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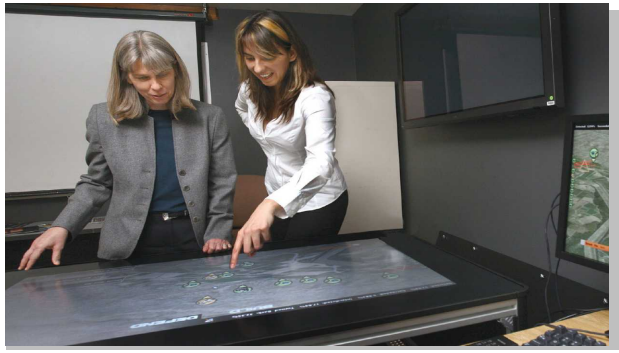

Applying Video Game AI to Physical Security

Jon Whetzel

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Interactive Systems & Analysis

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Who we are

- Operational Systems analysis and software engineering
- Simulation & Gaming Terrain Team
- Embodied Agents (Physics, Behaviors, 3D environ.)
- Live Virtual Constructive Simulations

Impact

- DOE Physical Security – Safety of NW Complex
- DOE Facility Design - Sensor layouts
- DoD Warfighter Missions – Operational Information
  - Reduce Mission Risk to Save lives

Software Tools

Modular Software Framework

Terrain Generation & Gaming

Force-on-Force Constructive and Tabletop

Sensor Operations & Path Planning

What is Wargaming?

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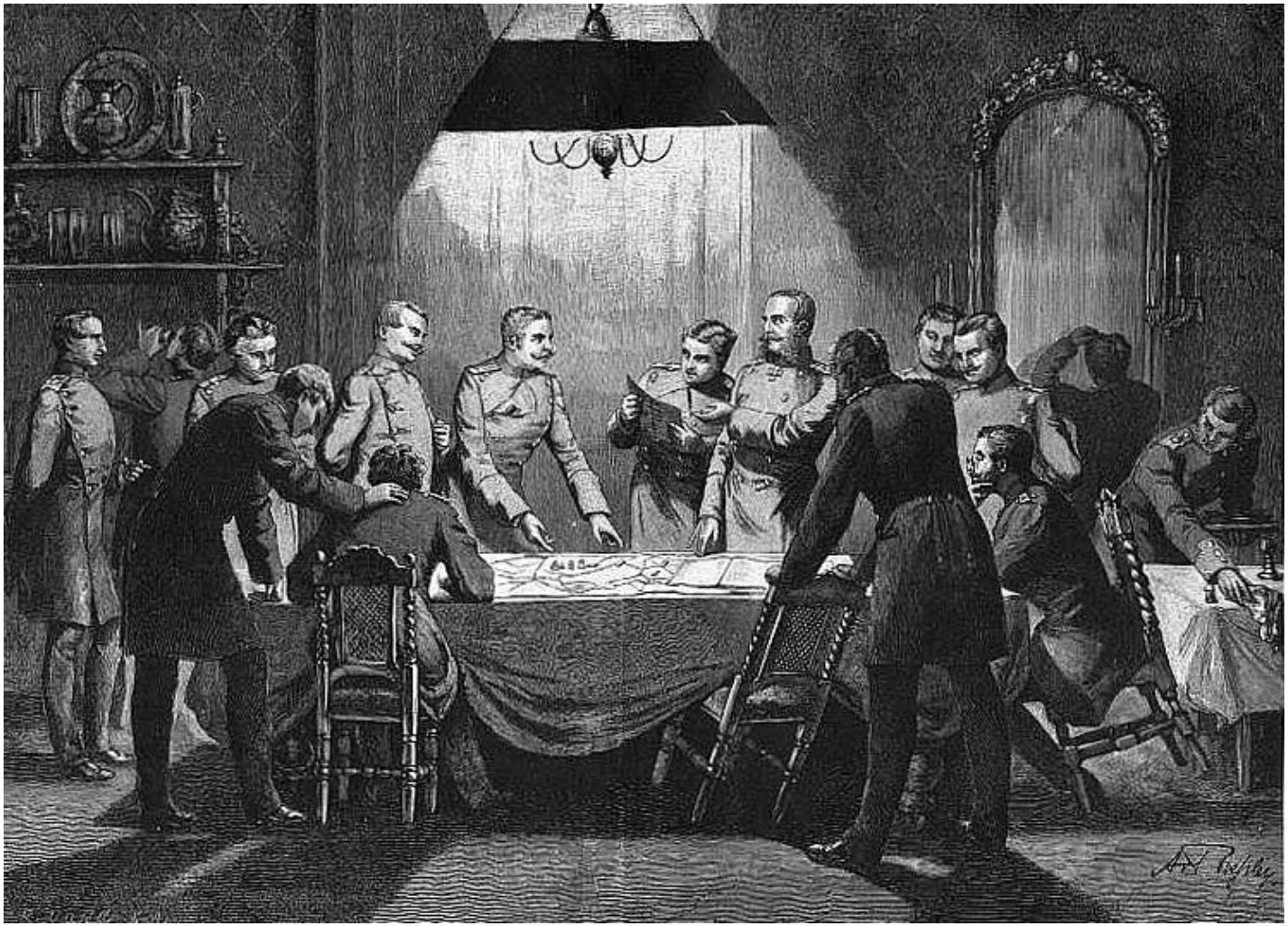

