General Tactics, not Scripted Behavior

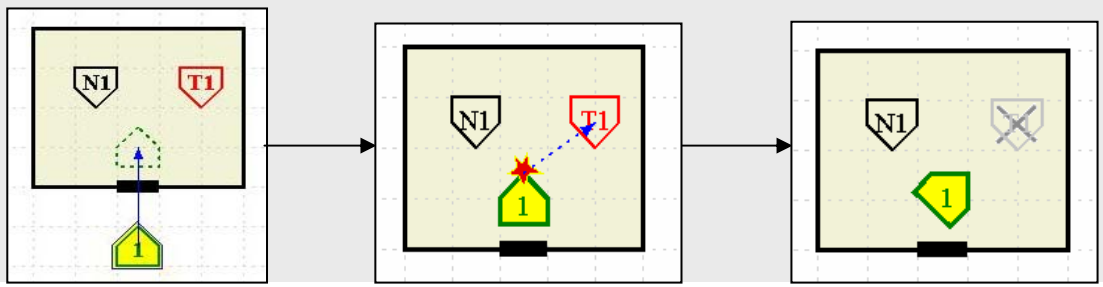
Incorrect Scripted Behavior



Original Example



Correct General Behavior



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User Controls the Generality of the Examples

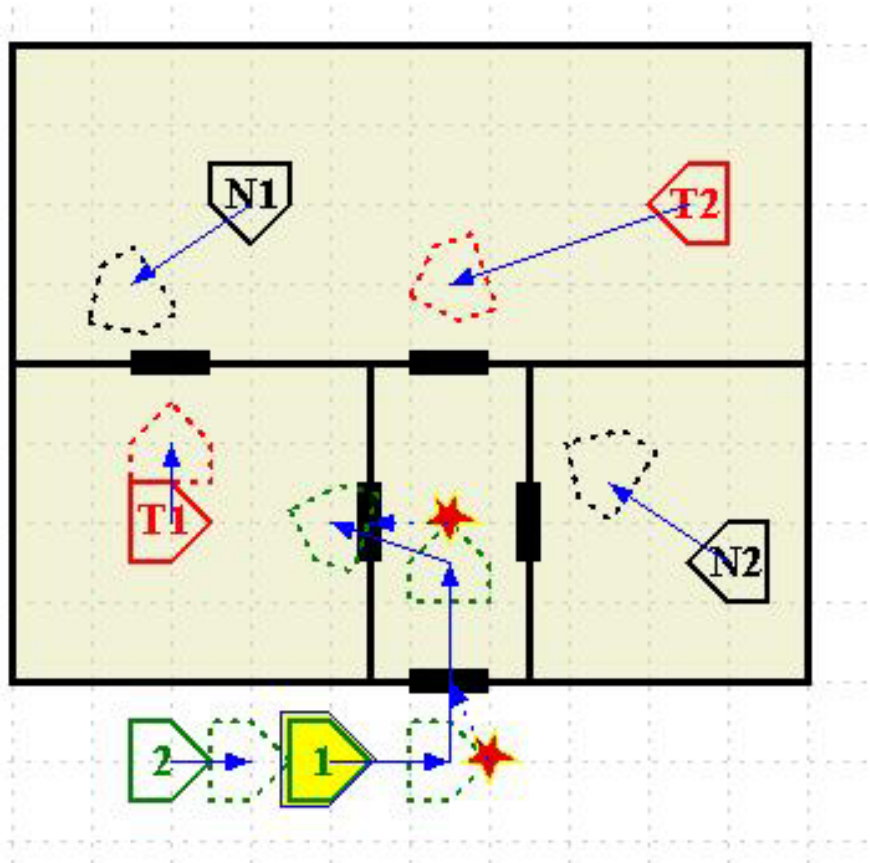
- Select few features
  - General rule
  - More coverage
  - But easier to introduce errors
- Select lots of features
  - Specific rule
  - Less coverage
  - But less chance of errors

