Evolving Artificial Intelligence

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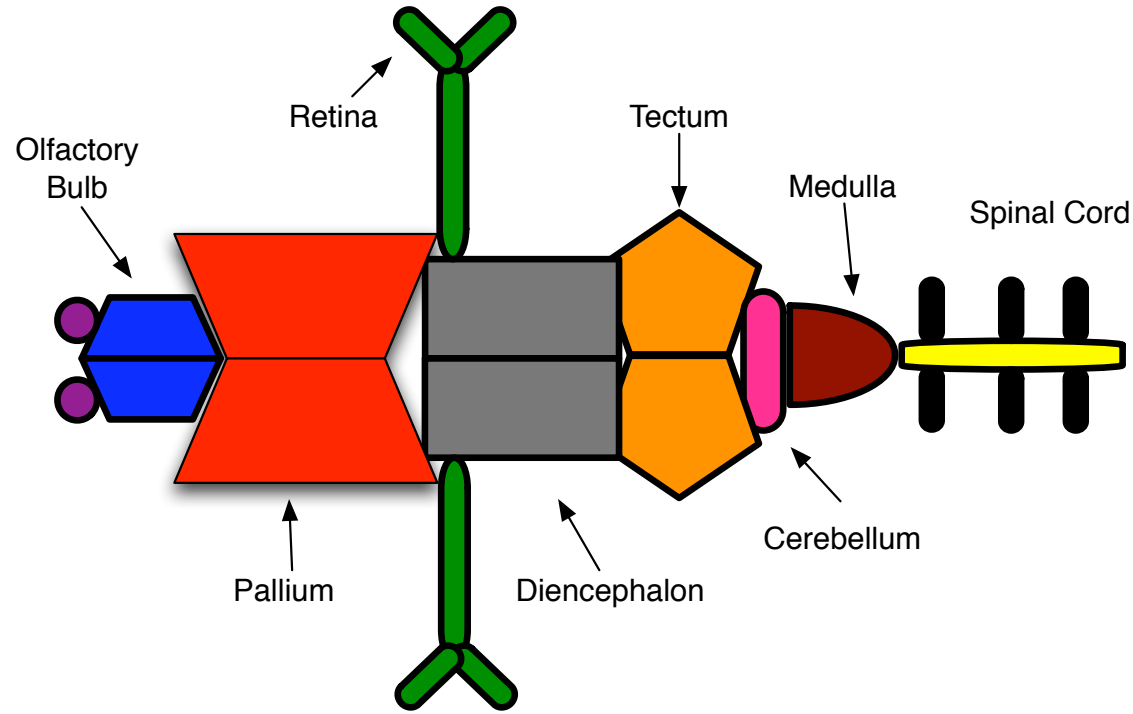
Evolving Brains



- *Principles of Brain Evolution* (G. Streidter, 2005)
- What does this tell us about evolving AI systems?