Why We Exist

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Virtual

Live

Challenges in Creating Behaviors

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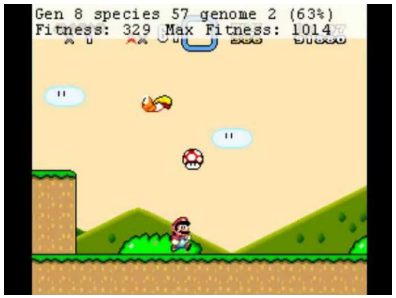
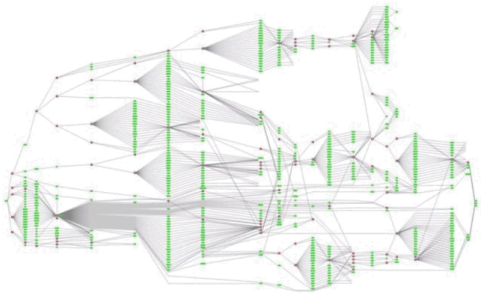
- What do we desire?
  - Behaviors need to be “realistic”: pass the test for experts
  - Architecture needs to allow for intuitive agent construction

- Where current AI trends fall short?
  - Current game AI architecture have limitations for building complex plans and/or competing goals
  - Novel trends (machine learning) not yet suitable for easily designing agents to have varying levels of expertise





