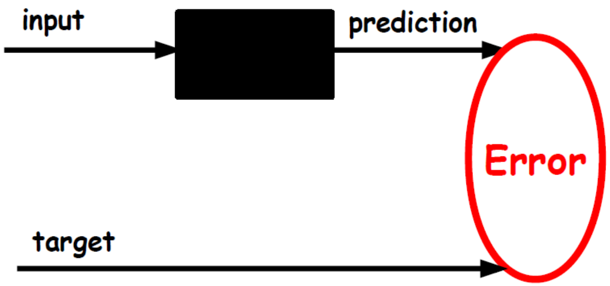
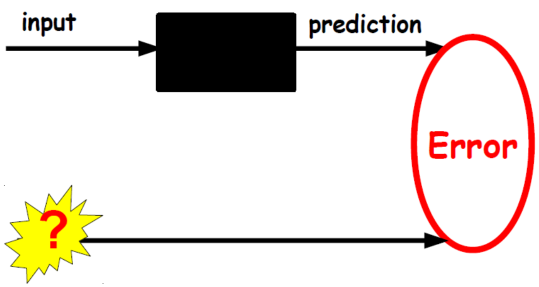
UNSUPERVISED LEARNING

Unsupervised learning

- Supervised learning



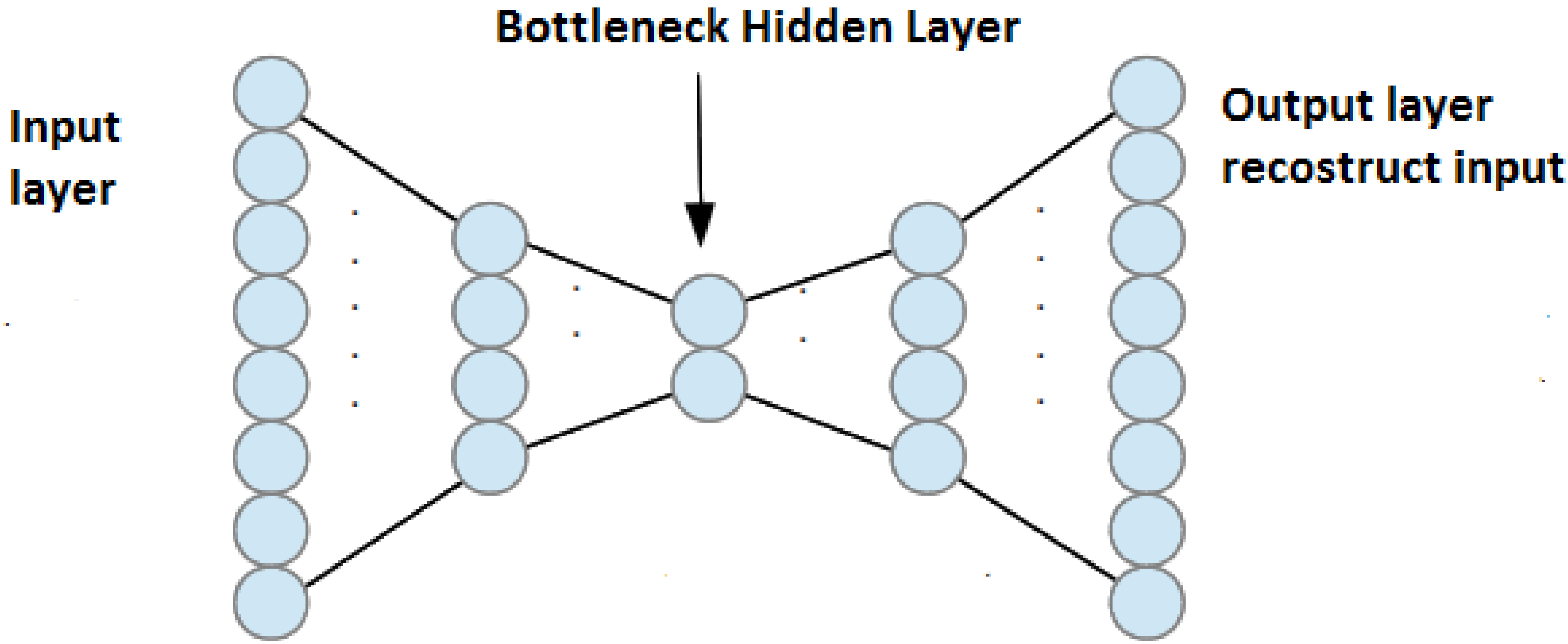
- Unsupervised learning

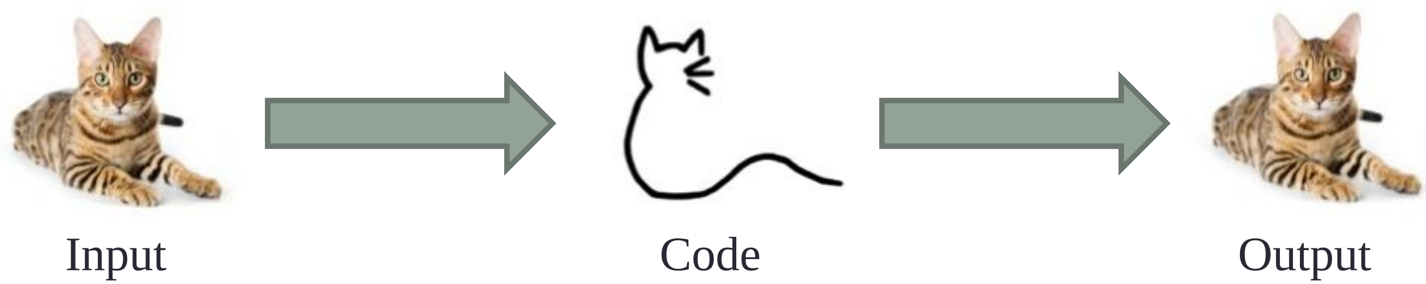


Unsupervised learning (Autoencoder)

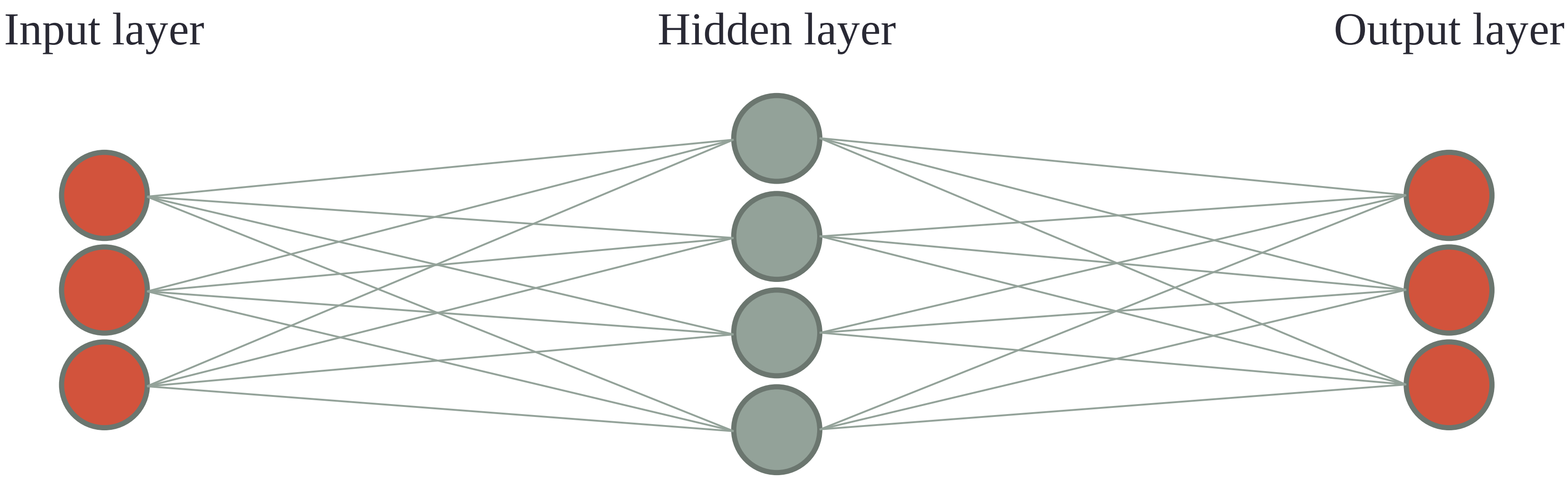
- How to constrain the model to represent training samples better than other data points?
  - [Restricted Boltzmann Machine]
    - Make models that defines the distribution of samples
  - [Auto-encoder with bottleneck]
    - reconstruct the input from the code & make code compact
  - [Sparse auto-encoder]
    - reconstruct the input from the code & make code sparse
  - [Denoising auto-encoder]
    - Add noise to the input or code

