



Human
Computer
Interaction

Artificial Curiosity

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What is Curiosity?

- An intrinsic drive towards “interesting” situations
- “Many interesting things are unexpected, but not all unexpected things are interesting.” – Juergen Schmidhuber



Curiosity Rewards

- Humans and many animals learn from reinforcements (rewards/punishment)
- Examples of primary reinforcements: food, sex, pain... and “interestingness?”
- Evidence: primate dopamine neurons fire reward signals in novel situations
 - Kakade, S. & Dayan, P. 2002. Dopamine: Generalization and Bonuses. *Neural Networks*, 15, 549-559.



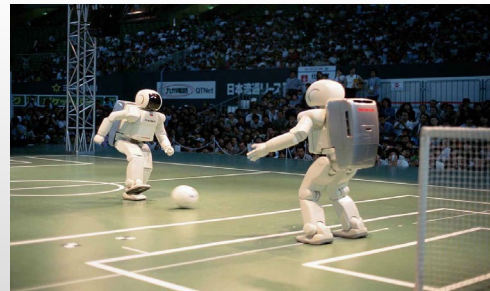
So What is “Interesting?”

- “...situations which are neither too predictable nor too unpredictable.” “...the edge of order and chaos in the cognitive dynamics.”
 - Oudeyer, P. & Kaplan, F. 2004. Intelligent Adaptive Curiosity: A Source of Self-Development. *In Proceedings of the 4th International Workshop on Epigenetic Robotics, Volume 117*, 127-130.
- Based on previous experience (very subjective!)



Why Artificial Curiosity?

Robots and software agents today depend on human teachers; they lack an intrinsic drive to seek new information

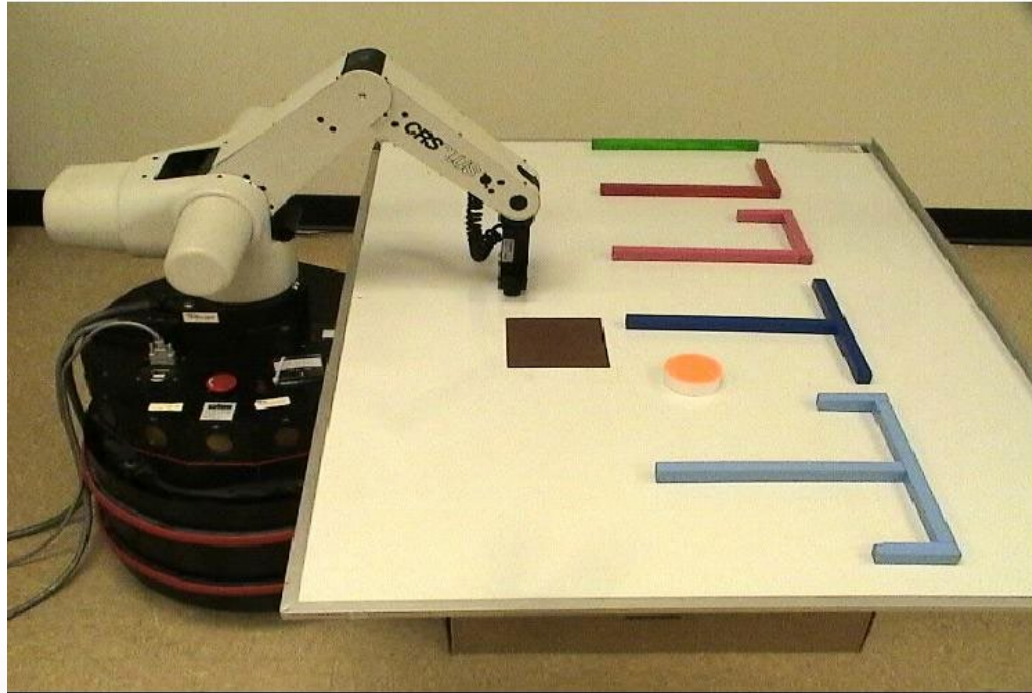


Hypothesis

Curious agents will learn broader, more robust sets of skills (even if they must develop more slowly)



Examples of Autonomous Self-Development



Stoytchev, A., "Autonomous Learning of Tool Affordances by a Robot", *In Proceedings of the Twentieth National Conference on Artificial Intelligence (AAAI), Pittsburgh, Pennsylvania, July 9-13, 2005.*



Examples of Autonomous Self-Development



Oudeyer, P., Kaplan, F.; Hafner, V.V., & Whyte, A. 2005. The Playground Experiment: Task-Independent Development of a Curious Robot. *In Proceedings of the AAAI Spring Symposium Workshop on Developmental Robotics.*



How to Model Curiosity

- Agents must develop predictive models of their environments
 - “Based on what I’m seeing, what will happen next?”
- Predictive models enable simulated experiences/imagination

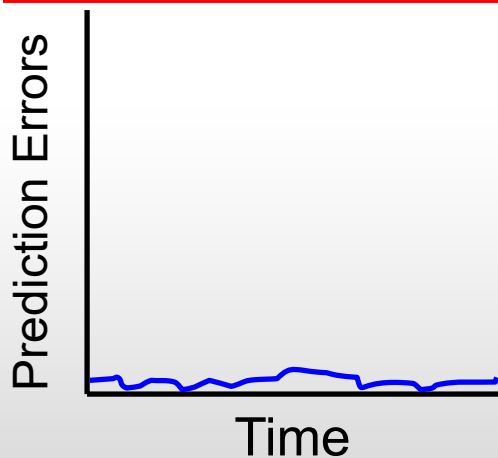


How to Model Curiosity

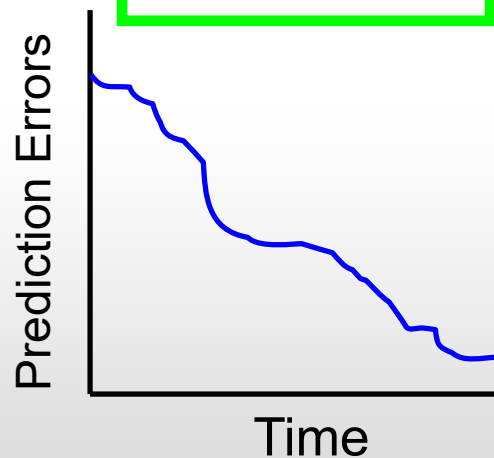
Reward agents in situations that become *more predictable* over time

