Making Machines Learn

Introduction to Deep Learning

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Outline

1. Learning problem formulation
2. Types of learning tasks
3. Learning techniques and their variants
4. Deep learning architectures for different domains
The Learning Problem

Questions?

1. What? "Cats"
2. How many? "5"
3. Where? "Bounding Boxes"

Given some data $X$, can we infer something $y$ about it?

$X :=$ Input features or data representation
$y :=$ Desired inference

$h: X \rightarrow y$

How do we learn?

Data → Feature Extractor → Loss / Objective function → Good → Performance Metric
Types of Tasks

1. What? "Cat"
   **Classification**

2. How many or How much? "5"
   **Regression**

3. Where? "Bounding Boxes"
   **Segmentation**
Types of learning

**Supervised Learning**

Given a paired dataset

\[ D := \{(X_1, y_1), (X_2, y_2), \ldots, (X_N, y_N)\} \]

Train a \( h : X \rightarrow y \) to predict the \( y \) from a given \( X \)

**Unsupervised Learning**

Given a dataset

\[ D := \{X_1, X_2, \ldots, X_N\} \]

Group similar data points as a category

**Reinforcement Learning**

Given an environment, action-space and states;
an agent interacts or trains to maximize a reward function.
Transfer Learning

- Use already learnt features from a **different** task but from a **related** domain

![Diagram showing transfer learning process](image_url)
Self-supervised learning

- Use already learnt features from a **different** task but from a **related** domain
Self-supervision tasks

1. Embedding learning
2. Colorization
3. In-painting
4. Jigsaw
5. Orientation prediction
6. Compression
7. Temporal consistency in adjacent frames
Colorization

Ex. 3: Colorization (predict color given intensity)
Inpainting

(a) Input context
(b) Human artist
(c) Context Encoder ($L2$ loss)
(d) Context Encoder ($L2 +$ Adversarial loss)

Image courtesy: Context Encoders: Feature Learning by Inpainting, Pathak et al.
Temporal alignment in video frames

Image courtesy: Temporal Cycle-Consistency Learning, Dwibedi et al.
Types of Deep Networks

1. Neural Networks
2. Convolutional Neural Networks
3. Recurrent Neural Networks
4. Graph Convolutional Neural Networks
5. Generative Adversarial Networks
Neural Networks

Convolutional Neural Networks

Convolution + nonlinearity

max pooling

convolution + pooling layers

vec

fully connected layers

Nx binary classification

Image courtesy: https://adeshpande3.github.io/A-Beginner%27s-Guide-To-Understanding-Convolutional-Neural-Networks/
Recurrent Neural Networks

Image courtesy: https://fr.wikipedia.org/wiki/R%C3%A9seau_de_neurones_r%C3%A9currents
Graph-Convolutional Neural Networks
Generative Adversarial Networks

Thank you

Questions?