A random walk in Machine Learning

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Overview

The bread and butter of Machine Learning
A typology of Machine Learning
Unsupervised learning
Supervised learning

Selected topics
ML-based games
Enhancement/Restauration
Automatic face detection and recognition
Tracking
Recommender systems
Natural language processing and speech recognition

Generative models
Procedural content generation
Automatic image captioning
Image generation
Style transfer

Conclusion
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A typology of Machine Learning

Machine Learning (ML) encompasses several areas:

**Unsupervised learning**: finding structure/regularities in large set of data.

**Supervised learning**: building an input-output model from the observation of a large set of data in order to predict the target value of new examples.

**Reinforcement learning**: taking sequential actions in an uncertain environment to maximize some cumulative reward.

Common theme: the machine learns by itself; the solution is not programmed *a priori.*
It was the technique used by Google DeepMind to build AlphaGo, the program who beat a professional Go human player in March 2016.
Unsupervised learning

Goal:
- Discover structure/regularities in large set of data.
- Preprocessing step for other techniques.

Common techniques:
- Dimensionality reduction.
- Clustering.
Dimensionality reduction

Goal: find a simpler basis to express the data.
Clustering

Goal: group data that are similar together.

Dendrogram

Compression (7 colors)
Unsupervised learning — limitations

Limitations:

- Require lots of data.
- Not always well-posed:
  - **Dimensionality reduction** How many variables left? What is a good approximation?
  - **Clustering** How many clusters? Similarity of complex data?
Supervised learning

Goals:
▶ Build an input-output model from the observation of a large set of data in order to predict the target value of *new examples*.
  ▶ Contrary to unsupervised learning, there is a clear target.

▶ Derive an understanding of the input-output relationship.

Depending on the nature of the output, we distinguish:
*Classification*: the output is discrete (label, class).
*Regression*: the output is a real value.
Supervised learning — learning part

Dataset → Learning algorithm → Model
Classification

The output is discrete (label, class).

Medical diagnosis

Optical character recognition (ORC)

Spam detection

Voice identification
Regression

The output is a real value.

House price estimation

Sentiment analysis

Epidemic diffusion

Stock market prediction
Segment, locate, dispatch and classify (SLDC)

http://www.cytomine.be/
https://github.com/waliens/sldc
Better understand the input-output relationship

From physiochemical properties of wine predict wine taste preference.

\[ \rightarrow \text{understand why some wine are preferred over other.} \]

Predict the delay of arriving flights.

\[ \leftarrow \text{understand why planes arrive late.} \]
Multi-output

The model can predict several outputs at once:

Classification

Regression

Automatic scene tagging

Chemical diffusion prediction
Case study: Microsoft’s Kinect

Supervised learning — limitations

Limitations:

▶ Require lots of labeled data.

▶ Tedious, time-consuming, expensive, difficult.

▶ Require relevant features.

▶ No free lunch: for every correct extrapolation a model makes, there exists at least one other consistent problem for which the model is wrong.

▶ Overfitting.
Supervised learning — limitations: overfitting

When the model is too powerful, it will not generalize well.
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ML-based games

Guess who?

http://en.akinator.com/

Any good at Pictionary?

https://aiexperiments.withgoogle.com/quick-draw
Machine learning, a branch of artificial intelligence, is a scientific discipline concerned with the design and development of algorithms that allow computers to evolve behaviors based on empirical data, such as from sensor data or databases. A learner

**In machine learning, unsupervised learning refers to the problem of**

Enhancement/Restauration — Image (re-)coloration

Automatic face detection and recognition: DeepFace

Tracking objects in video

https://www.youtube.com/watch?v=R1dAFjrzGC8

Recommender systems

Given many user histories and possibly other relevant information, predict the rating a known user will give to a specific item.

Use that prediction to recommend (new) items to a user.
Recommender systems
https://www.youtube.com/watch?v=Ro-HfETpzhc

Natural language processing and speech recognition: Amazon Echo

https://www.youtube.com/watch?v=24Hz9qjTDfw
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Procedural content generation

https://medium.com/@ageitgey/machine-learning-is-fun-part-2-a26a10b68df3#.yyrzqol0p
Automatic image captioning

Case study: DeepDream – Inception

https://deepdreamgenerator.com
http://googleresearch.blogspot.ch/2015/06/inceptionism-going-deeper-into-neural.html
Style transfer

Style transfer with semantic map

(a) Original painting by Renoir, (b) semantic annotations, (c) desired layout, (d) generated output.

Style transfer for video

Artistic style transfer for videos

Manuel Ruder
Alexey Dosovitskiy
Thomas Brox

University of Freiburg
Chair of Pattern Recognition and Image Processing

https://www.youtube.com/watch?v=Khuj4AS1dmU
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Machine learning (ML) is a versatile building block and is becoming widespread in our everyday life.

Despite its relatively long history, new application of ML are still coming to life nowadays.

It cannot solve everything but it is applicable in a surprisingly large number of scenarios.

It requires lots of (labeled) data.