Auto-encoder with bottleneck



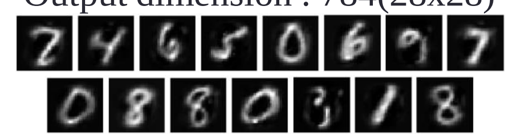


Sparse auto-encoder



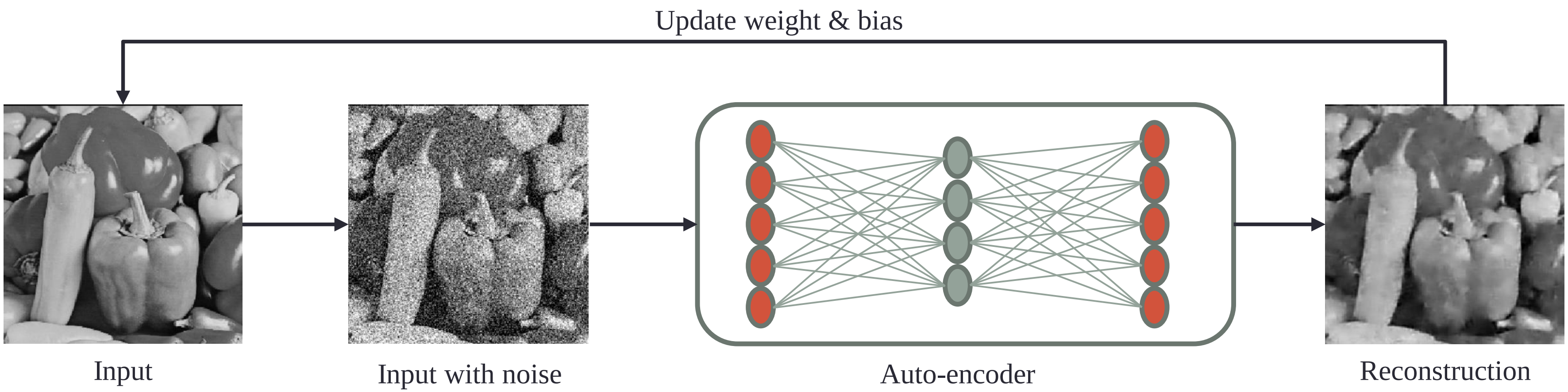
Input : MNIST Dataset
Input dimension : 784(28x28)

Reconstructions
Output dimension : 784(28x28)

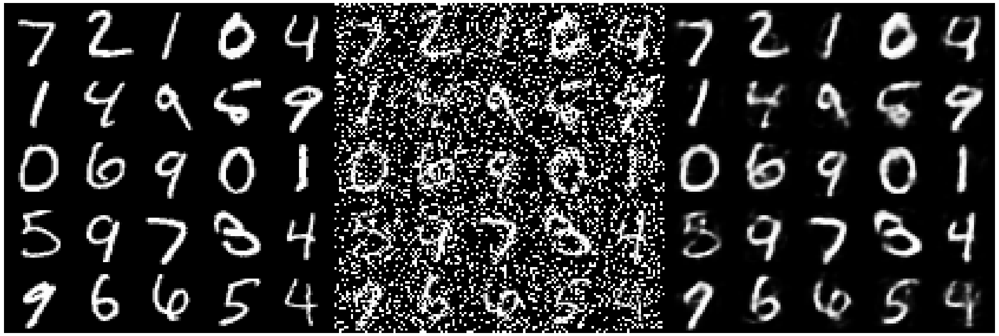


Denoising auto-encoder

Training the denoising auto-encoder



Result



Input Input with noise Reconstruction

ONE LEARNING ALGORITHM HYPOTHESIS? GRANDMOTHER CELL HYPOTHESIS?

