Effective (Ab)se of HPC with Non-parallelized Software

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Any abuse of Sooner was purely unintentional.

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I promise.

Overview

- PhD in Computer Science from OU
- Interested in:
  - Autonomous agents
  - Multi-agent systems
  - Machine learning
  - Evolutionary computation
- Exclusively simulation
- First in research group to use Sooner
- HPC made my research possible

Scientific Problem

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Motivations for Initial Research

- Develop controllers for autonomous agents
- Authentic agent problems

→ Complex tasks

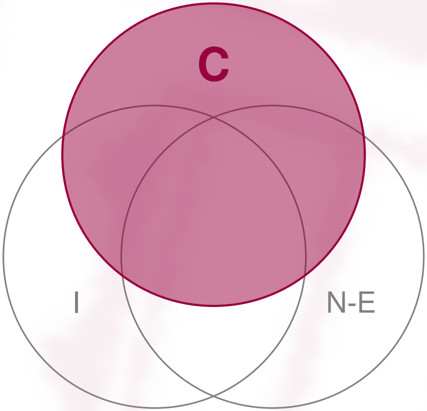
- Authentic solutions

→ Combination of techniques to solve

Motivations for Initial Research

- ▶ Develop controllers for autonomous agents
- ▶ Authentic agent problems
- → Complex tasks
- ▶ Authentic solutions
- → Combination of techniques to solve

Complex CINE Tasks



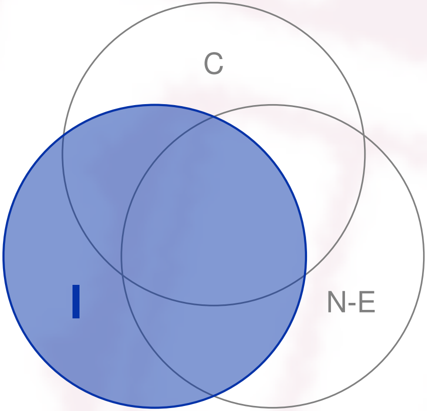
CINE

- Concurrent
- Interfering
- Non-Episodic

Details

Multiple tasks actively being addressed

Complex CINE Tasks



CINE

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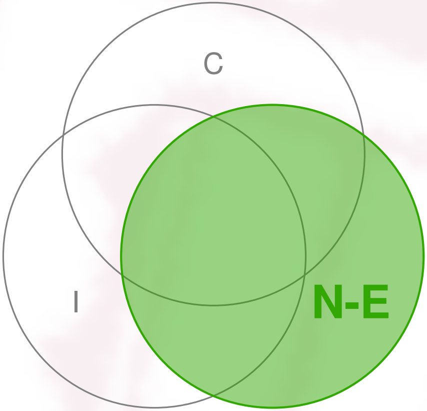
Details

Tasks have competing goals and share the same action space

Complex CINE Tasks



CINE

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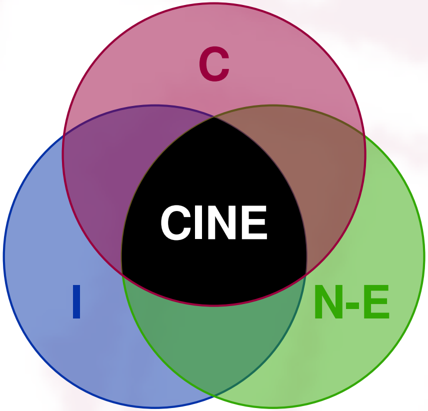
Details

Tasks do not terminate and are always active

Complex CINE Tasks



CINE

- Concurrent
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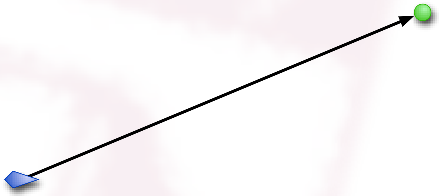
Details

