

## **Tutorial Outline**

### ***Machine Learning With Neural Networks***

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#### **Description**

Artificial neural networks have come to dominate machine learning over the last decade, enabling substantial advances in areas such as computer vision, robotics, speech recognition and natural language processing. In this tutorial we provide an introduction to Artificial Neural Networks, covering fundamental concepts such as gradient descent, back-propagation, multi-layer perceptrons, auto-encoders, convolutional networks, recurrent networks, and Transformers. Concepts will be developed in a roughly historical order, with reference to historical context and enabling technologies. We will review network architectures, as well as techniques for training and performance evaluation, including methods for supervised, semi-supervised and self-supervised learning.

While this is an introductory course, students will be assumed to have a basic understanding of linear algebra, basic calculus, probability and statistics.

#### **Tutorial Outline:**

##### **1. Learning and evaluation for Pattern Recognition**

- The pattern recognition problem
- Training methods
- Performance Evaluation

##### **2. Perceptron Learning and Gradient Descent**

- History and mathematics of the Perceptron
- Multilayer Perceptrons
- Training Perceptrons with gradient descent
- The back-propagation algorithm for distributed gradient descent.
- Network architectures, loss functions and training techniques
- A simple Keras example of a MLP

##### **3. Generative Networks and Auto-encoders**

- Generative Networks
- Autoencoders and self-supervised learning
- Variational autoencoders
- Generative Adversarial Networks

##### **4. Convolutional Networks**

- The story of LeNet5
- CNN Hyperparameters
- Common CNN architectures: AlexNet, VGG,
- A simple Keras example of a CNN
- Generative Convolutional networks

## **5. Advanced Topics: Where to go from here**

Recurrent Networks and LSTM

Transformers and Self-Supervised Learning

About the Professor:

James L. Crowley is a Professor at Grenoble Institut Polytechnique, where he teaches courses in Computer Vision, Machine Learning and Intelligent Systems. Over the last 35 years, Professor Crowley has made a number of fundamental contributions to computer vision, robotics and multi-modal interaction. He has recently been named to the Chair on Intelligent Collaborative Systems at the MAIA AI Institute at the University Grenoble-Alpes.

This tutorial is based on course material taught to 4th and 5th year engineering students at Grenoble Institut Polytechnique.