Agent Goal Management using Goal Operations

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Outline

- Intelligent Autonomous Agents
- Agent Selecting Goal Operations
- The Problem Domains
- Empirical Results
- Conclusion

Intelligent Autonomous Agents

A **Cognitive System** that combines perception, actuation, and communication to operate *robustly* in the real world

- **Capabilities:**
  - Perceive: Gather information about the real world.
  - Think: Process the percepts to achieve and generate thoughts/goals.
  - Act: Perform actions in the real-world using controls.
  - Communicate: Explain thought process to other agents.
- **Issues:**
  - Unexpected events
  - Partial Observability
- **Examples:**
  - Self-driving cars
  - Humanoid robots.

- **Simon**

- **Waymo**

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Agent Selecting Goal Operations

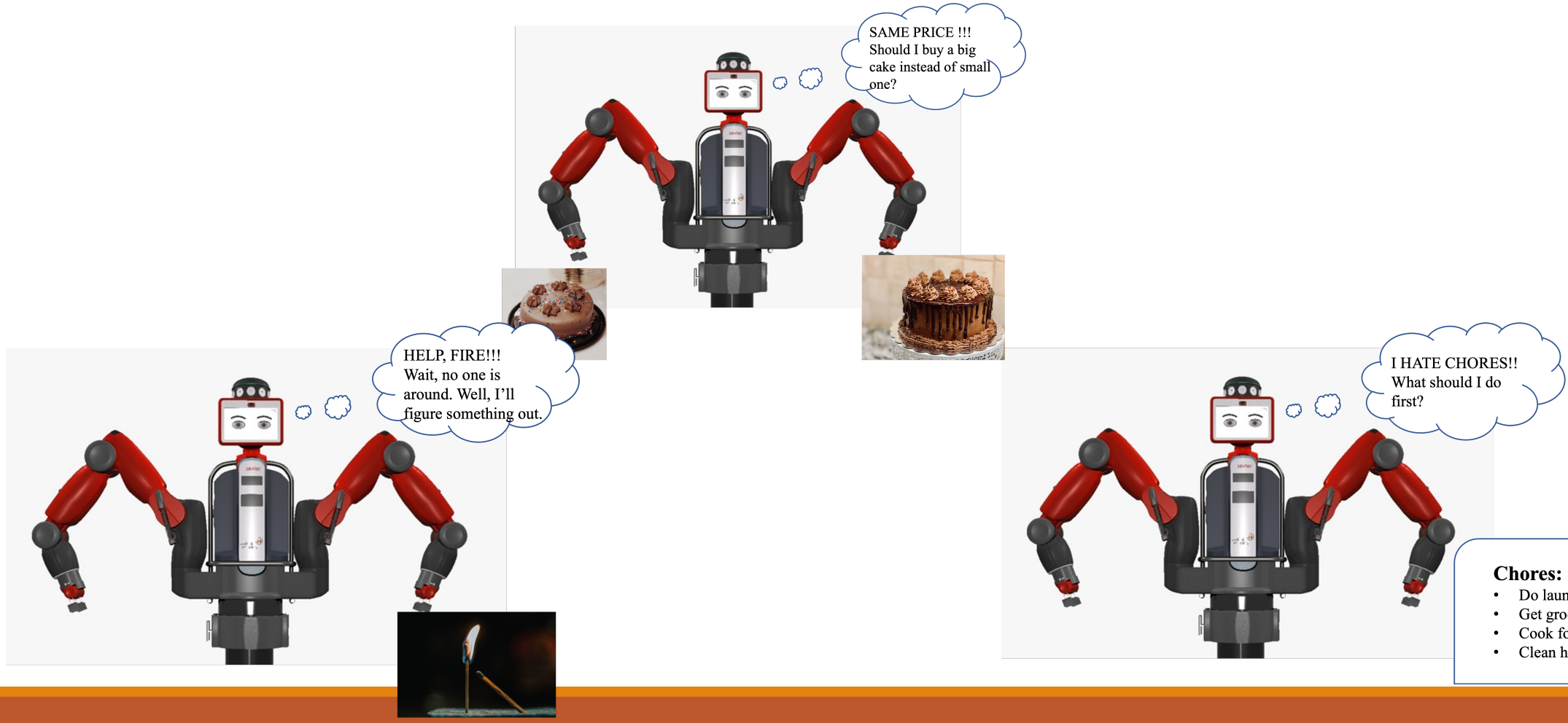
A Framework Focused on Reasoning about Agents' Goals.