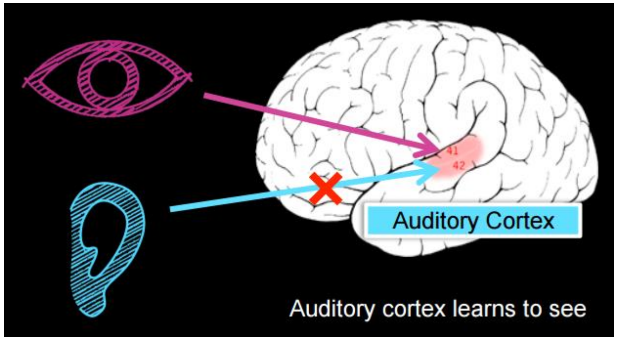
THERE'S A THEORY that human intelligence stems from a single algorithm.

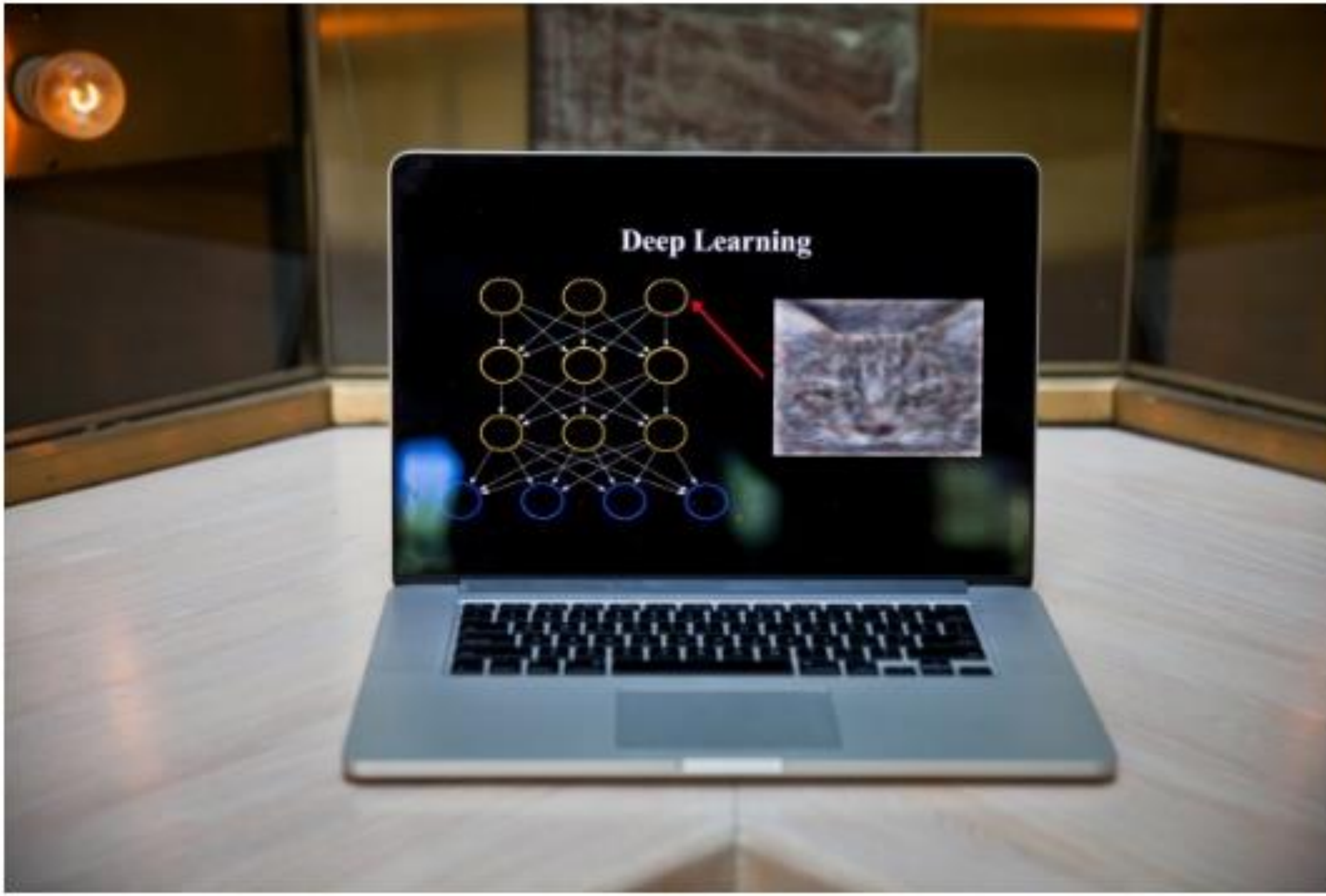
The idea arises from experiments suggesting that the portion of your brain dedicated to processing sound from your ears could also handle sight for your eyes. This is possible only while your brain is in the earliest stages of development, but it implies that the brain is — at its core — a general-purpose machine that can be tuned to specific tasks.