Current Game AI: Behavior Trees

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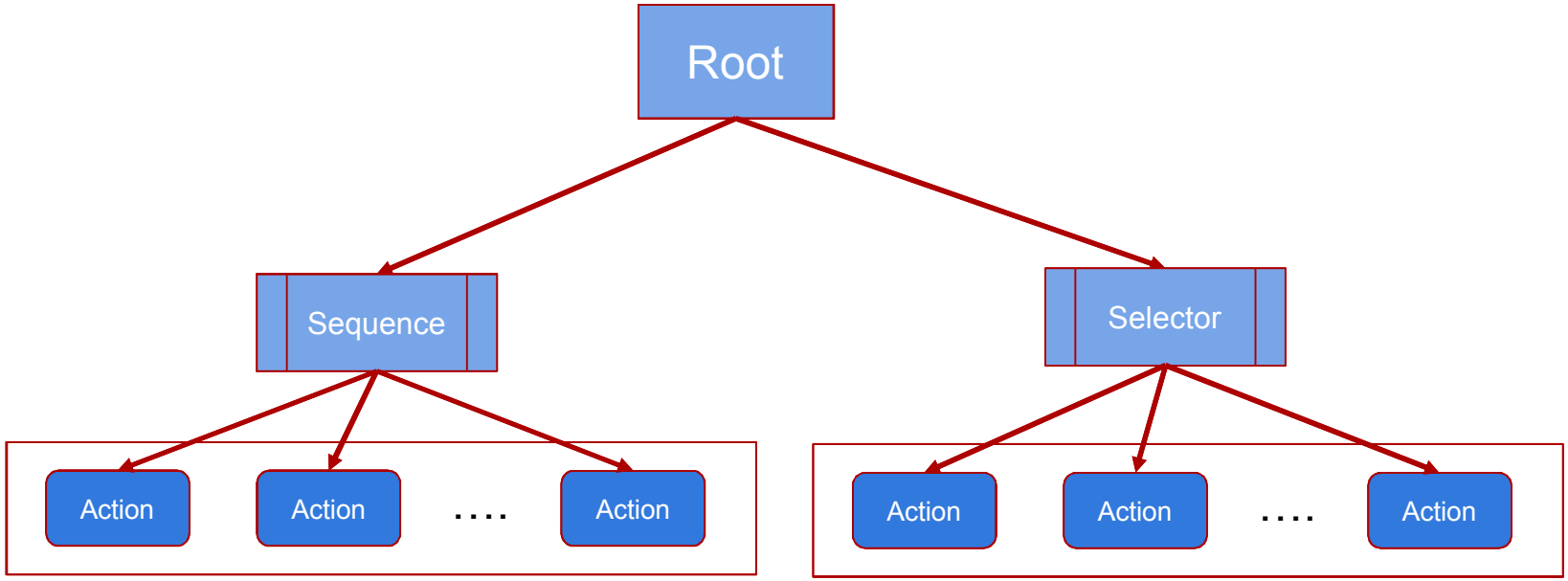
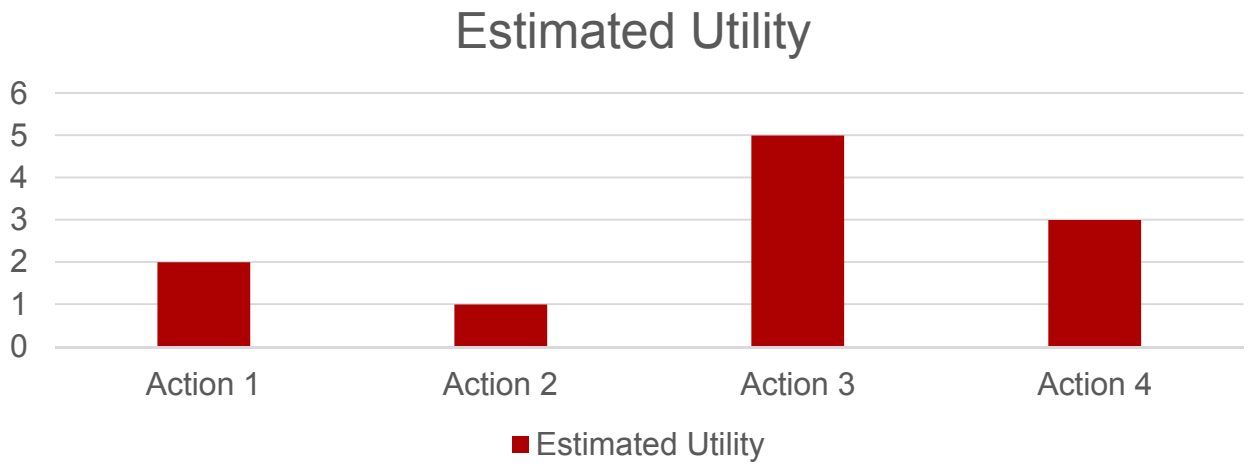