Goal Operations

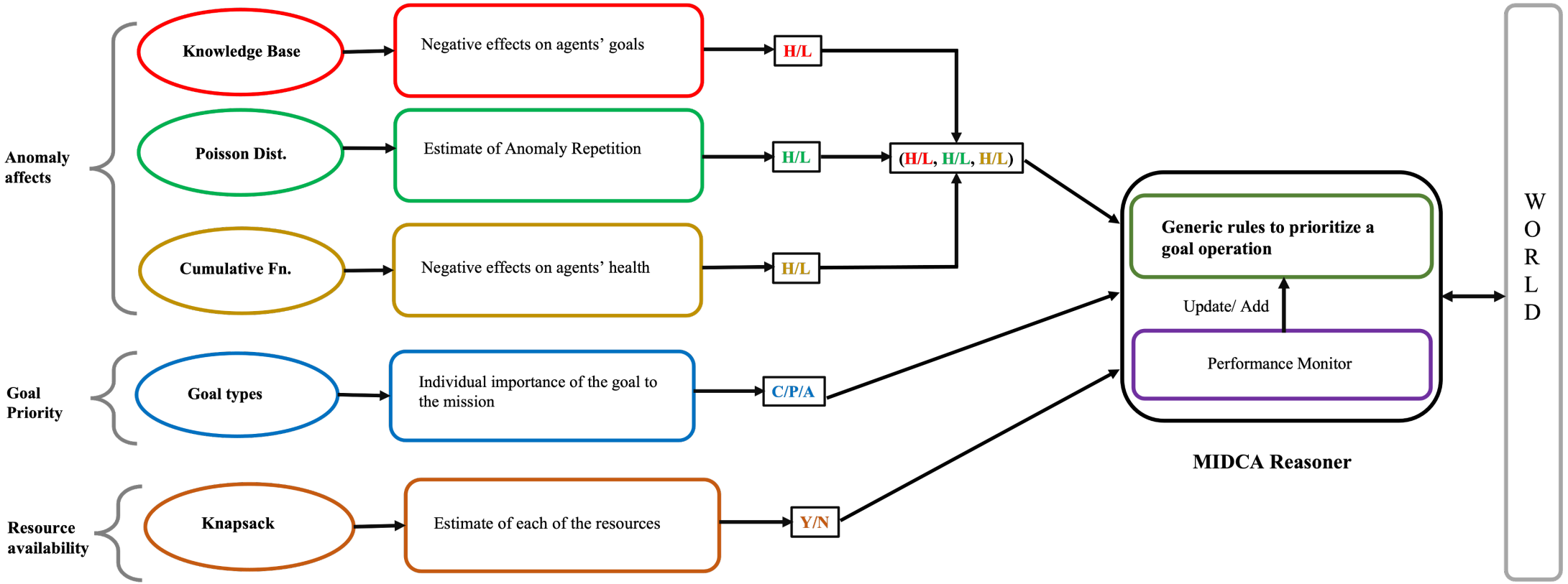
- Goal Selection: Select one appropriate goal among multiple goals.
- Goal Change: Change a goal to a similar one.
- Goal Formulation: Create a new goal.

