CT4101
Machine Learning

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About this Module

- CT4101 Machine Learning is taken by…
  - 4th BSc CS&IT
  - 4th Electronic & Computer Engineering
  - 4th Maths
  - Structured PhD & other misc.
- Lecturer: Dr Frank Glavin, Email: Frank.Glavin@UniversityOfGalway.ie
- 2 hours/week for 1 semester (September – November)
- Written Exam (70%)
- Continuous Assessment (30%, details to follow)

Important Notice

- The lecture slides are provided so that you can focus on understanding the material as it is being discussed and **take supplementary notes**.

- Additional material **will** be covered in lectures that does not appear in these notes.

- Getting the notes is **not** a substitute for attending lectures!

- Sample code and other resources will be available for download on Blackboard.

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Module Overview

- Machine Learning (ML) allows computer programs to improve their performance at a task with experience (i.e., data).
- This module is targeted at learners with no prior ML experience, but with university experience of mathematics and statistics and **strong** programming skills.
- The focus of this module is on practical applications of commonly used ML algorithms, including deep learning applied to computer vision.
- Students will learn to use modern ML frameworks (e.g., scikit-learn, Tensorflow / Keras) to train and evaluate models for common categories of ML task, including classification, clustering, and regression.

Module Learning Objectives (1/2)

On successful completion, you will be able to:

1. Explain the details of commonly used Machine Learning algorithms
2. Apply modern frameworks to develop models for common categories of Machine Learning task, including classification, clustering, and regression
3. Understand how Deep Learning can be applied to computer vision tasks
4. Pre-process datasets for Machine Learning tasks, using techniques such as normalisation and feature selection

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Module Learning Objectives (2/2)

On successful completion, you will be able to:

5. Select appropriate algorithms and evaluation metrics for a given dataset and task
6. Choose appropriate hyperparameters for a range of Machine Learning algorithms
7. Evaluate and interpret the results produced by Machine Learning models
8. Diagnose and address commonly encountered problems with Machine Learning models
9. Discuss ethical issues and emerging trends in Machine Learning

Topics We Will Cover

1. Machine Learning Fundamentals (this week)
2. Getting started with Python for ML
3. Classification tasks
4. Regression tasks
5. Clustering tasks
6. Data processing
7. Model Selection and evaluation
8. Neural Networks & Deep Learning

Topics we won't get to…
(or we will only briefly cover)

- Support Vector Machines
- One-Class Classification & Anomaly Detection
- Association Rules, Clustering and Topic Modelling
- Ensemble Learning
- Reinforcement learning
- And many more …

The School of Computer Science offers advanced MSc degrees in Artificial Intelligence and Data Analytics where many of the above topics are covered.

If this module is interesting to you consider enrolling in one of those programmes next year!

Module Prerequisites

This module is intended for students who already have substantial experience in computer science, software development or a closely related subject area

You need to understand:
    How to program (any language)
    Algorithm analysis
    Basic statistics and probability
    Knowledge of standard mathematical notation
        i.e., how to read an equation

Python

If you do not already know Python 3, you will need to learn it to understand the code samples and complete the assignments in this module

I will introduce you to key Python concepts during next week's lecture
Python is relatively easy to pick up if you are familiar with other commonly used programming languages such as Java, C, C++, C#, JavaScript, etc.
Python allows us to avail of a rich ecosystem of very useful libraries that are commonly used for tasks like ML, data science and data manipulation, computer vision, general AI, …
Such libraries include TensorFlow, Keras, scikit-learn, pandas, SciPy, NumPy, OpenCV. We will use many of these this semester!

