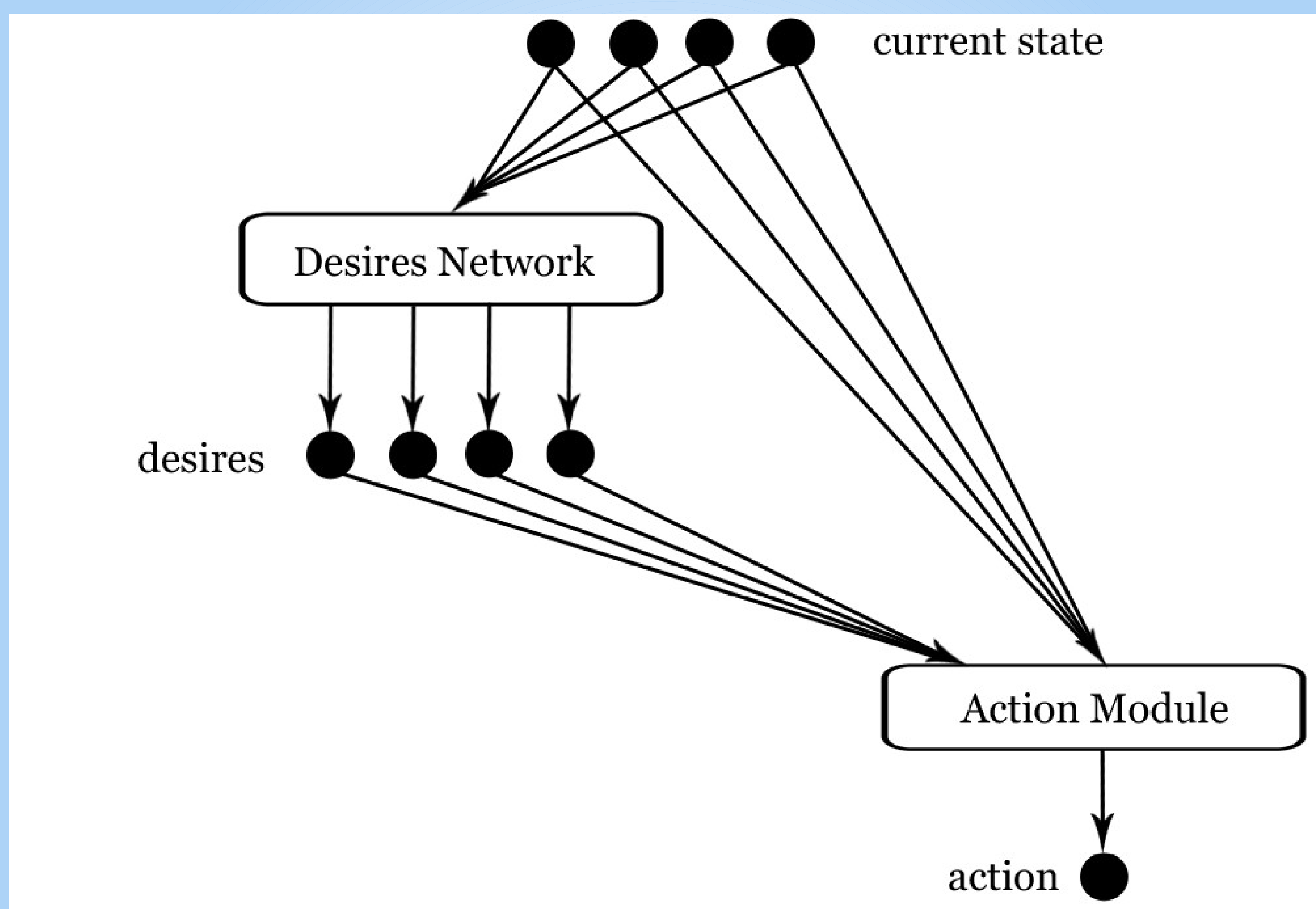
Evolving Robotic Desires: A New Approach to Bridging the Reality Gap