Friendly-1	
Property	Value
canSee(Threat-1)	true
Distance(Threat-1)	Medium
Threat-1	
Property	Value
canSee	...
canSee(Friendly-1)	true
Distance	...
Distance(Friendly-1)	Medium
inRoom	Room-1
Is-a	Person
isDestroyed	false
isFriend	false
isThreat	true
nearestThreat	Friendly-1
Speech	
Stance	Standing

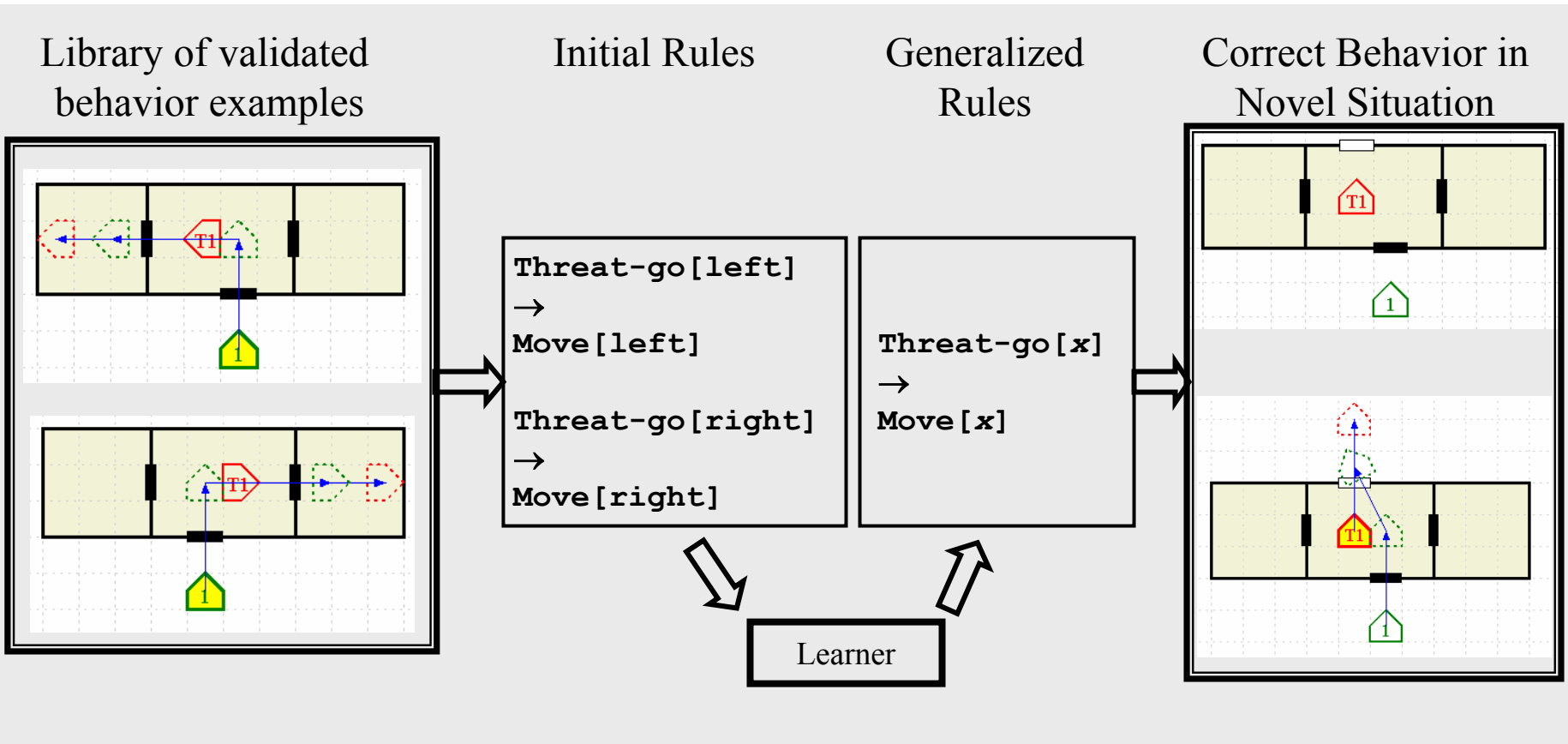
