High-Dimensional Evolution (HiDEv^{G})
Bringing Neural Networks and Evolutionary Simulations Onto Common Ground

Santa Fe Institute Complexity Interactive
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Slack: #project_hi-d_evolution
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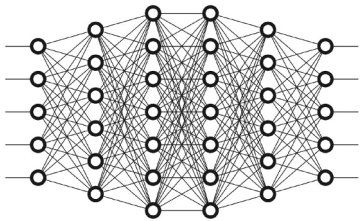
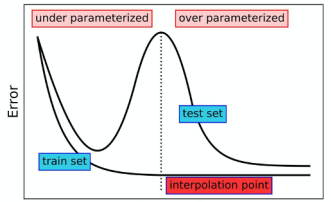
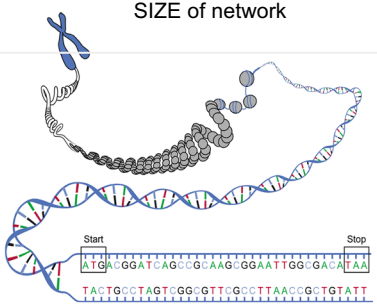
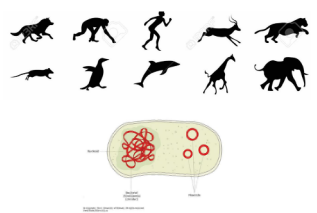
Github: `@HiDev`

High-D Parameter Spaces in Neural Networks and Genomes

Comparability of learning mechanisms and space?

Learning mechanisms	Learning space (scale)	Outcome (benefit?)
Machine learning	 SIZE of network	
Evolution	 LENGTH of genome	 Complex organisms and ecosystems

Does there exist an optimal length of genome?

Comparing Neural Networks With Simulations of Evolution

Neural Network

NN Training ***searches*** for good models.

Structure is encoded in learning parameters,

which determines the ***behavior*** of learned model.

The generalization loss denotes a ***measure of performance***.

Biological Models

Evolution ***searches*** for fit organisms or populations.

Structure is encoded in genotypes ,

which determines the ***behavior*** of phenotypes.

The genetic fitness denotes a ***measure of performance***.

Neural Agents vs. Evolutionary Populations

Comparison is enabled via a common agent simulation framework:

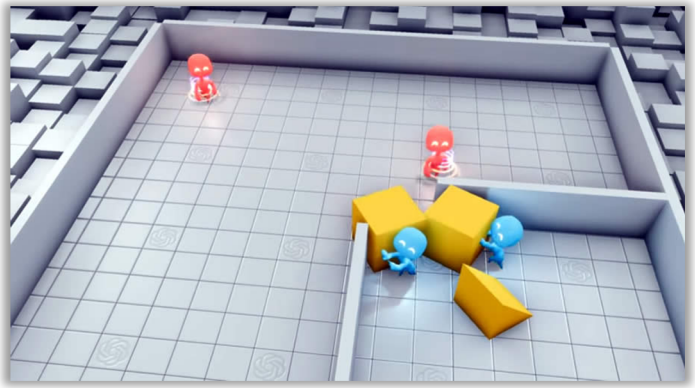


Figure: A screenshot of OpenAI's multi-agent interaction tool

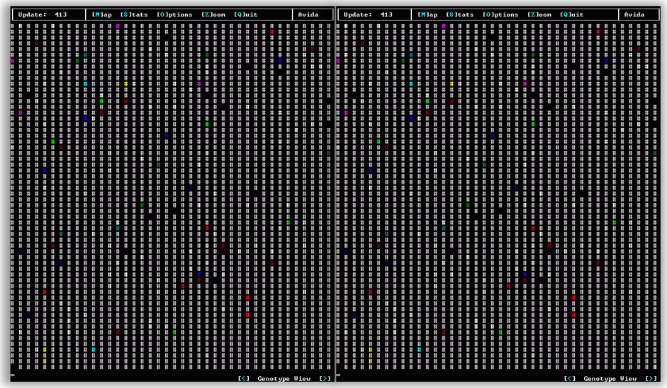


Figure: A screenshot of Avida 2.6, a digital organism simulator.

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Future

Products and Innovation

1. Design a formal framework for comparing learning between ML/DRL and EA
2. Design an artificial world platform for such comparisons
3. Scale to an Open Science Cloud-Platform for experimental games using AR (open to the public as a “game of hd.evolution”)

Scientific exploration

Analyze solution spaces explored by different algorithms

Incorporate various environmental constraints and challenges: dynamic or malleable environments

Extend comparative analysis to composite systems: co-evolving populations/species or composite NN architectures (GANs)