Russell Toris, Dickinson College '11
Advisor: Prof. Grant Braught

Overview

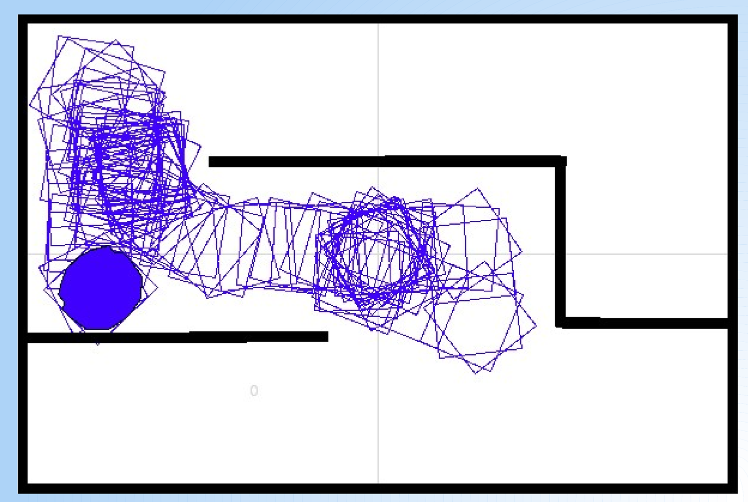
- **Evolutionary Robotics** is the approach of evolving controllers for autonomous robots through the modeling of biological evolutionary phenomena. Such an approach has established benefits over a more traditional hand-coded approach.
- **The Reality Gap Problem** emerges from a decrease in performance when transferring a robotic controller from a simulator (used to speed up the evolutionary processes) to the physical robot. In this research, a new approach to bridging this gap is presented and explored.
- **Robotic Desires** are generated by an agent based on its current state (e.g. sensor values). It then uses a technique known as reinforcement learning to select actions that achieve these desires (depicted in the figure to the right).
- **The Goal** is to have a robotic controller adapt to differences, uncertainties, and perturbations within the real world once transferred from simulation.

The Framework



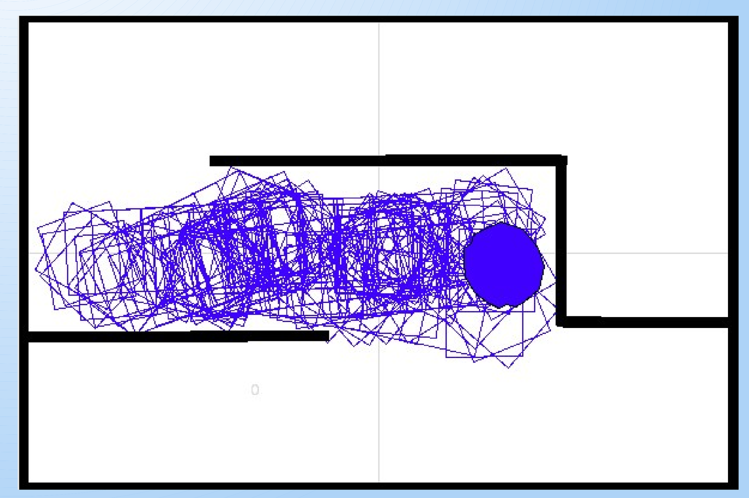
The agent passes its current state into the *Desires Network* (an artificial neural network) to produce a set of desires. The *Action Module* then learns what actions will best satisfy these desires.