Learn Tactics for all Entities

Specify tactics for many entities in single example

- Friendly forces
- Adversary forces
- Neutrals

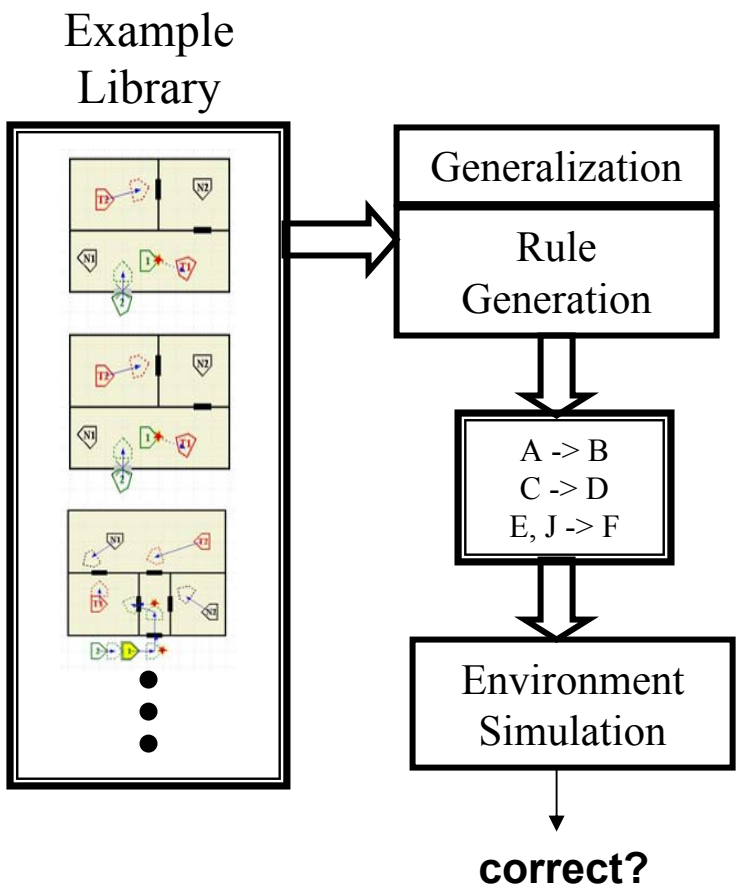


Learn Behavior for Novel Situations

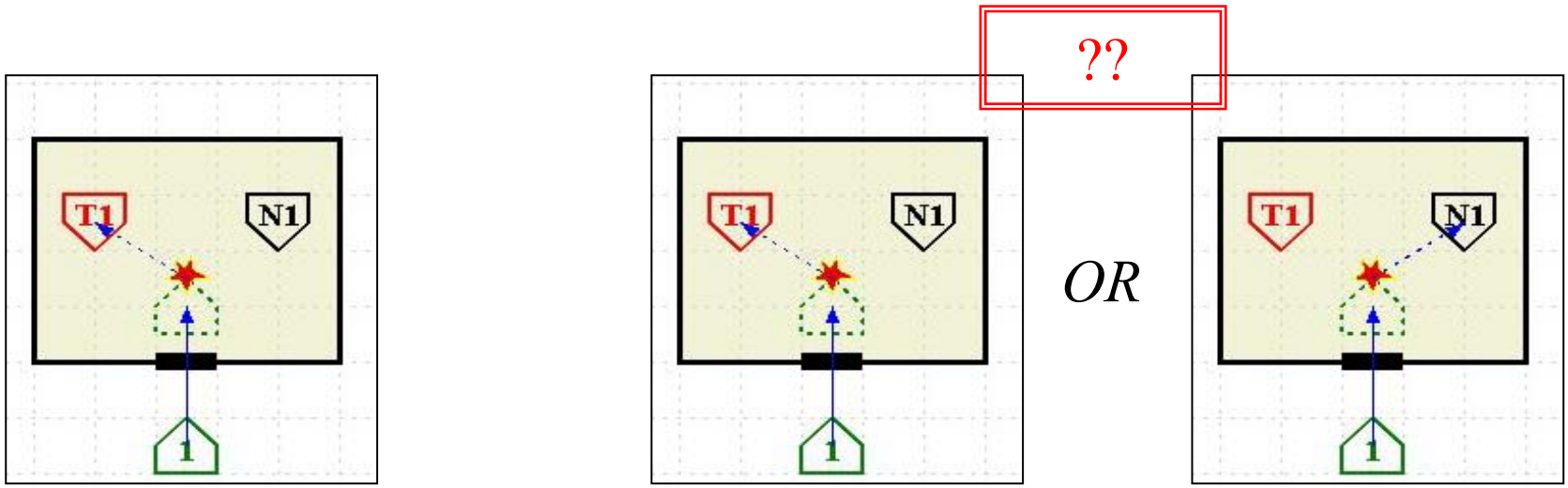


Compare to Desired Behavior Automatically