Situated and Embodied AI

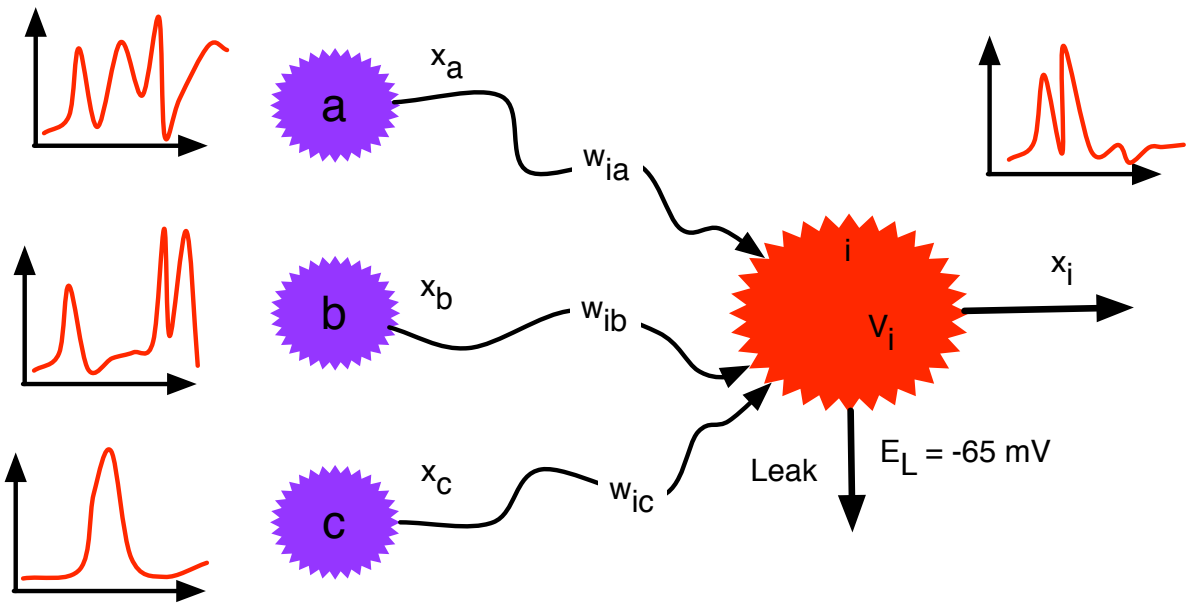
Comparative Evolution (Hans Moravec, 1998)

	Living Organisms	Computers
Sense & Act	10,000,000 years	25 years
Reason	100,000 years	40 years
Calculate	1,000 years	60 years

Key Implication

You cannot produce general intelligence in a vacuum. If we are to create computers with human intelligence, then these systems should have a solid sensorimotor base upon which higher cognitive functioning can be built (or evolved).

Artificial Neural Networks



Utility for SEAI

- Same, basic, neural signals carry information of perceptual, cognitive and motor nature. No need for special representations for each aspect of intelligence.
- Handle learning easily, with different degrees of biological plausibility.
- Easy to evolve in an evolutionary algorithm (EA).

