Data Representations as a Driving Force in Al Research

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## Data Representation



### The Evolving History of Neural Networks





## **Neural Networks as Functions**

InputHiddenOutputlayerlayerlayer



 $\nu = \sigma_L \circ \rho_L \circ \sigma_{L-1} \circ \rho_{L-1} \circ \dots \circ \sigma_1 \circ \rho_1$ 

#### The Simplest Network



Fig. 2-Organization of a simple perceptron.

#### Working in 2-D to understand network redundancy



Equivalent Neural Networks

$$f(x) := \max_{k} \{A_k(x), P(x)\} \equiv \max_{k} \{A_k(x)\}$$

## **Consequences for Understanding Learning**



## Synthetic Intelligence

- The origins of AI owe a significant debt to the study of human cognition, but synthetic cognition is worthy of recognition on its own merits

## Hierarchies in the Image Domain





#### **Domain Generalization**





### Phylogeny



### **Brownian Motion**





## **CLIP Embeddings**





## Synthetic Images with a Known Hierarchy



Class	Mean	Std	1 - p-value
n02093256	0.174	0.084	1.000
n02105412	0.091	0.114	0.917
n02091467	0.029	0.035	0.923
n01641577	0.074	0.087	0.928
n02093428	0.081	0.062	0.988
n02129165	0.036	0.03	0.981
n02190166	0.077	0.142	0.827
n01682714	0.081	0.042	1.000
n02447366	0.127	0.135	0.949
n01855672	0.148	0.123	0.982
Average	0.092	0.085	

#### Predicting Domain Inconsistency



## **Consequences for Learning**



## Evaluating the Synthetic Intelligence

- Psychometrics
- The study of abstraction

#### Local vs. Global Abstraction

- The continuing utility of graph representations in the computational study of art

# Contact

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