- Generate rules from example library
- Execute rules on example scenarios
- Detect when rule behavior ≠ expert behavior
- Ensures correctness



Errors are Detected Immediately

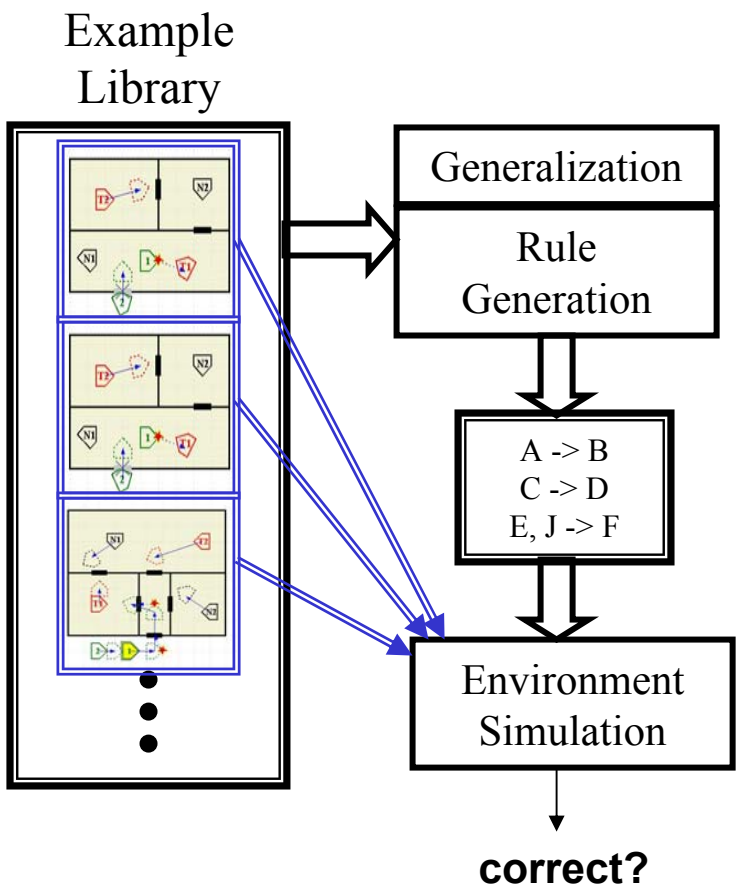


Specified behavior

- Detects if behavior could be interpreted two ways
- Tool detects this at design time – not run time