Tasks in the intersection are the most difficult

Complex CINE Tasks: Examples

Active Tasks

- GoalSeek
- CollisionAvoidance
- RunAway
- Flocking
  - Alignment
  - Cohesion
  - Separation



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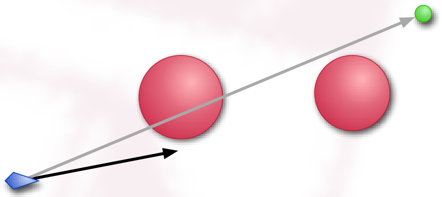

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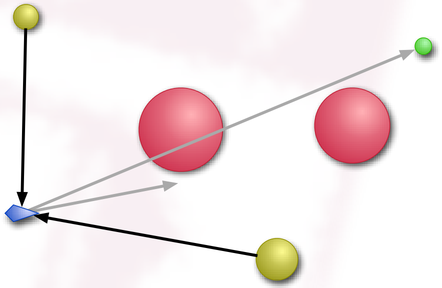

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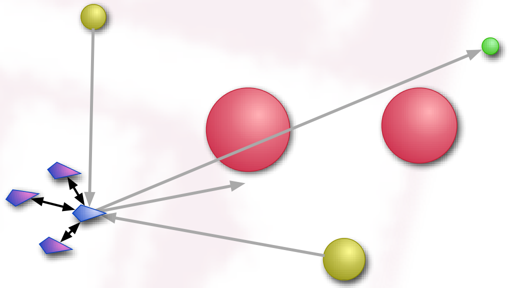

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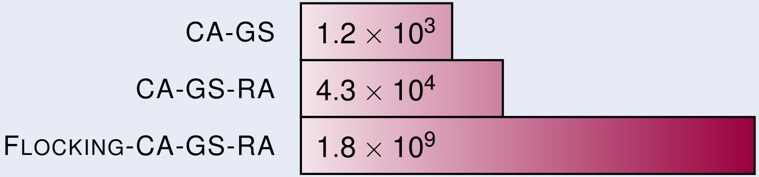
Research Motivations

Log comparison of state space sizes



- Developing controllers for these tasks is difficult
- Need to make development of controllers practical
- State and action abstraction can help, but
- What are the benefits/costs of abstraction?

Experiments

- Developed controllers using different levels of abstraction
- Controllers were learned using:
  - Reinforcement learning (RL)
  - Evolutionary computation (EC)
- A total of 72 different experiments
- Each experiment required 40 runs

Recent Research

- Parameter choice in EC is a black art
- Are these parameters good?
- Triple Parameter Hypothesis tries to predict, but
- Does it work for a variety of problems?
- A total of 23 experiments
- Each experiment required 4,400 runs

Using HPC to Accomplish the Science

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Software Limitations

- Programming Java for 10 years
- ECJ project in Java
    - Multi-threaded
    - Not really useful for Sooner's architecture
- Custom simulator in Java
- Sooner has an old version of Java installed
- Java and MPI didn't mix

Options

1. Spend time parallelizing existing project
2. Rewrite in C++ and use MPI
3. Abandon hope

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Parallelizing the software is only one option...

The Ace Up My Sleeve

- Remember the total number of runs?

Simulation	$72 \times 40 =$	2,880
Parameters	$23 \times 4,400 =$	101,200

- Why not parallelize the runs?
- More bookkeeping, but
- Won't change working code

Scripting to the Rescue

- Need to deal with:
  - Submitting jobs
  - Identifying failed jobs
  - Organizing results
  - Analyzing results
- Scripts can do all these things
- A full program is too much
- Used Perl and Bash scripts
  - Bash for scripting command line
  - Perl for parsing and analysis

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So, How Did I Abuse Sooner?

- It wasn't my fault
- It was their scheduler
- Other jobs required *N* nodes at once
- Mine took single nodes when available
- Kept recycling jobs on same nodes
- Other jobs were starved

Questions?

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