Robotic Domain

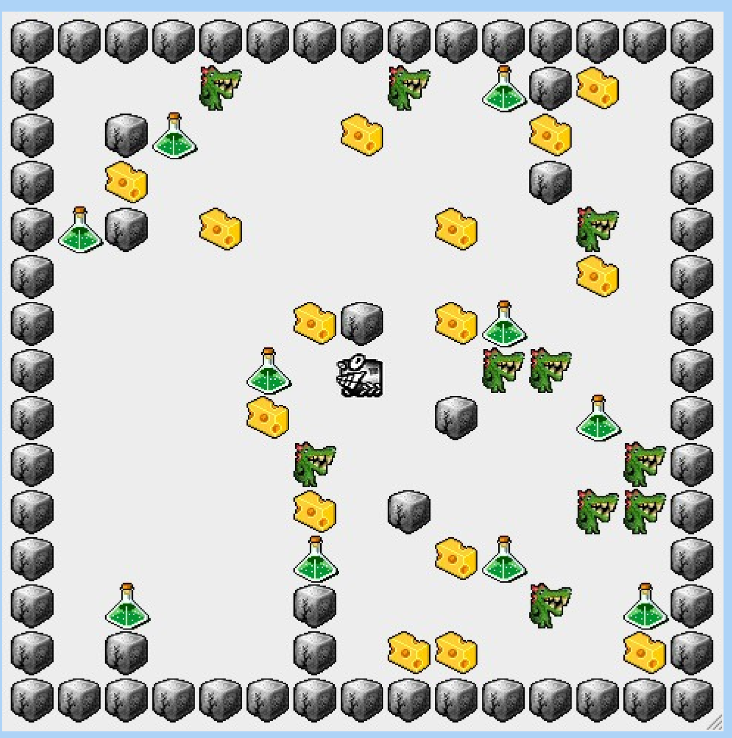


A Khepera III Robot successfully evolves obstacle avoidance using the proposed framework. It is able to choose appropriate actions based solely on its desired sensor readings.

An alternate representation of the desires is used to evolve a longer lasting robot. Desires now represent *bigger* or *smaller* sensor readings as opposed to actual sensor values.



SimpleWorld Domain

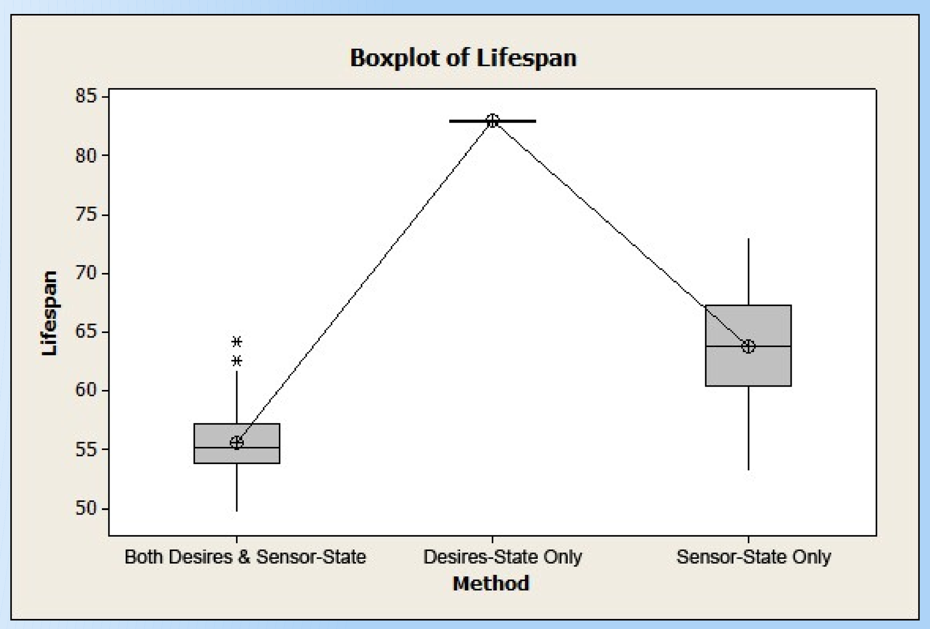


- A *SimpleWorld* is an elementary gird-world model consisting of a single agent.
- The agent has 3 color sensors and 1 smell sensor to detect objects in the world.
- Agents have three basic actions:
  - Move Left
  - Move Right
  - Move Forward

- Overlaps in smell create a sense of uncertainty in the world.
- The goal is to evolve an agent that can overcome these uncertainties.

Object	Color	Smell
Food	*green*	*sweet*
Poison	*green*	*sour*
Predator	*red*	*sour*
Obstacle	*red*	*none*

- 3 separate experiments run.
- An agent used one of the following for the action module:
  - only its current sensor-state
  - only its desires
  - both its desires and current sensor-state
- Each was compared to see which could produce the longest living agent in 35,000 random *SimpleWorld*s.



- Boxplots show clear statistical evidence that using only the desires information helps to overcome uncertainty.

Conclusions

- Evolution is capable of producing appropriate desire values for the action module to learn.
- The proposed framework is able to overcome uncertainty.
- Such a model can be used in multiple domains including the *SimpleWorld* and robotic domains.
- Porting the best learned controllers to physical robots shows promising future results.

Sources

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