- Schmidhuber, J. 1991. Curious Model-Building Control Systems. *In Proceedings of the International Joint Conference on Neural Networks, Singapore, Volume 2, 1458-1463.*

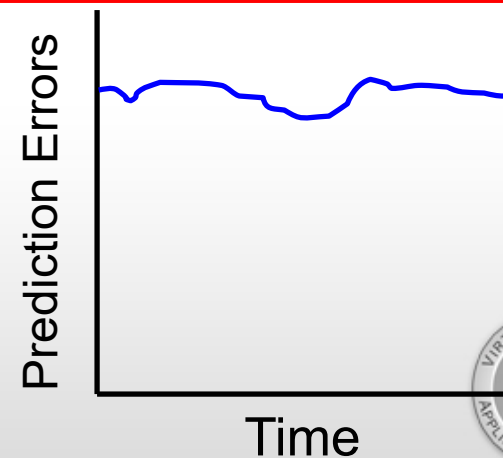
Boring (Too Predictable)



Interesting!



Boring (Too Unpredictable)



Open Source Implementation



Verve

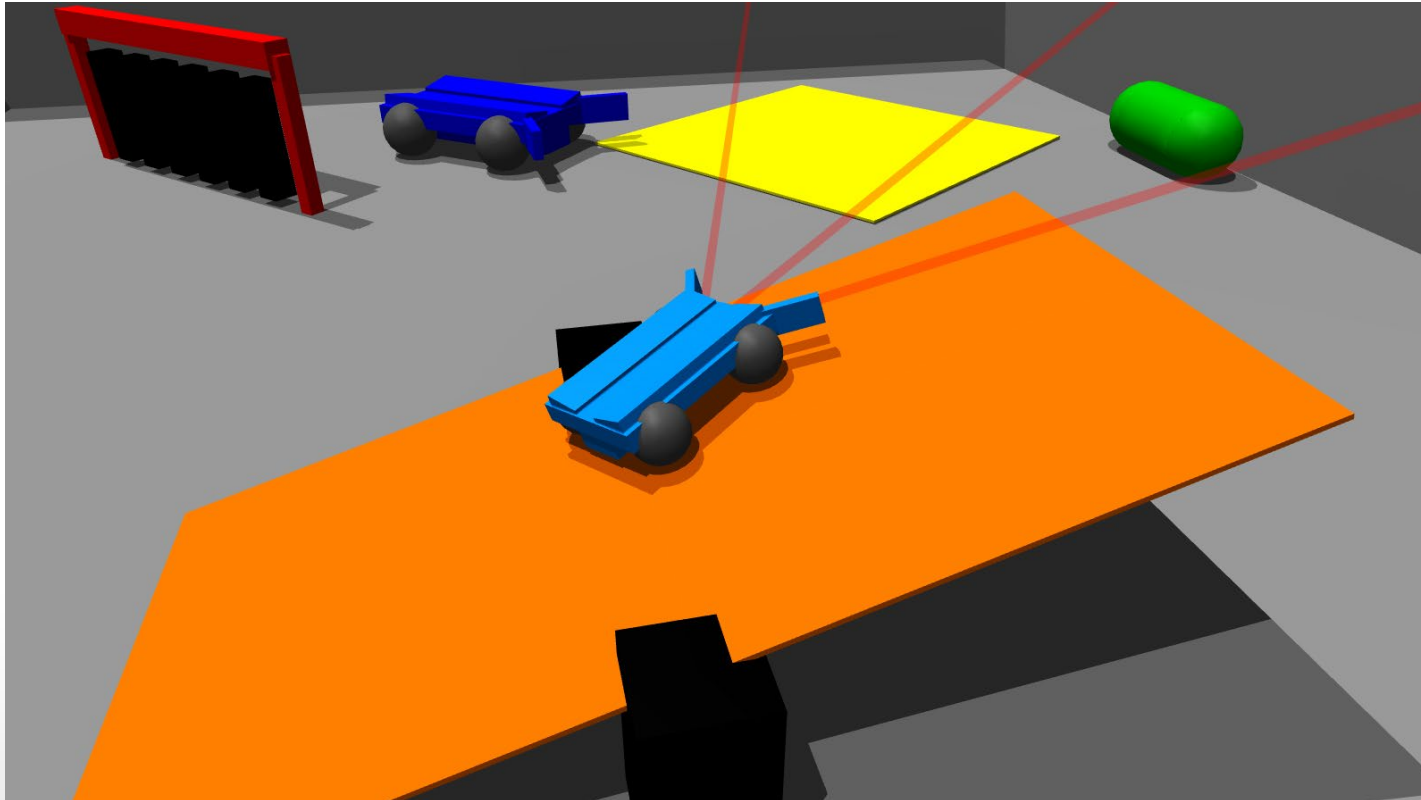
General Purpose Agents

Verve: an open source implementation of curious software agents, developed by Tyler Streeter

<http://verve-agents.sourceforge.net>



Interactive Demo



Tyler Streeter, Curious mobile robot demo, HCI Forum 2006