- Cox, M., Dannenhauer, D., **Kondrakunta, S.** (2017, February). Goal operations for cognitive systems. In *Proceedings of the AAAI Conference on Artificial Intelligence, 31(1),* 4385-4391. AAAI Press.
- **Kondrakunta, S.,** Gogineni, V. R., Molineaux, M., & Cox, M. T. (In Press). Problem recognition, explanation and goal formulation. In *Fifth International Conference on Applied Cognitive Computing (ACC)*. Springer.
- **Kondrakunta, S.,** & Cox, M. T. (In Press). Autonomous Goal Selection Operations for Agent-Based Architectures. In *Fifth International Conference on Applied Cognitive Computing (ACC).* Springer.

Multiple Goal Operations co-occur



The Rational Selection of Goal Operations



- **Kondrakunta, S.,** Gogineni, V. R., Cox, M. T., Coleman, D., Tan, X., Lin, T., Hou, M., Zhang, F., McQuarrie, F., & Edwards, C. (in press). The Rational Selection of Goal Operations and the Integration of Search Strategies with Goal-Driven Marine Autonomy. In *the Ninth Annual Conference on Advances in Cognitive Systems*. Cognitive Systems Foundation.

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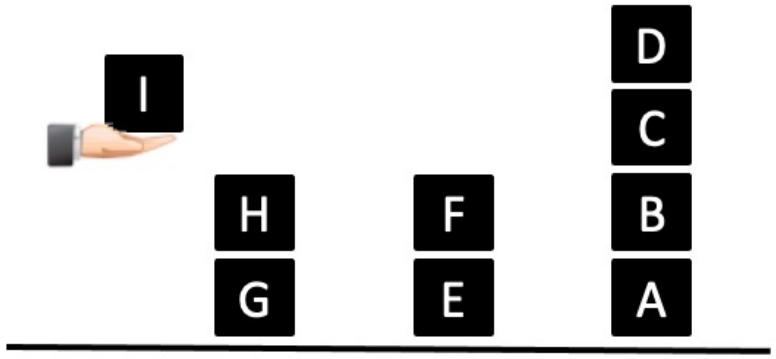
The Problem Domains

The Construction Domain and The Marine Survey Domain.

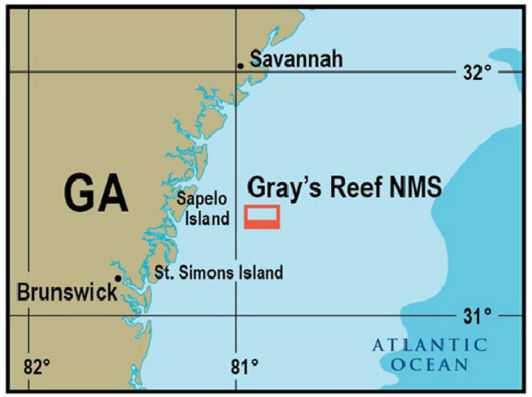
The Construction Domain



GOALS and PROBLEMS

- Construct towers
- Arsonist
- Thief

The Marine Survey Domain



Sanctuary Coordinates

Southwest: 31°21.764'N (31.362732°N)
80°55.272'W (80.921200°W)

Northwest: 31°25.264'N (31.421064°N)
80°55.272'W (80.921200°W)

Northeast: 31°25.264'N (31.421064°N)
80°49.689'W (80.828145°W)

Southeast: 31°21.764'N (31.362732°N)
80°49.689'W (80.828145°W)

- Long missions (one - two months)
- Minimum communication

Goals and Problems

GOALS

- **Gather measurements**
  - Temperature
  - Salinity
  - Pressure
- **Discover hot spots**
- **Track fish**