About seven years ago, Stanford computer science professor Andrew Ng stumbled across this theory, and it changed the course of his career, reigniting a passion for artificial intelligence, or AI. "For the first time in my life," Ng says, "it made me feel like it might be possible to make some progress on a small part of the AI dream within our lifetime."

THE MAN BEHIND THE GOOGLE BRAIN: ANDREW NG AND THE QUEST FOR THE NEW AI

Stanford professor Andrew Ng, the man at the center of the Deep Learning movement.
Photo: Ariel Zambelich/Wired





Andrew Ng's laptop explains Deep Learning. *Photo: Ariel Zambelich/Wired*

Google's Artificial Brain Learns to Find Cat Videos

BY WIRED UK 06.26.12 | 11:15 AM | PERMALINK

By Liat Clark, Wired UK

When computer scientists at Google's mysterious X lab built a neural network of 16,000 computer processors with one billion connections and let it browse YouTube, it did what many web users might do — it began to look for cats.

BUILDING HIGH-LEVEL FEATURES USING LARGE SCALE UNSUPERVISED LEARNING

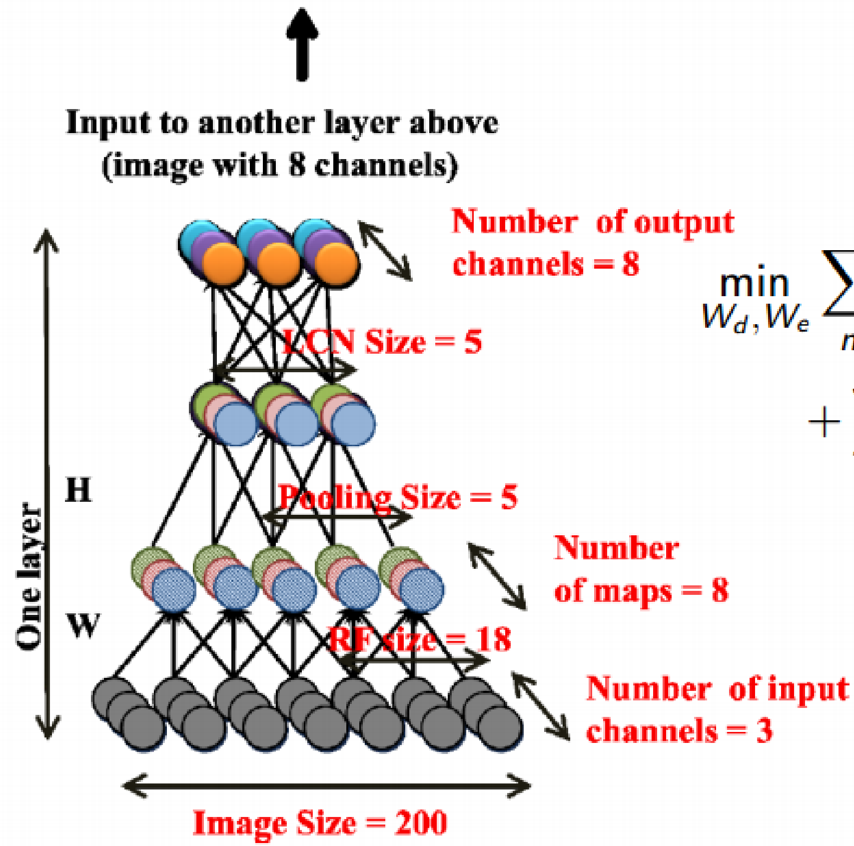
Quoc V. Le et al, ICML, 2012

Motivating Question

- Is it possible to learn high-level features (e.g. face detectors) using only unlabeled images?

- "Grandmother Cell" Hypothesis
  - Grandmother cell: A neuron that lights up when you see or hear your grandmother
    - Lots of interesting (controversial) discussions in the neuroscience literature

Architecture (≃sparse deep auto-encoder)



$$\min_{W_d, W_e} \sum_m ||W_d W_e x^{(m)} - x^{(m)}|| \quad (1)$$

$$+ \sum_{m,k} \sqrt{\epsilon + P_k (W_e x^{(m)})^2} \quad (2)$$

(1): auto-encoder
(2): pooling

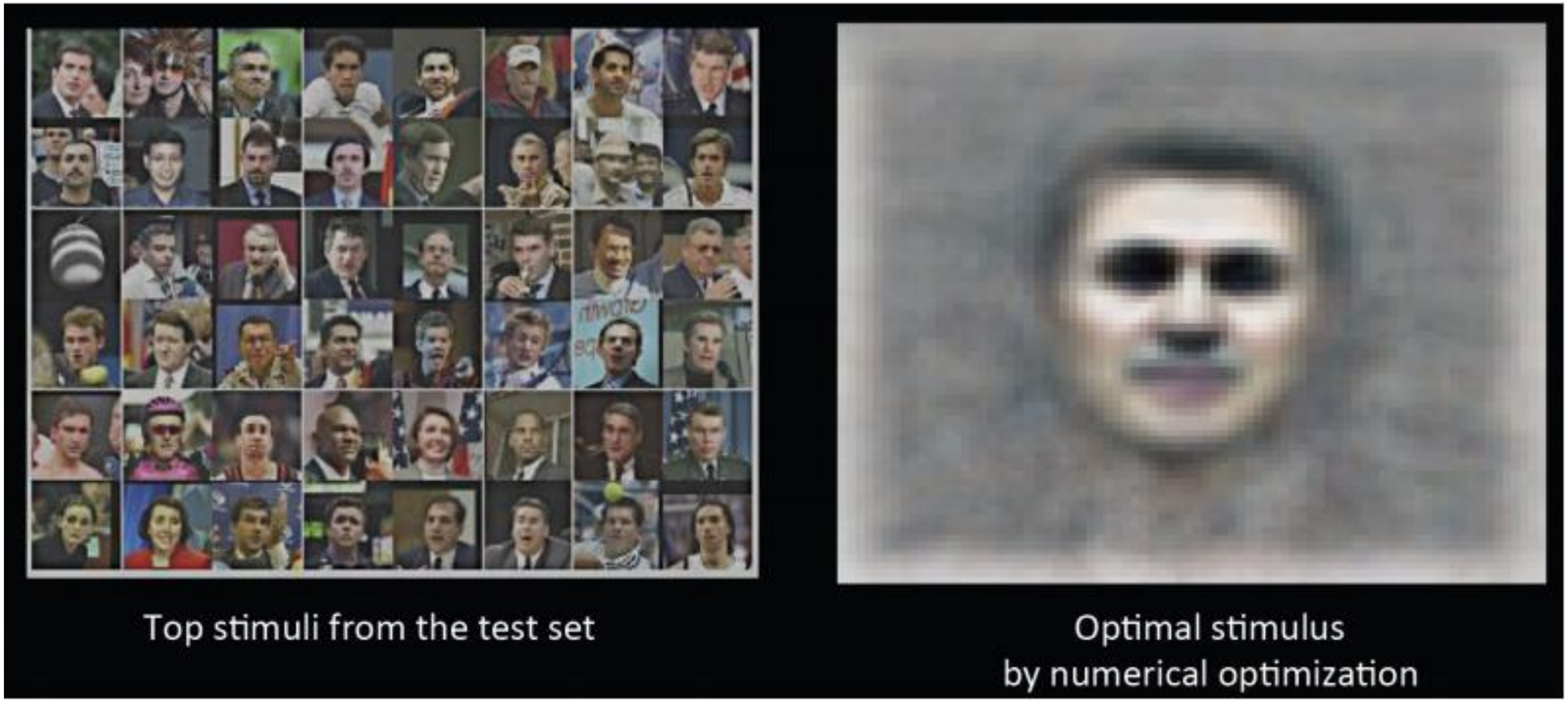
Repeated 3 times to form Deep Architecture
$x^{(m)}$ = image of 200x200 pixels x3 channels