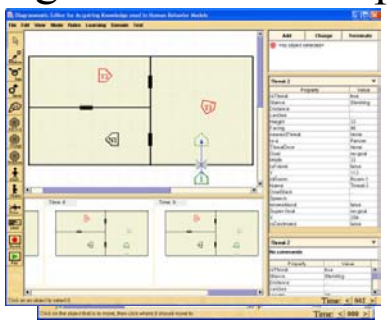
Detect Inconsistencies Across Examples

- Not limited to just testing within scenarios
- Test knowledge automatically across all defined scenarios
- With standard KA this is too expensive – usually not done at all.

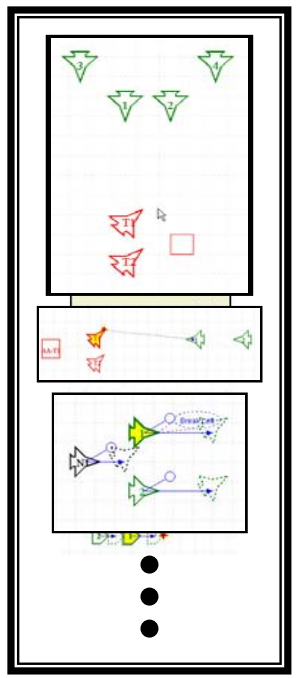


Use Tool in Multiple Domains

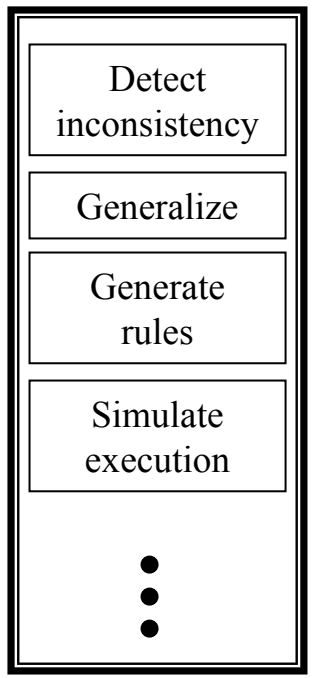
Define behavior with diagram-based examples



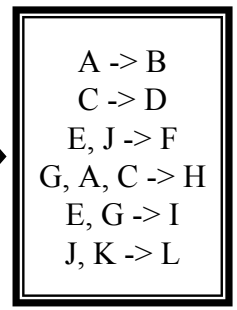
Library of validated behavior examples



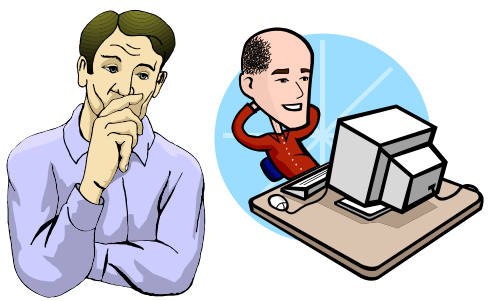
Analysis & generation tools



Rules (Soar)



