Curiosity: Emergent robot behavior through interacting multi-level predictions

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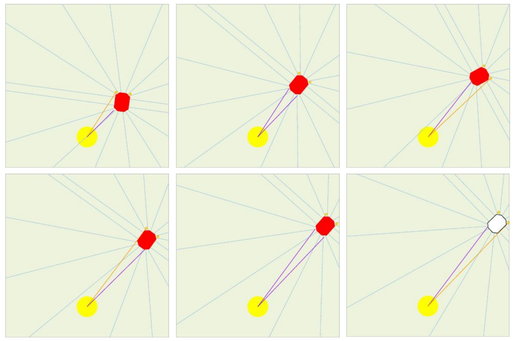
Developmental robotics

- Create intelligent robots by allowing them to go through a developmental process of adaptation
- Endow robots with curiosity, but no knowledge
- They explore the environment in an open-ended way
- Learn about themselves and their world through experience

Experimental questions

- How can a robot develop goals?
- How can it develop plans to achieve these goals?

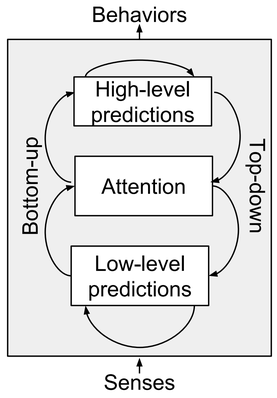


Curiosity-driven development

- Intrinsic interest based on differences in moment-to-moment perceptual states
- Goal discovery based on interest
- Goals represented as protoplans: model's internal state at time of discovery
- Protoplans developed through instant replay learning
- Protoplan sequences assembled into longer-term plans

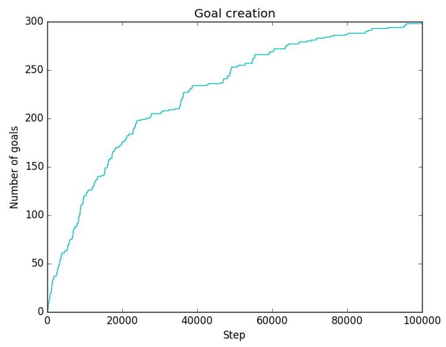
Developmental system

- A multi-level recurrent neural network trained via prediction
- System alternates between motor babbling and self-directed experimentation
- Lower-level network learns perceptual consequences of actions
- Upper-level network learns abstracted, longer-term behaviors

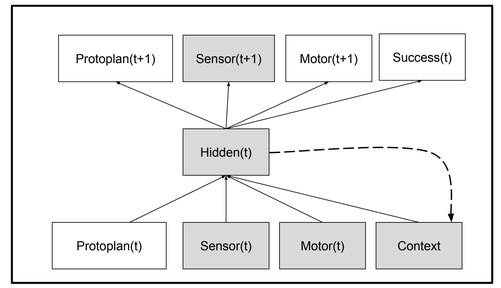


Analysis of learning

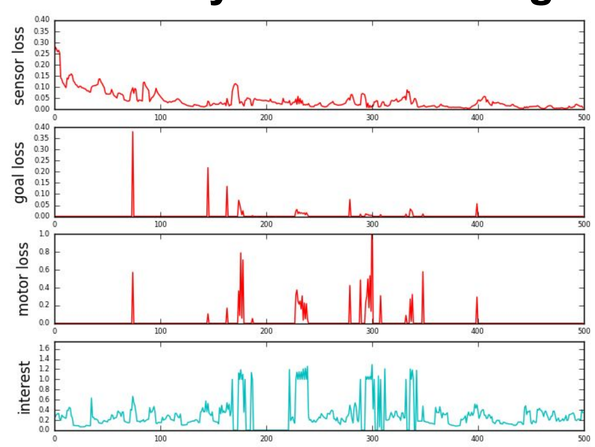
- System begins by motor babbling with no information about its sensors, actions, or environment
- System finds interesting situations and associates them with protoplans



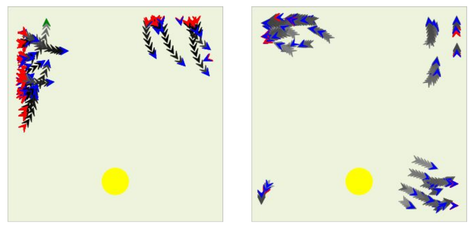
Lower-level network



Curiosity-driven learning



Protoplan behaviors



Conclusions

- Robots can autonomously develop goals based on curiosity
- Robots can create protoplans for these goals based on instant replay learning