Darwinian Evolution

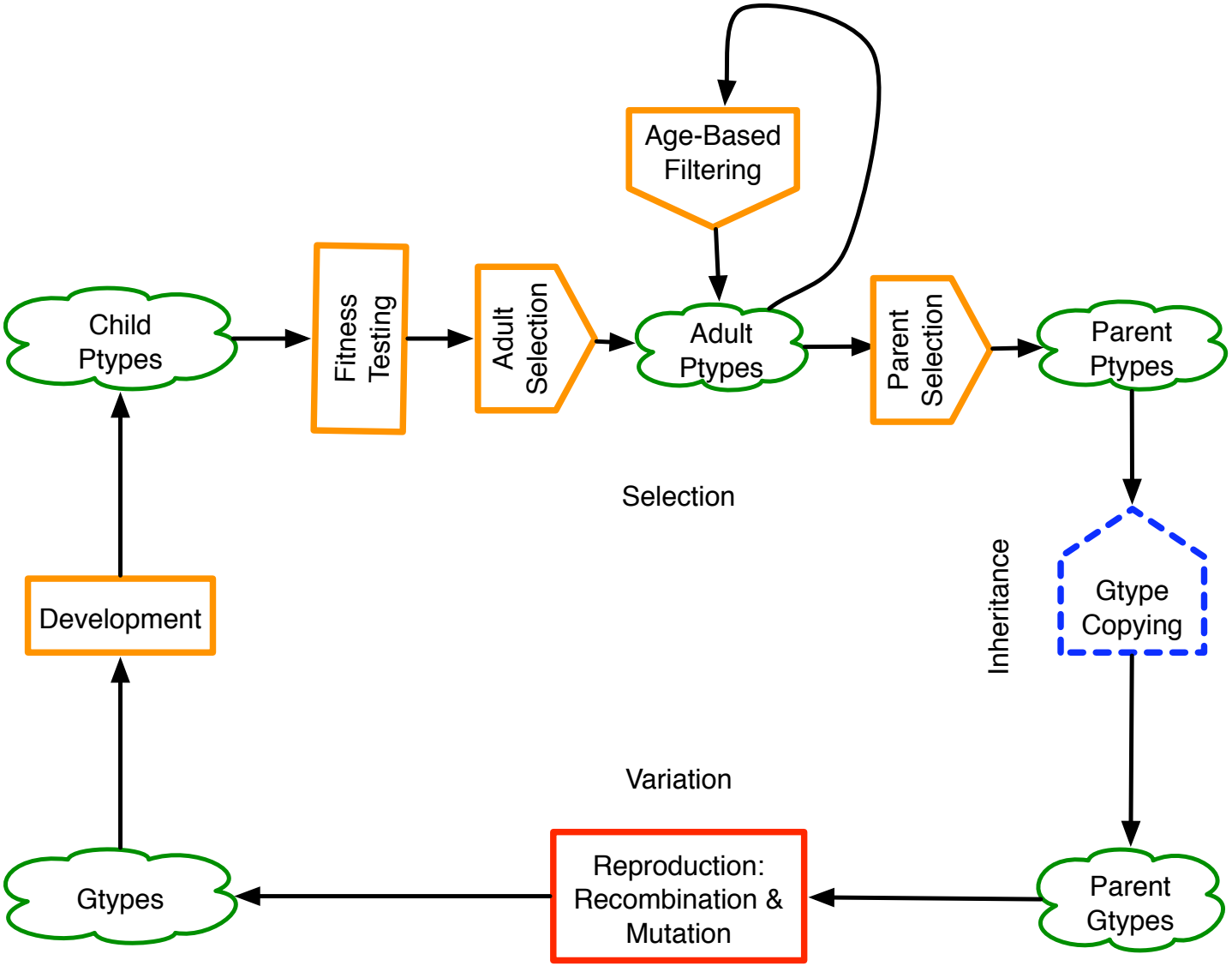
Cornerstones

- Variation - Create phenotypic diversity upon which selection can work.
- Selection - Survival of the fittest.
- Inheritance - Children retain many of the parents' phenotypic traits.

Give the computer these three basic capabilities, and it can:

1. solve many difficult problems, and
2. display fascinating creativity.

Evolutionary Algorithms



Artificial Life (ALife)

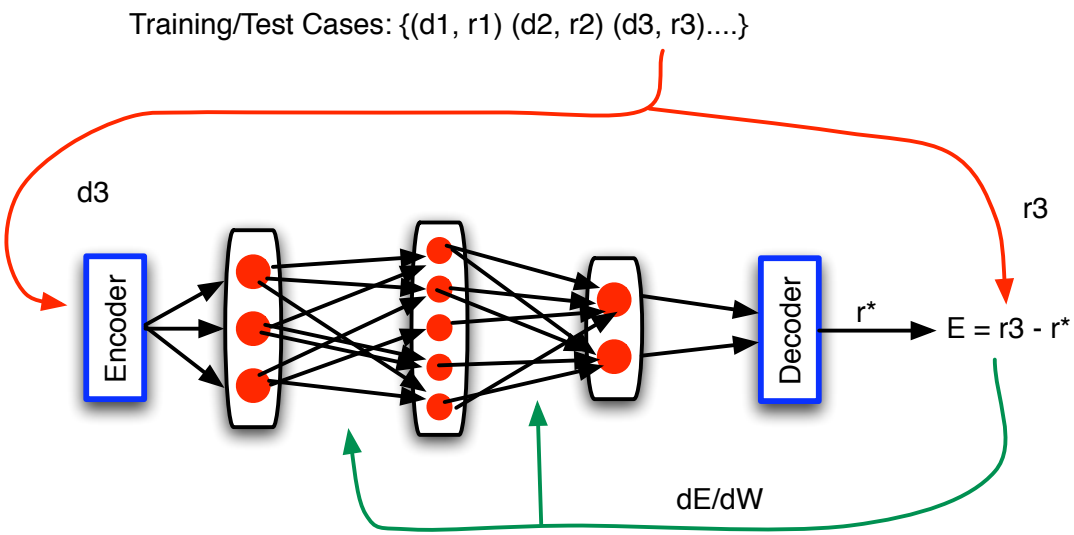
Properties of ALife Systems:

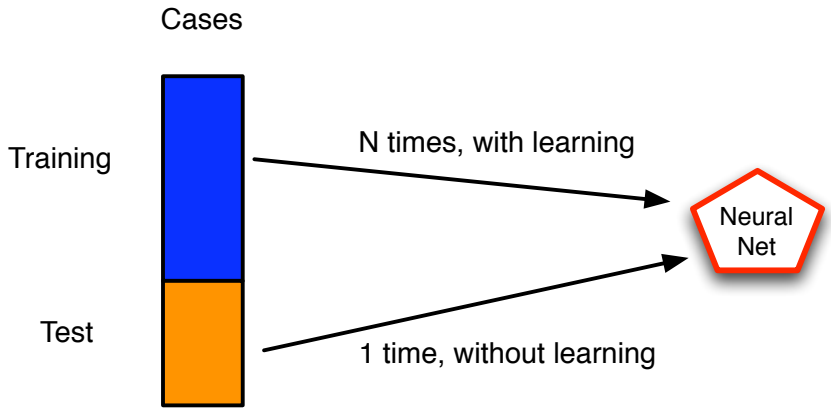
- Synthetic: Bottom-up, multiple interacting agents.
- Self-Organizing: Global structure emerges from local interactions.
- Self-Regulating: Distributed (non-global) control (self-maintaining, autopoietic)
- Adaptive Learning and/or evolving.
- Complex: On the edge of chaos; dissipative.

How does intelligence emerge through:

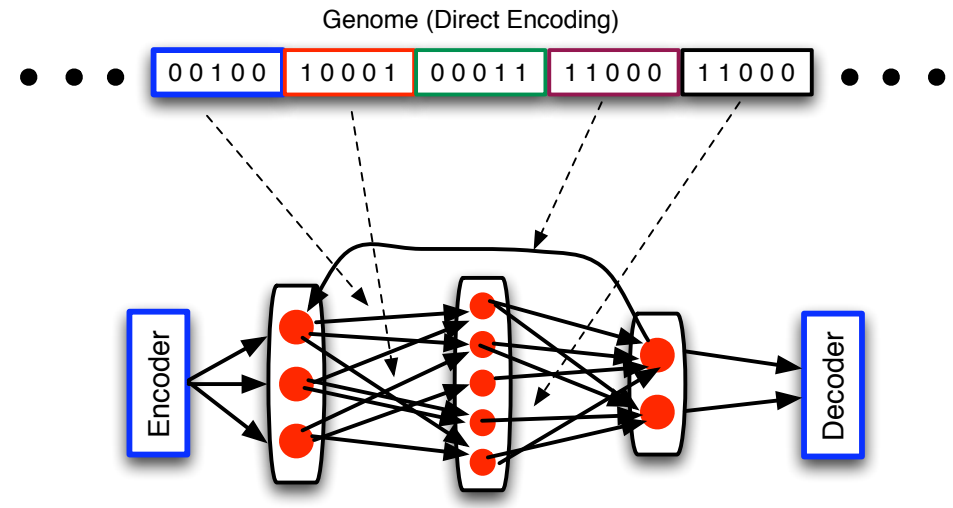
- the course of evolution
- the interactions of numerous neurons

