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

SimpleWorld Domain

- A *SimpleWorld* is an elementary grid-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.

<table>
<thead>
<tr>
<th>Object</th>
<th>Color</th>
<th>Smell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>green</td>
<td>sweet</td>
</tr>
<tr>
<td>Poison</td>
<td>green</td>
<td>sour</td>
</tr>
<tr>
<td>Predator</td>
<td>red</td>
<td>sour</td>
</tr>
<tr>
<td>Obstacle</td>
<td>red</td>
<td>none</td>
</tr>
</tbody>
</table>

- 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 *SimpleWorlds*.

- 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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