All actions must succeed to return true

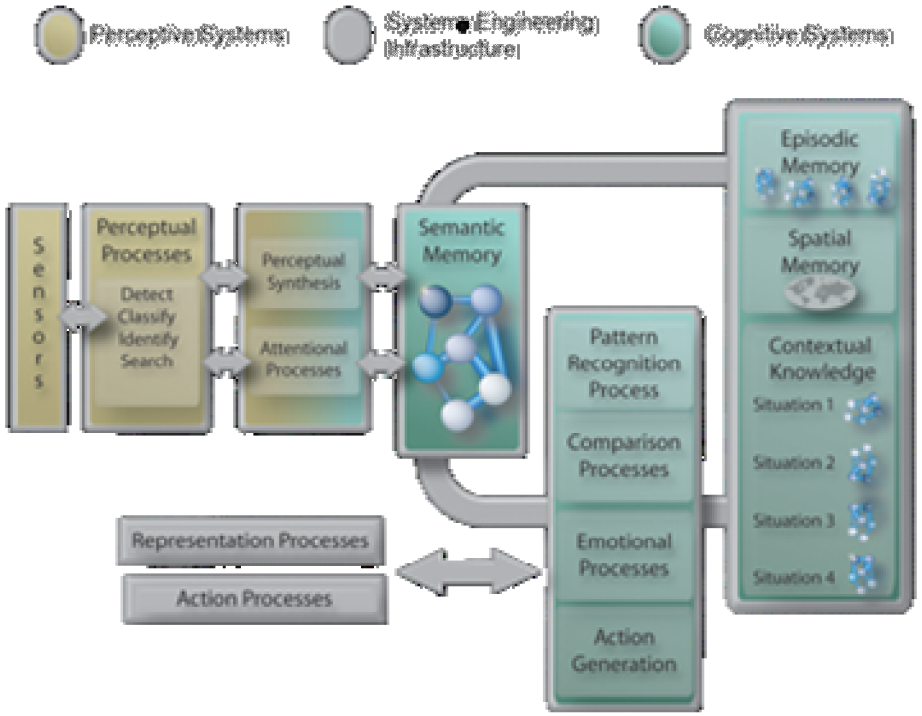
Only one action must succeed to return true

Current Game AI: Utility Theory

- $A = \{a_1, \ldots, a_n\}$ → All possible actions
- $W = \{w_1, \ldots, w_n\}$ → All possible world states
- Estimated utility of a_k
  - $EU(a_k) = \sum_{i=1}^{n} U(w_i) p(w_i \mid a_k)$

