Introduction to machine learning

Frederique Bone

Introductory Data Science for Innovation (995N1) – Week 10,
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Outline

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- Lecture's objectives
- What is machine learning?
- The different types of machine learning
- Working with supervised machine learning
- Working with unspervised machine learning
- Ethical considerations of machine learning
- What is next?

Lecture's objectives

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After having learned about getting data, processing it, working with text (text mining) and understanding data visualisation, this lecture is going to introduce machine learning. You may already have encountered some of the machine learning algorithms we are going to see today.

This lecture aims first at giving you an overview of what machine learning is, giving you a few definitions, what it is generally used for, and in broad lines what are the different types of machine learning that you may encounter.

Second we will delve into a few examples of common algorithms used in machine learning and run a few practical examples in R. We will also discuss some ethical concerns that you should keep in mind when using or implementing such a system.

What is machine learning?

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Machine learning gives computers the ability to acquire their own knowledge, by extracting patterns from data, without the need to give explicit rules / hard-coded knowledge (Ian Goodfellow, Yoshua Bengio and Courville 2016). The computer will learn from experience.
Machine learning uses computer agorithms to solve problems through the building of models and in turn allows it also to take decisions.

What is machine learning?

"Every algorithm has an input and an output: the data goes into the computer, the algorithm does what it will with it, and out comes the result. **Machine learning** turns this around: in goes the data and the desired result and out comes the algorithm that turns one into the other. Learning algorithms -also known as learners- are algorithms that make other algorithms."
The master algorithm - Source : Domingos (2015)

Types of machine learning

Types of Machine learning

How can the algorithm learn from data?

Here are the most common types of machine learning techniques:

- Supervised learning
- Unsupervised learning
- Semi-supervised learning
- Reinforcement learning
- Active learning

There are many ways in which a model can be built using data.

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First, we will explore in more details what is meant by supervised

Supervised Learning

General principles

Supervised learning is used when the analyst has a clear idea of the target to be reached. The target is instructed to the machine using data, where one variable acts as the target.
The target can either be a classification, where there can be two (binary) or more (factors) classes; or a regression problem, where the target is a number, and the algorithm will learn by looking how far off it is from the target.
The model will learn from each of the example given; and to be performant you will need to give it a variety of cases.
The data given to the algorithm is split into two sets, a training set which will be used to build the model, and a test set to evaluate how good the model constructed actually is.

General principles

In **supervised learning**, there are five main steps to follow:

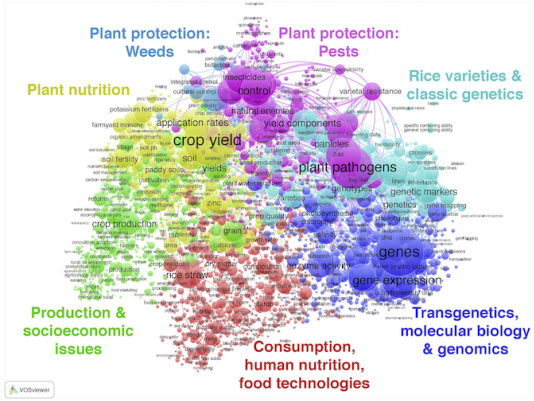
- Prepare the data to the appropriate format
- Split the data into two sets: one to build the model (training data), one to check the performance of the model (testing

Unsupervised Learning

General principles

Unsupervised learning is used for more exploratory purposes, looking at features in the data, and group them into classes. There is no given target, the algorithm finds similiarty in the observations or underlying relevant features. The analyst may need to input some parameters, such as the number of clusters to be found, and usually needs to identify/label clusters after the algorithm has done the grouping.
You have already seen some examples of unsupervised learning in previous classes, such as topic models, or co-word analysis.

Supervised learning (co-word analysis)



Source: Ciarli and Ràfols (2019)

Other techniques

Clustering techniques

Clustering techniques are more traditional unsupervised learning techniques (for any types of problems), a little less used for text mining than the above.

Clustering is the process of partioning a set of observations into subsets (i.e. classes or clusters). In each cluster, the observations are similar to one another, while dissimilar to observation in other clusters. (Han, Kamber, and Pei 2012, 444)

To do clustering analysis, you need to evaluate how similar observations are in your data, and then having an algorithm (i.e. learner), which will group them into cluster; different learners may bring different clustering. To prepare data for the learner you may want to run similarity measures on the observations (e.g. cosine similarity).

Clustering techniques

There are three main types of clustering:

Method	General Characteristics

Ethical considerations

Ethical considerations

Training data

The model that you developped is as good as your training data. The training data can overrepresent or underrepresent certain categories / characteristics. Thus the resulting model when implemented may not work well for these undererpresented examples.

One example was the automatic labelling of objects in pictures.

Google's solution to accidental algorithmic racism: ban gorillas

Google's 'immediate action' over AI labelling of black people as gorillas was simply to block the word, along with chimpanzee and monkey, reports suggest

Questions

What's next?

Next week

Week 10, we will have a session to discuss your assessments, especially the reports. If you have any ideas for your report, you will have a chance to share these on a padlet, and we will give comments ahead of the session. Your report is due on the 10th of May 2021 at 16:00 (see sussex direct)
Week 11, we will have a workshop with Chantale Tippett from the Nesta innovation team, and we will look at how to best use of data science tools to communicate with policy makers.
The group assessment is also due on the Friday 30th of April by 17.00: submit on the canvas site by going to goup assignment and submit your assignment (one submission is expected for every group). **Can you tell me who is going to make the submission?** Any question on assessments?
More information on Canvas.

Internship at ResearchFish / Interfolio UK

Application process and tentative timeline:
Next week: Sharing of the Ad / application process for the

References

References

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