PROBLEMS

- **Remora attacks**
- **Blowouts**
- **Obstacles**
- **Shark attacks**

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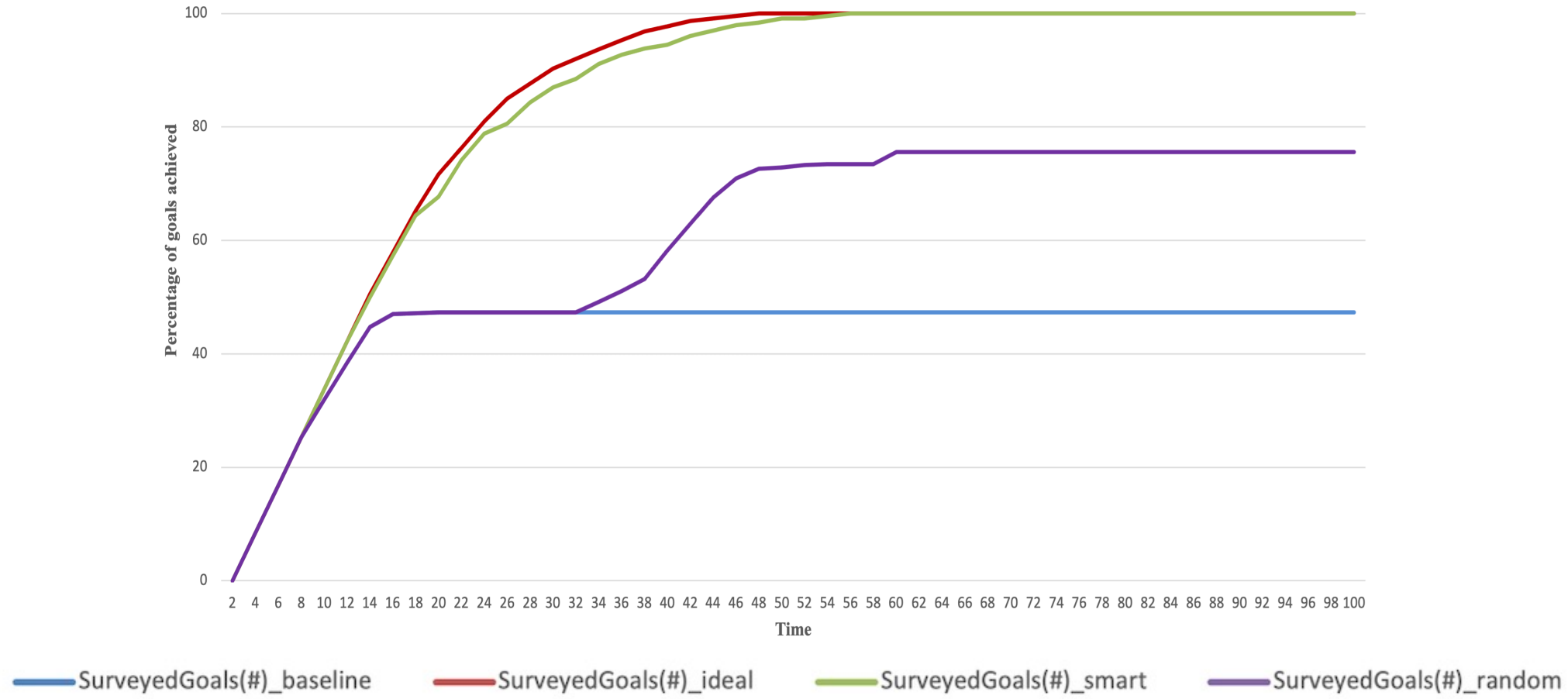
Experimental Setup: Construction Domain

- Assumption: 100 blocks and mortar.
- Agent begins construction on 30 different problem sets.
- We repeat the trials two times with two different seeds.
- Anomalies: Arsonist and Thief.
- Performance metric: Performance of goals achieved.
- Agents for comparison:
  - Baseline: Only achieves given goals
  - Random: Chooses goal operations in random
  - Smart: Uses the developed algorithm
  - Ideal: Agent working in an ideal environment.