Simulation Environment



SME KE

90% code base is domain independent

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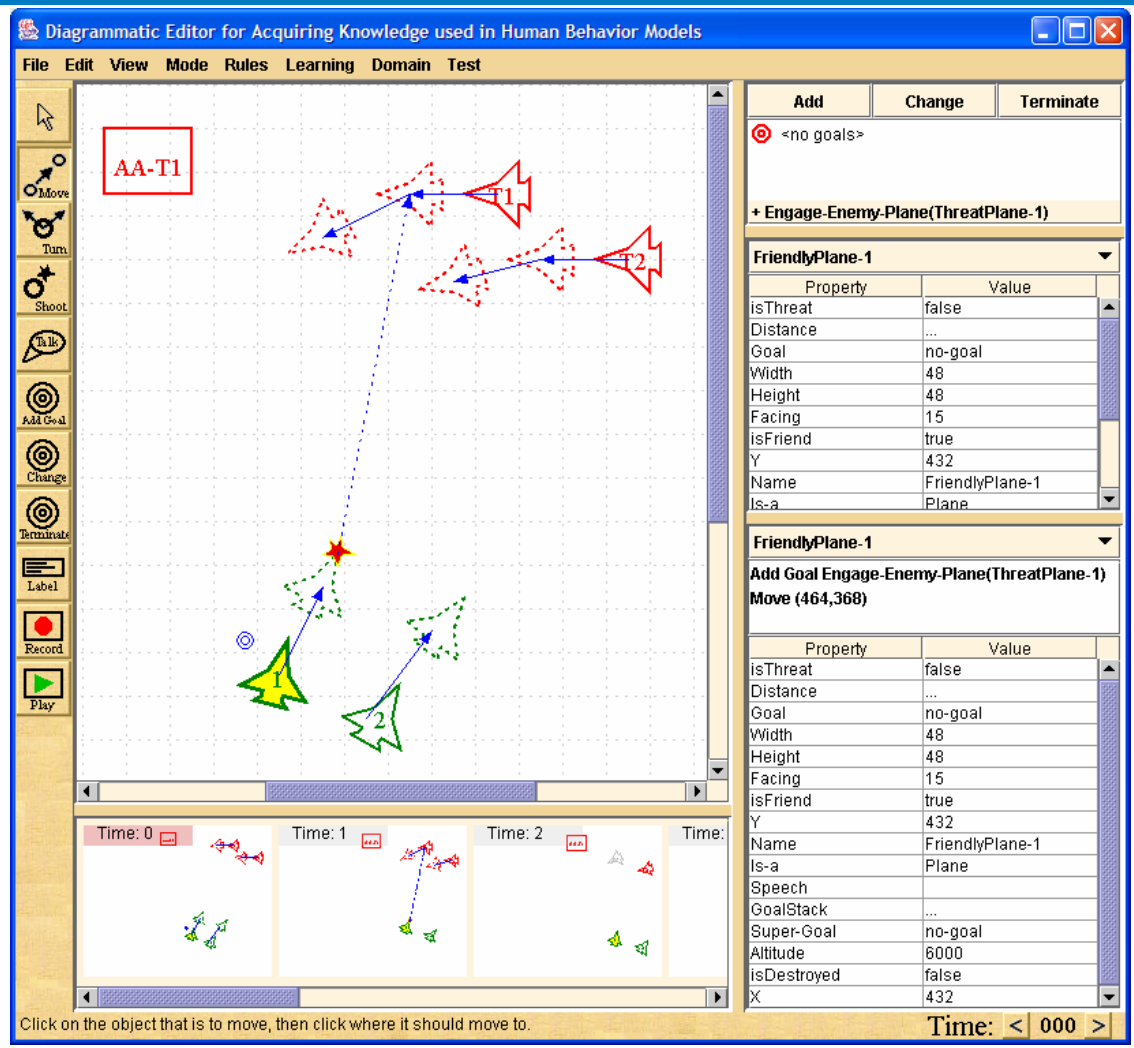
Use Same Tool for Air Domain



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Planned Evaluation

- Build an agent in the MOUT domain and compare against current development efforts.

- Additional funding required to formally evaluate.

