LOTI.05.046 PATTERN RECOGNITION

HOMEWORK 1 - GETTING FAMILIAR WITH MACHINE LEARNING

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1 BRIEF

Machine learning is the field of study that gives computers the ability to learn without explicitly being programmed. A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E [1].

In general, any machine learning problem can be classified to one of three broad classifications:

- Supervised Learning
- Unsupervised Learning
- Reinforcement learning

2 SUPERVISED LEARNING

In supervised learning, a given data set is provided with an intuition of what the correct outputs should look like, having the idea that there is a relationship between the input and the output.

Supervised learning problems are categorized into "regression" and "classification" problems. In a regression problem, the aim is to try to predict results within a continuous output, resulting the ability to map input variables to some continuous function. In a classification problem, the idea is to instead try to predict results in a discrete output. In other words, the input variables are mapped onto discrete categories.

2.1 Supervised Learning: Case Examples

1. Given data about size of houses on the real estate market, supervised learning could be used to predict the price of houses. In this example, the price would be a continuous output, hence it would be a regression problem.
2. Given data with pictures of males/females, supervised learning could be used to predict the age of the person based on the picture. This is another example of a regression problem.

3. Given data with pictures of dogs, supervised learning could be used to predict the breed of the dog. This is an example of a classification problem.

2.2 Supervised Learning: Flow chart

The following is a flowchart describing a general architecture of supervised learning:

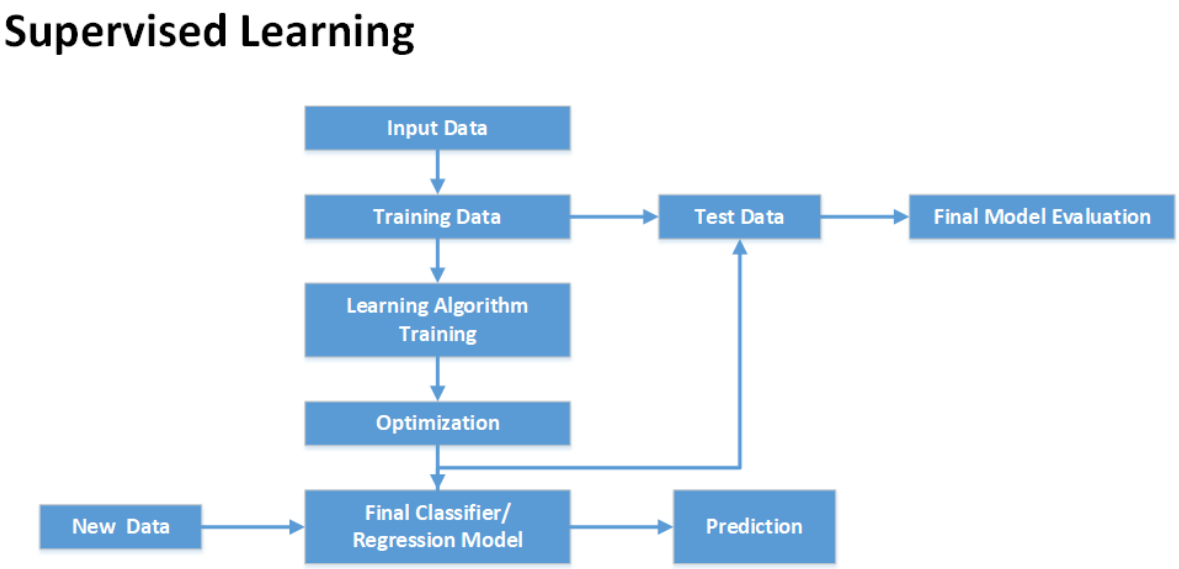

Figure 1: Flowchart of Supervised Learning

3 Unsupervised Learning

Unsupervised learning, on the other hand, allows one to approach problems with little or no idea what the results should look like. Structures are derived from data where one doesn't necessarily know the effect of the variables. Structures are derived by clustering the data based on relationships among the variables in the data. With unsupervised learning there is no feedback based on the prediction results.

3.1 Unsupervised Learning: Case Examples

1. Given a collection of 1000 essays written on the High Schools, and find a way to automatically group these essays into a small number that are somehow similar or related by different variables, such as word frequency, sentence length, page count, and so on. This is a clustering problem.

2. Given a dataset that contains a mixed audio from a party, unsupervised learning could be used to separate the different components and find patterns within. This however is a non-clustering problem.

3. Similar to the example given above, for the supervised learning, but a similar dataset of images of dogs can be used and then unsupervised learning can be used to separate clusters of different breeds.

3.2 Unsupervised Learning: Flow chart

The following is a flowchart describing a general (simplified) architecture of unsupervised learning:

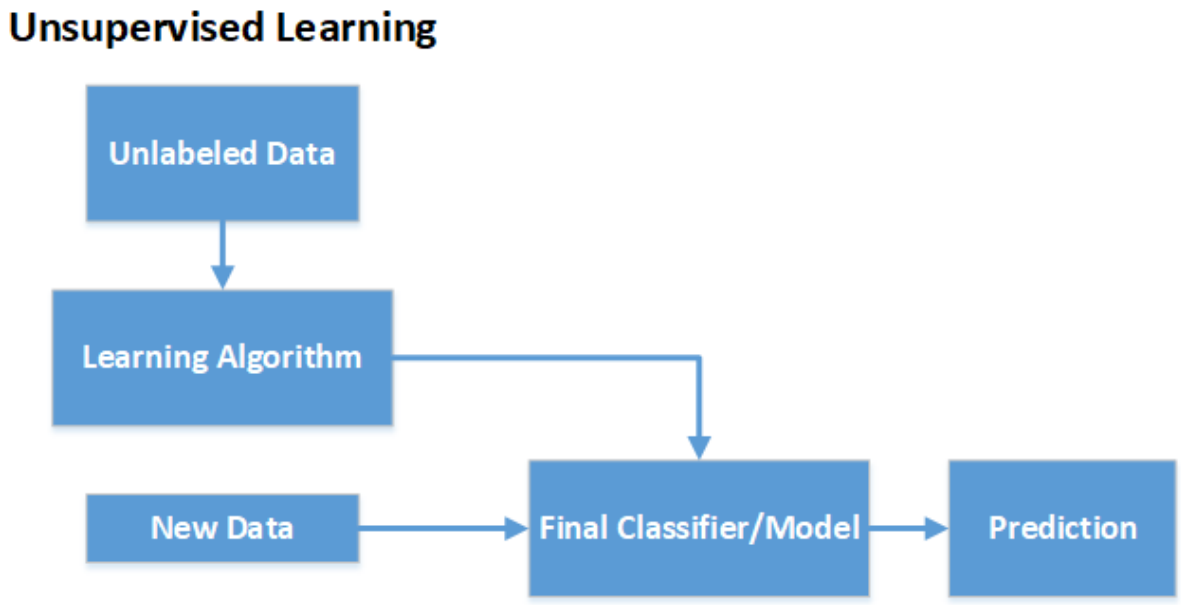

Figure 2: Flowchart of Unsupervised Learning

4 Reinforcement Learning

Also called Semi-supervised learning, reinforcement algorithms learn by trial and error to achieve a clear objective. It tries out lots of different things and is rewarded or penalized depending on whether its behaviors help or hinder it from reaching its objective. This is a goal-oriented learning method based on interaction with the environment. Reinforcement Learning is usually modeled as a Markov Decision Process (MDP).

4.1 Reinforcement Learning: Case Examples

1. A traffic light control system could be implemented using reinforcement learning, where inputs can be lane controls and reduction in delay based on previous time step can be defined as the reward function.

2. Robotics can be another area of application. Images from a camera can be used as inputs to the algorithm and motor torques can be the outputs. Given a specific task, the state distributions can be used as the training data to the algorithm.

3. Driver-less cars are another application that reinforcement learning can be applied to. Using input data from an array of sensors, and then using desired behaviour of the vehicle as a reward function. Training data can also be generated using the sensor data from the previous time step.

4.2 Reinforcement Learning: Flow chart

The following is a flowchart describing a general (simplified) architecture of unsupervised learning:

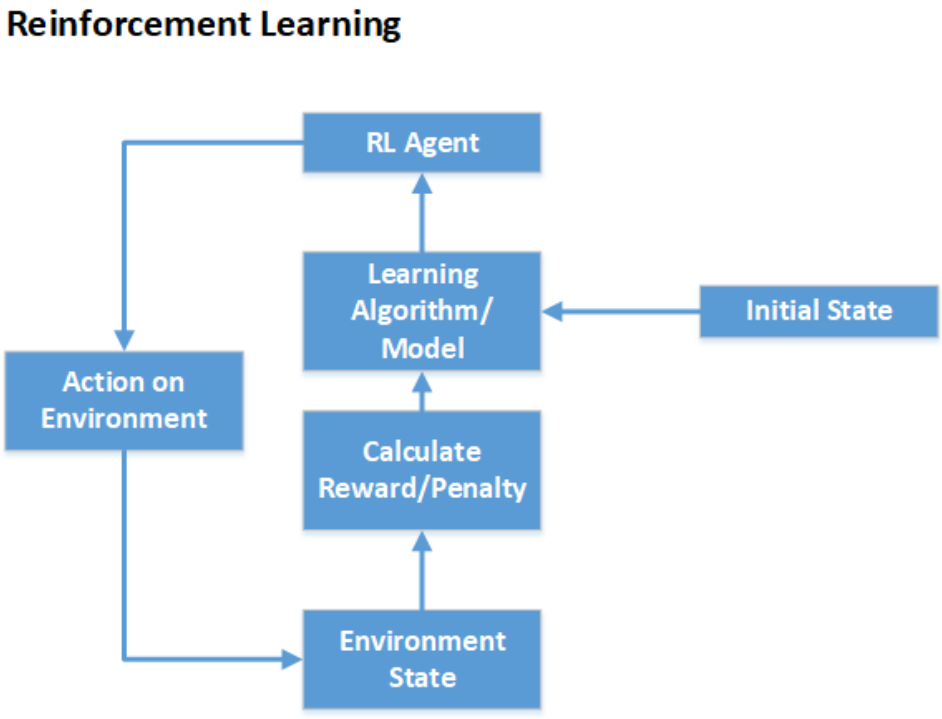

Figure 3: Flowchart of Reinforcement Learning

REFERENCES

[1] Tom M. Mitchell. *Machine Learning.* (Published) 2017.

[2] Steven Cooper. *Machine Learning for Beginers.* (Published) 2018.

[3] Medium. *A brief introduction to reinforcement learning* [online]. Available at: <https://medium.freecodecamp.org/a-brief-introduction-to-reinforcement-learning-7799af5840db> [Accessed 3 March 2019].