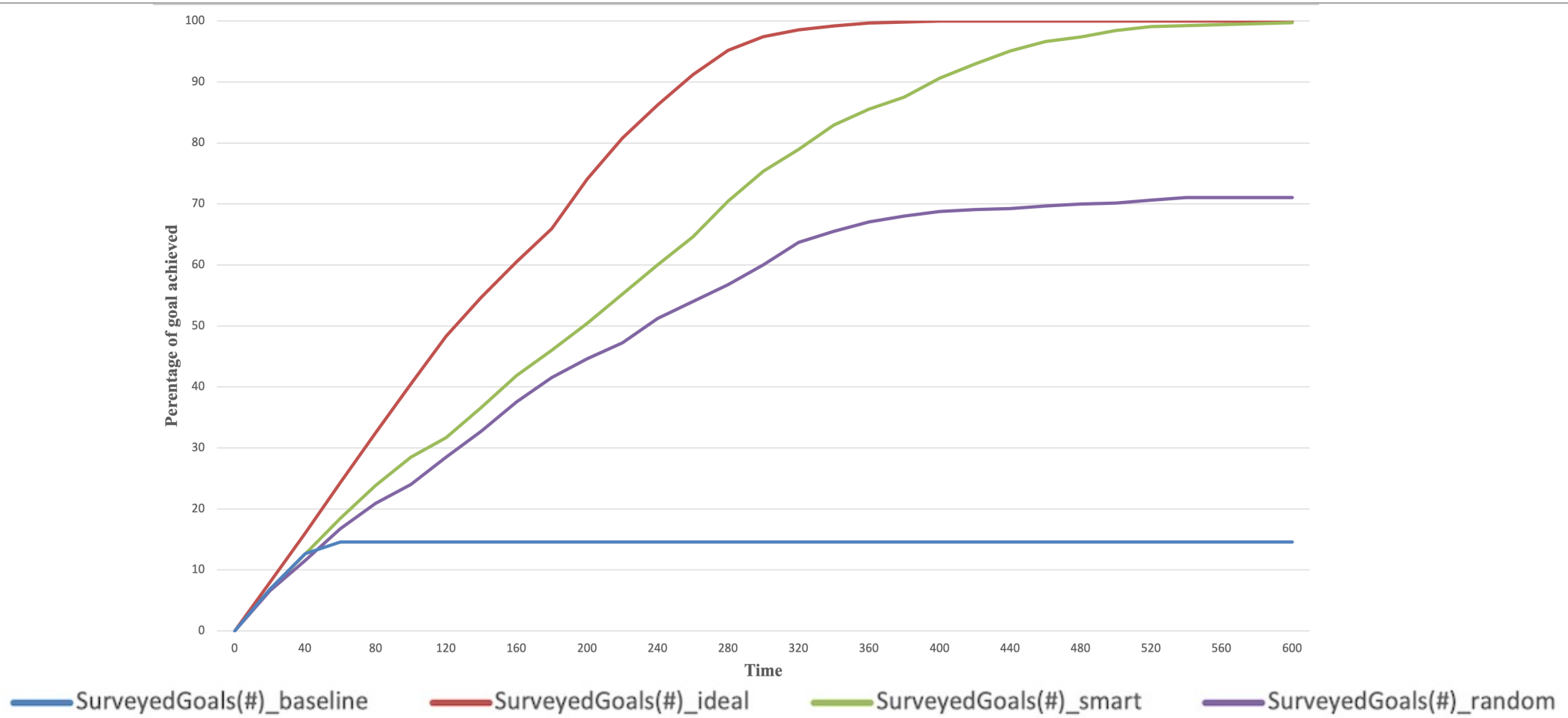
Empirical Results: Construction Domain



Experimental Setup: Marine Survey Domain

- Assumption: 1000 Fish tags
- Grace begins surveying with 100 initial starting locations, we have 100 trials.
- We repeat the100 trials 3 times with three different seeds. Therefore, the results obtained are for 300 trials.
- Anomalies: Remora attacks, blockades and flow.
- Performance metric: Performance of goals achieved.
- Agents for comparison:
  - Baseline: Only achieves given goals
  - Random: Chooses goal operations in random
  - Smart: Uses the developed algorithm
  - Ideal: Agent working in an ideal environment.

Empirical Results: Marine Survey Domain



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Conclusion

- **Open-source Code available at** https://github.com/COLAB2/midca
- Much still in preliminary stages, but exciting results are emerging
- Combining simulation studies and fielded trial promises advances in intelligent autonomous agents