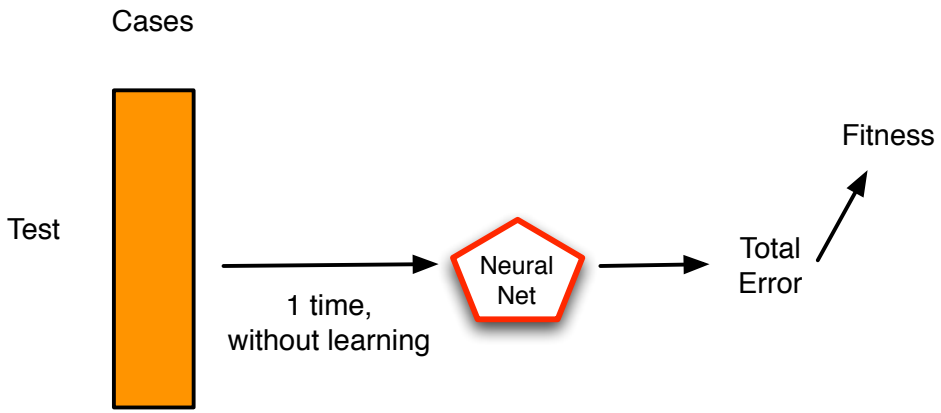
Training Artificial Neural Networks



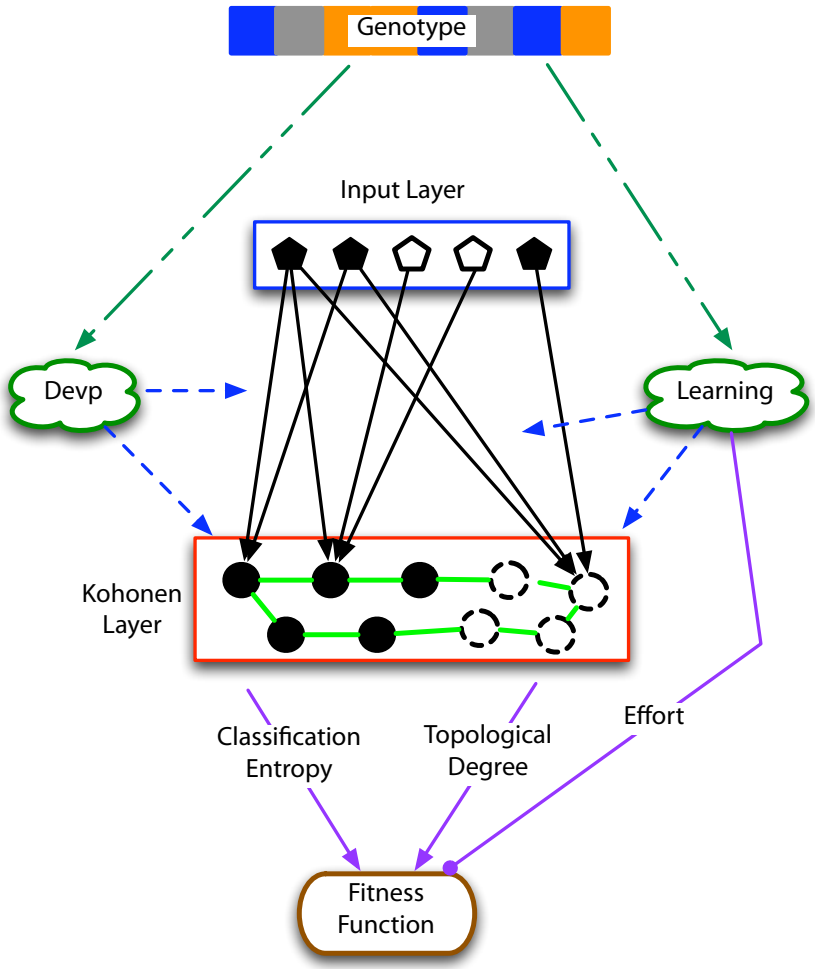


Evolving Artificial Neural Networks (EANNs)





Deep Biological Inspiration



Exploring interactions between evolution, development and learning in the emergence of intelligent neural networks.

Typical Masters Projects

1. Apply an Evolutionary Algorithm (EA) to a problem of your choice.
2. Apply an Artificial Neural Network (ANN) to a problem of your choice.
3. Use EAs to **design** an artifact.
4. Combine EAs and ANNs to build a controller for a robot (real and/or simulated).
5. Computational Neuroscience - Use ANNs to model some aspect of biological brains.
6. Swarm Intelligence - Use EAs and/or ANNs to create simple agents with simple brains that do cool things.