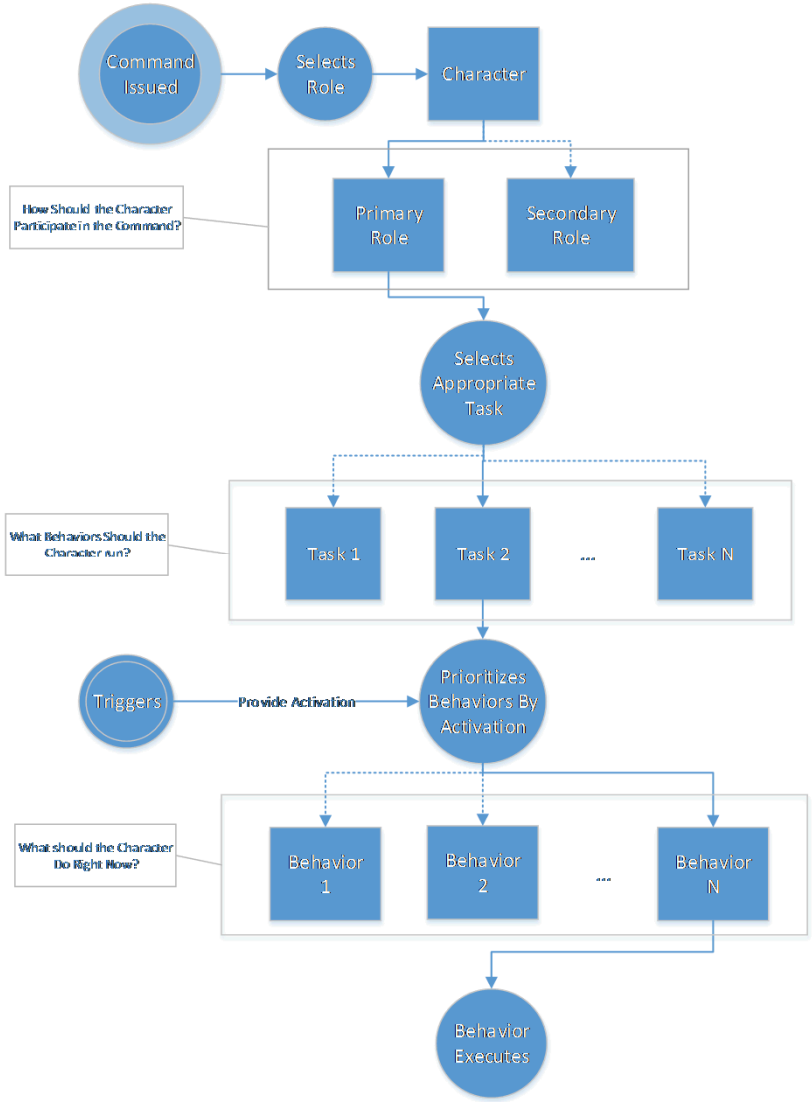


SNL Research in Cognitive Modeling



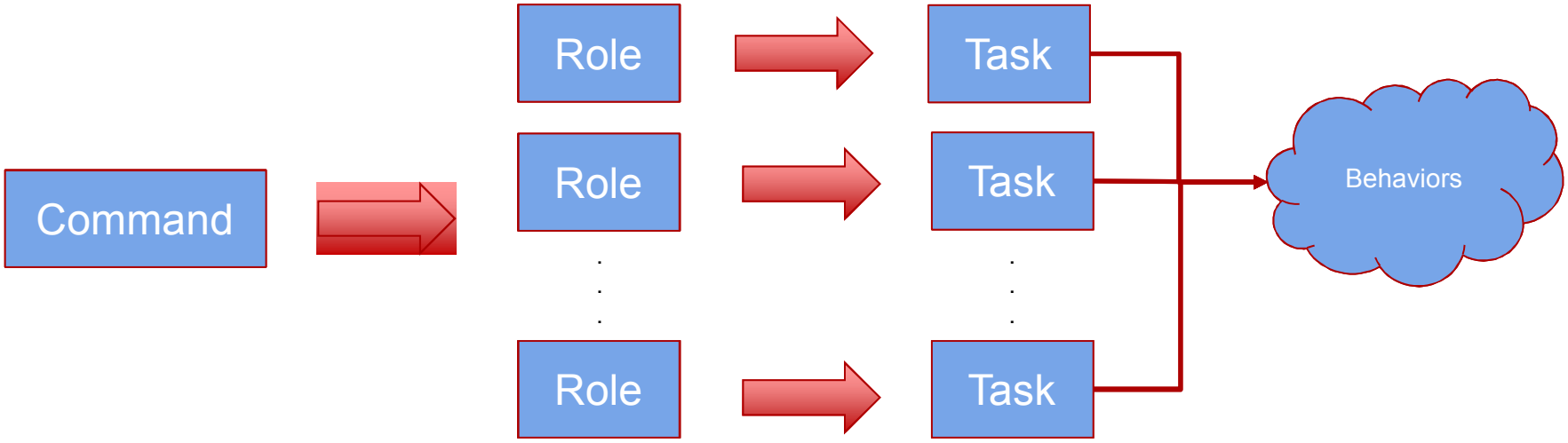
SCREAM: Sandia's Cognitive Runtime Engine with Active Memory

Dante Behavior Architecture



Commands, Roles, and Tasks

- Commands: Defines the goal for character(s) to accomplish
- Roles: Determines how each member of the team should respond to a given command
  - Why: Enables for dynamically handling role between member
- Tasks: A collection of behaviors that can be executed for satisfying the command.