Training

- Using a deep network of 1 billion parameters
  - 10 million images (sampled from Youtube)
  - 1000 machines (16,000 cores) x 3 week.

- Model parallelism
  - Distributing the local weights W_d, W_e in different machines
  - Asynchronous SGD

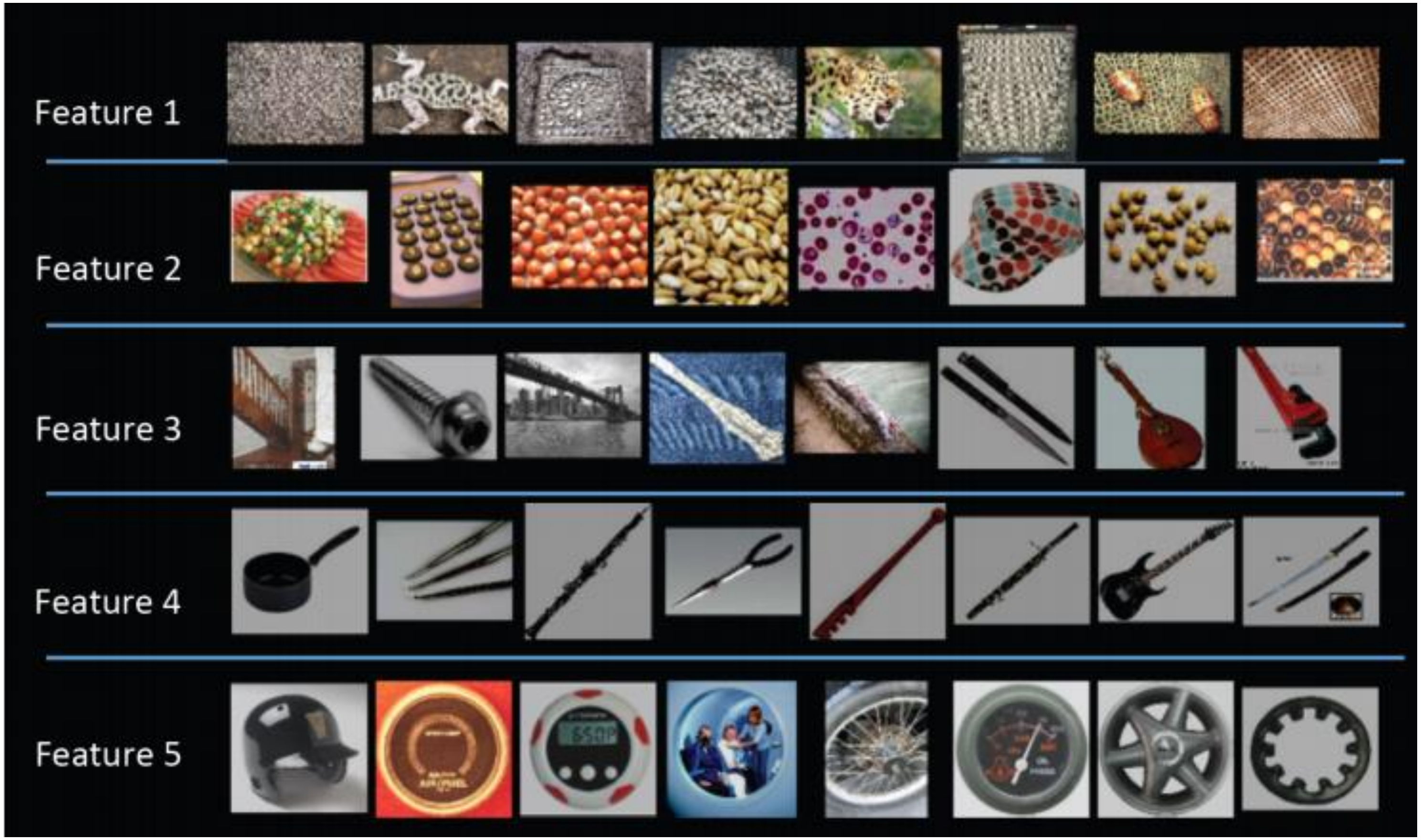
Face neuron


Top stimuli from the test set
Optimal stimulus
by numerical optimization

Cat neuron

Top stimuli from the test set
Optimal stimulus
by numerical optimization

More examples



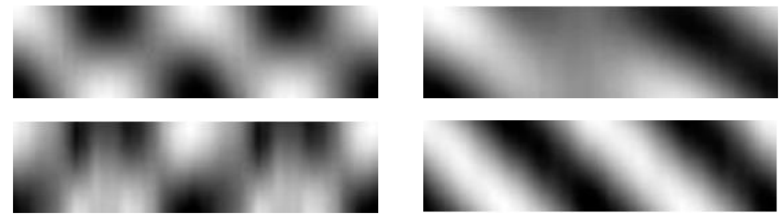
APPLICATION

				Tasks					
				ADAS					
				Self Driving					
				Localization	Perception	Planning/ Control	Driver state	Vehicle Diagnosis	Smart factory
Methods	Traditional	Non-machine Learning		GPS, SLAM		Optimal control			
Methods	Traditional	Machine-Learning based method: Supervised	SVM MLP		Pedestrian detection (HOG+SVM)				
