

Assignment #1

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Q1 - List eleven types of machine learning tasks. For each task:

- **What type of input data it deal with?**
- **What type of challenges it can handle ?**
- **List number of example applicaion(s)**

Tasks types :

1- Classification

- Input data type:
numerical data,image data, and text.
- Type of challenge handle:
Specify which of K categories some input belongs to.
- Applications:
 - Willow Garage PR2 robot is able to act as a waiter that can recognize different kinds of drinks and deliver them to people on command.
 - automatically tag people in photo collections.

2- Classification with missing inputs

- Input data type:
numerical data,image data, and text.
- Type of challenge handle:
To solve the classification task, the learning algorithm only has to define a single function mapping from a vector input to a categorical output. When some of the inputs may be missing
- Applications:
 - Medical diagnosis.

3- Regression

- Input data type:
numerical data.
- Type of challenge handle:
predict a numerical value given some input.
- Applications:
 - algorithmic trading
 - insurance premiums
 - future prices of securitie.

4- Transcription

- Input data type:
Audio data , image data.
- Type of challenge handle:
observe a relatively unstructured representation of some kind of data and transcribe the information into discrete textual form.
- Applications:
 - Google Street
 - speech recognition

5- Machine translation

- Input data type:
Text data.
- Type of challenge handle:
the input already consists of a sequence of symbols in some language, and the computer program must convert this into a sequence of symbols in another language.
- Applications:
 - Translation apps.

6- Structured output

- Input data type:
Audio data , image data ,Text data.
- Type of challenge handle:
the program must output several values that are all tightly interrelated.
- Applications:
 - the words produced by an image captioning program must form a valid sentence

7- Anomaly detection

- Input data type:
Text data, numeric data .
- Type of challenge handle:
The computer program sifts through a set of events or objects and flags some of them as being unusual or atypical.
- Applications:
 - Credit card fraud detection.

8- Synthesis and sampling

- Input data type:
Image data , video data , audio data ,Text data.
- Type of challenge handle:
Generate new examples that are similar to those in the training data.
- Applications:
 - Video games can automatically generate textures for large objects or landscapes.

9- Imputation of missing values

- Input data type:
Numeric data , Image data , video data , audio data ,Text data.
- Type of challenge handle:
The algorithm must provide a prediction of the values of the missing entries.
- Applications:
 - calculate a statistical value for each column (such as a mean) and replace all missing values for that column with the statistic.

10- Denoising

- Input data type:
Numeric data , Image data , video data , audio data ,Text data.
- Type of challenge handle:
Predict the clean example from its corrupted version.
- Applications:
 - Image noise processing .
 - Noise cancellation

11- Density estimation or probability mass function estimation

- Input data type:
Numeric data , Image data , video data , audio data ,Text data.
- Type of challenge handle:
the algorithm needs to learn the structure of the data it has seen. It must know where examples cluster tightly and where they are unlikely to occur.
- Applications:
 - to obtain a probability distribution
 - can use that distribution to solve the missing value imputation task.

Q2- In up to 3 sentences, explain the “No Free Lunch Theorem”

- No Free Lunch Theorem: there is no single best optimization algorithm .
- There is no single best machine learning algorithm for predictive modeling problems.
- The practical implications of the theorem may be limited given we are interested in a small subset of all possible objective functions.

Q3- List three main challenges that Machine Learning algorithms suffer from and Deep Learning can overcome. Explain the each challenge in up to 2 sentences.

- Complex output types: Machine learning is mostly limited to numeric types for classification and scoring applications on other side Deep learning output can be in any form including free form elements such as free text and sound
- Complex and colossal unstructured datasets: Machine learning algorithm required labeled/structured data to understand the differences between images like cats and dogs, learn the classification and then produce output. On the other hand, a deep learning network was able to classify images of both the animals through the data processed within layers of the network. It didn't require any labeled/structured data
- Human Intervention With ML systems, a human has to identify and code by hand the applied features, based on the type of data, such as shape, orientation, pixel value, etc.) A deep learning system, on the other hand, attempts to learn the features without the need for human intervention.