Commands, Roles, and Tasks

Triggers & Character Memory

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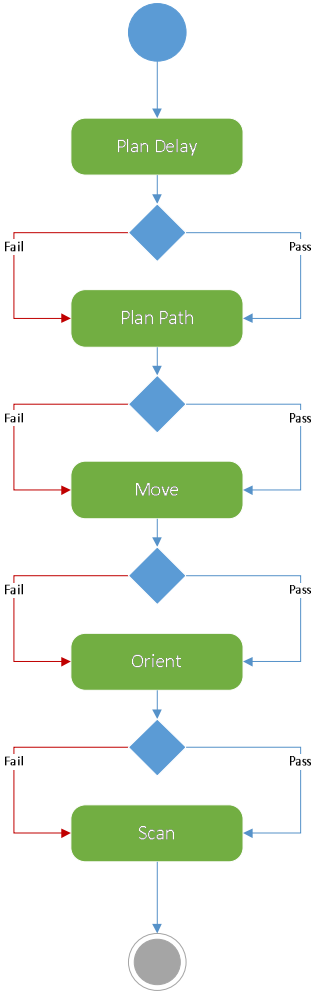
- How triggers work?
  - Triggers used to determine which behavior to run [-1 .. 1]
  - Each behavior may also have a priority [0 .. 1]
  - Triggers may be combined via AND/OR functions
  - Linear multiplier of triggers/priority determines behavior to run
- Blackboard used allocate triggers among character(s)
  - Character memory produces a set of possible trigger values
  - Character capabilities associated with set of triggers (e.g. UseWeapon)
  - Blackboard enables for team communication

Behaviors

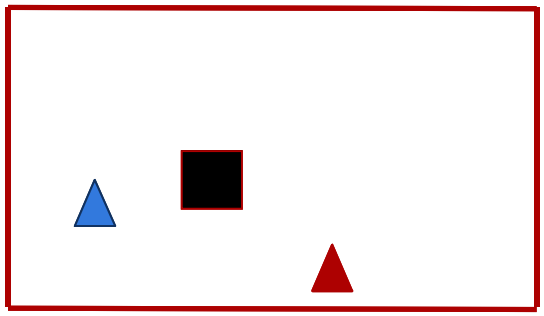
- Behaviors defined as state machines
  - Behaviors typically require a set of atomic actions
  - Easier to define than a traditional utility theory approach
  - If needed, behaviors can be a single state



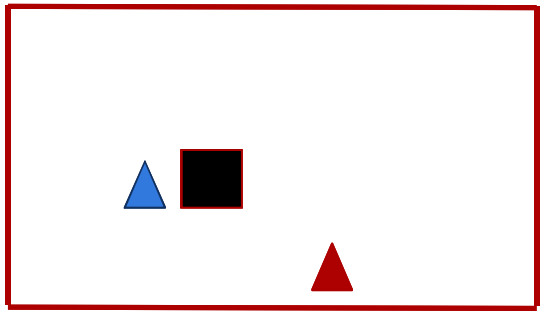
Path Planning

- Rely on A* with some tweaking to provide greater flexibility in the behaviors expressed from movement
  - ex. Stealthy, aggressive, tight/loose formations, etc

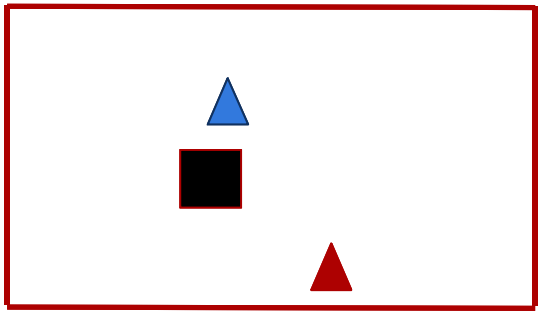
- Goal Predicates: Function that determines suitability for goal location in path search
  - E.g., Find cover → Need to seek best spot nearby to return fire



Blue needs to find cover



Shortest distance: not optimal for returning fire



Longer move time, but better location to return fire

Notional Scenario Simulation Replay

Demo

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Conclusions

- Dante behaviors considered ”valid” from many customers
- Research continues for improving realism & construction
  - Evolutionary algorithms for trigger tuning
  - Applying this as a virtual testbed for newer, AI-based sensing designs
  - Scaling for larger populations

Questions

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