# Recommended Textbooks

"Machine Learning" by Mitchell (1997)

"Data Mining" by Witten & Frank
(3e 2011), also responsible for **Weka
OSS data mining software**

"Artificial Intelligence" by
Russell & Norvig (3e 2010)

"The Elements of Statistical
Learning" by Hastie, Tibshirani
& Friedman (2e 2009)

"Principles of Data Mining" by
Hand, Mannila & Smyth (2001)

"Fundamentals of Machine Learning for Predictive Analytics",
Kelleher et al. (2020)
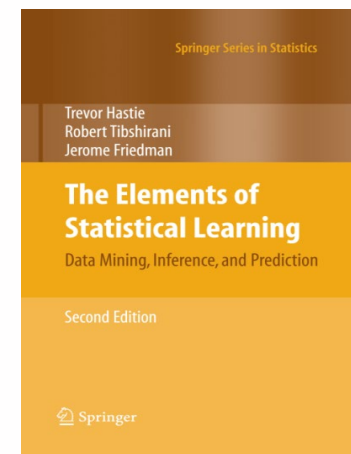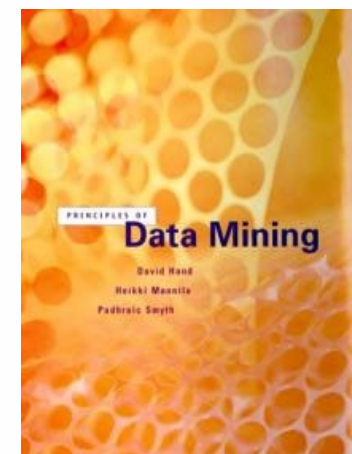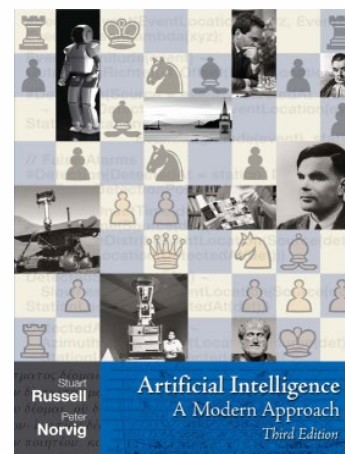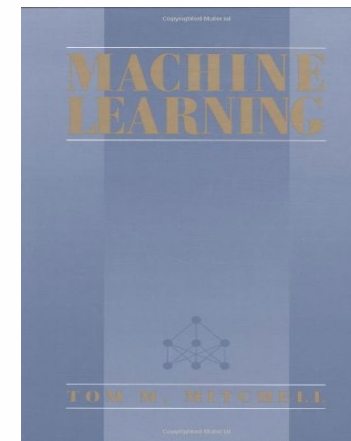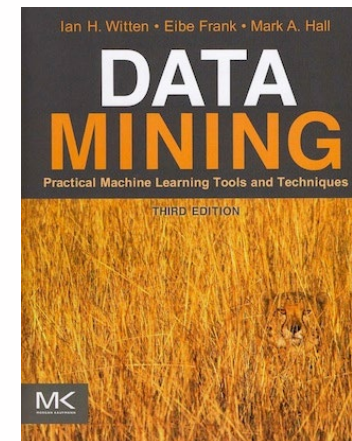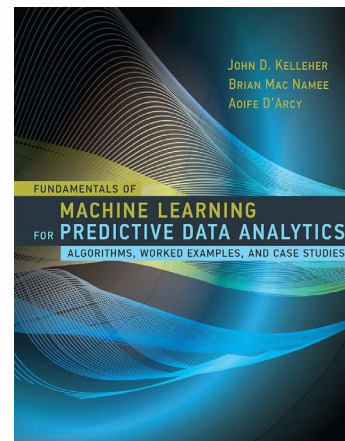
Useful Online Resources

There are many useful articles online for further reading such as:

- https://www.sas.com/en_ie/insights/articles/analytics/machine-learning-algorithms.html
- https://machinelearningmastery.com/start-here/
- https://machinelearningmastery.com/a-tour-of-machine-learning-algorithms/
- https://www.geeksforgeeks.org/machine-learning/
- https://pub.towardsai.net/machine-learning-algorithms-for-beginners-with-python-code-examples-ml-19c6afd60daa
- https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-are-machine-learning-algorithms/#overview
- https://www.ibm.com/cloud/learn/machine-learning
- https://www.javatpoint.com/machine-learning-algorithms