Methods	Deep-Learning based	Machine-Learning based method: Supervised	CNN		Detection/ Segmentation/Classification	End-to-end Learning			
Methods	Deep-Learning based	Machine-Learning based method: Supervised	RNN (LSTM)		Dry/wet road classification	End-to-end Learning	Behavior Prediction/ Driver identification		*
Methods	Deep-Learning based	Machine-Learning based method: Supervised	DNN					*	*
Methods	Deep-Learning based	Machine-Learning based method: Reinforcement				*			
Methods	Deep-Learning based	Machine-Learning based method: Unsupervised							*

Rotor System Diagnosis

Vibration image generation

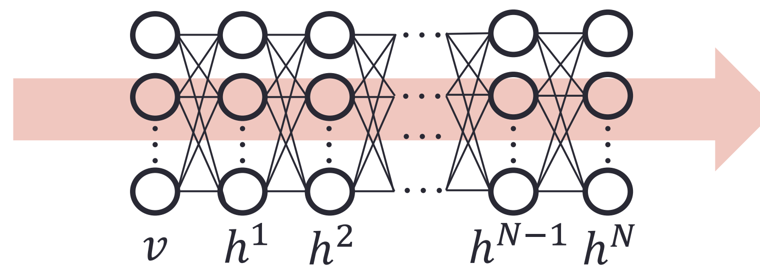
RK4 test-bed (Labeled)
Power plant (Labeled)
Power plant (Unlabeled)



Vibration images using ODR

High–level feature abstraction

- Greedy layer-wise unsupervised pre-training : Restricted Boltzmann Machine in deep belief network (DBN)



Health reasoning

- Classification : multi-layer perceptron (MLP)
- Clustering : self-organizing map