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Nuggets

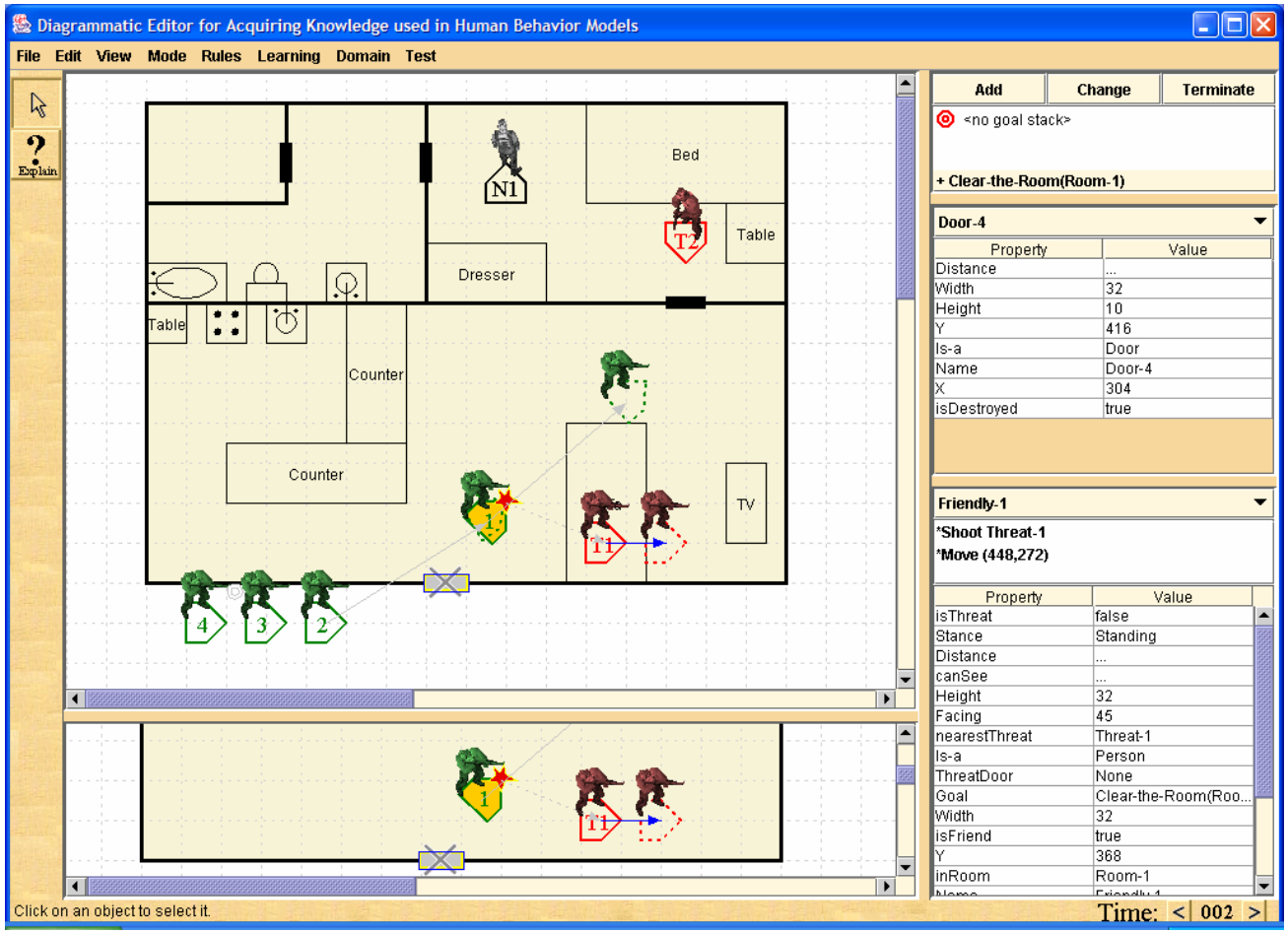
- Development Cost: 5x faster
  - 1-2 hours with tool = 1-2 days without
- Validation: 5x fewer errors
  - Eliminate errors during development
- Maintenance: 5x less effort
  - May eliminate need for KE

- Completely new opportunities for HBM use

Coal

- Still early days – mostly "potential"
- Extending the representation language (e.g. adding a new concept)
- Mapping between simulations and rules
- Interface doesn't make full use of diagrams and too hard for SMEs to use on their own
- Getting new tools adopted is always hard

The End



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