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

 $h: X \to y$



Image courtesy: http://www.rla.org.il/eng/articles/cat-family-expands-a-new-cat-in-a-house-with-cats

How do we learn?





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 $D:=\{(X_1, y_1), (X_2, y_2), \dots, (X_N, y_N)\}$

Train a $h: X
ightarrow \mathbf{y}$ to predict the **y** from a given **X**

Unsupervised Learning

Given a dataset
$$\mathrm{D}{:=}\{X_1,X_2,\ldots,X_N\}$$

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**



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



Image courtesy: Colorization as a Proxy Task for Visual Understanding, Gustav et al.

Inpainting



(a) Input context





(c) Context Encoder (L2 loss) (d) Context Encoder (L2 + Adversarial loss)

Image courtesy: Context Encoders: Feature Learning by Inpainting, Pathak et al.

Jigsaw



Image courtesy: Unsupervised Learning of Visual Representations by Solving Jigsaw Puzzles, Noroozi 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



input layer

hidden layer 1

hidden layer 2

output layer

Image courtesy: https://towardsdatascience.com/applied-deep-learning-part-1-artificial-neural-networks-d7834f67a4f6

Convolutional Neural Networks



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



Image courtesy: https://towardsdatascience.com/generative-adversarial-networks-gans-a-beginners-guide-5b38eceece24

