Intelligent Systems

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# Introduction

The scope of this project is to study and understand practically machine learning techniques in particular using Deep Learning techniques. The main focus of this project is on a dataset called “rock\_paper\_scissors” available on: <https://www.tensorflow.org/datasets/catalog/rock_paper_scissors>. The dataset contains 2892 images of hands playing rock, paper and scissor game.

The experiment is developed using resources and tools offered by Python Environment, in particular: Tensorflow, Keras, Neural Networks and more.

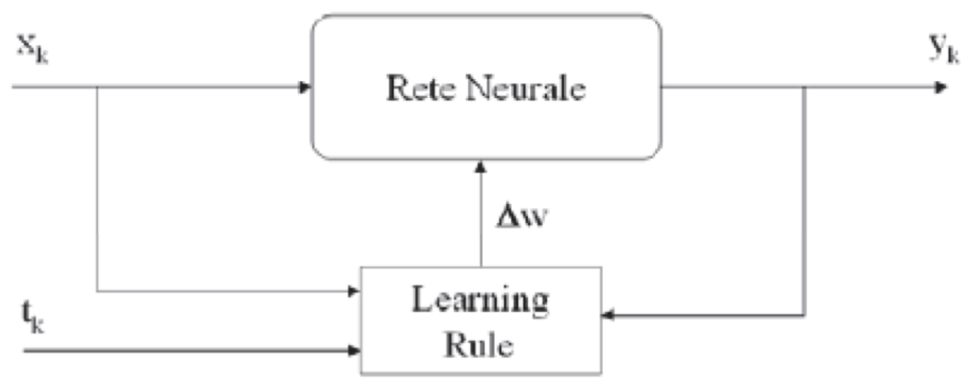
The experiment is designed to investigate the behaviour and the capability of the Neural Network comparing performances under different experimental conditions.

The project is divided in two phases: the first one using two Convolutional Neural Network (CNN) pretrained and the second one creating a new CNN. The obtained results have been compared in each phase and between the two phases.

# Theoretical Part

## Supervised Learning

Supervised learning involves somehow modelling the relationship between measured features of data and some label associated with the data; once this model is determined, it can be used to apply labels to new, unknown data. This is further subdivided into classification tasks and regression tasks: in classification, the labels are discrete categories, while in regression, the labels are continuous quantities.



(Xk, tk) training sample with input-output pairs

## Deep Learning

Deep learning means using a neural network with several layers of nodes between input and output: some of them are fully connected and other partially connected. The series of features between input & output do feature identification.

A deep neural network consists of a hierarchy of layers, whereby each layer transforms the input data into more abstract representations (e.g. edge → nose → face). The output layer combines those features to make predictions.

Deep leaning use of Convolutional Neural Networks (CNNs / ConNets). Convolutional Neural Networks are very similar to ordinary Neural Networks:

* They are made up of neurons that have learnable weights and biases.
* Each neuron receives some inputs, performs a dot product and optionally follows it with a non-linearity.

The difference between a CNN and an ordinary Neural Network (such as MLP) is about the connections between the layers. In CNN not all layers are fully connected and in ordinary Neural Network all layers are fully connected. This difference makes the CNN the best alternative to work with images.

CNN have a topology that organizes 3D volumes of neurons to be oriented to process images. Neurons in a layer will only be connected to a small region of the layer before it, instead of all of the neurons in a fully connected manner.

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## Tensorflow

TensorFlow is an open-source software library released in 2015 by Google to make it easier for developers to design, build, and train deep learning models. TensorFlow originated as an internal library that Google developers used to build models in-house, and we expect additional functionality to be added to the open-source version as it is tested and vetted in the internal flavor. Although TensorFlow is only one of several options available to developers, we choose to use it here because of its thoughtful design and ease of use.

On a high level, TensorFlow is a Python library that allows users to express arbitrary computation as a graph of data flows. Nodes in this graph represent mathematical operations, whereas edges represent data that is communicated from one node to another. Data in TensorFlow is represented as tensors, which are multidimensional arrays (representing vectors with a 1D tensor, matrices with a 2D tensor, etc.).

Although this framework for thinking about computation is valuable in many different fields, TensorFlow is primarily used for deep learning in practice and research.

## Keras

Keras is a high-level neural networks API developed with a focus on enabling fast experimentation. Being able to go from idea to result with the least possible delay is key to doing good research. Keras has the following key features:

* Allows the same code to run on CPU or on GPU, seamlessly.
* User-friendly API which makes it easy to quickly prototype deep learning models.
* Built-in support for convolutional networks (for computer vision), recurrent networks (for sequence processing), and any combination of both.
* Supports arbitrary network architectures: multi-input or multi-output models, layer sharing, model sharing, etc. This means that Keras is appropriate for building essentially any deep learning model, from a memory network to a neural Turing machine.

## OpenCV

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## Matplotlib

Matplotlib is a multiplatform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was conceived by John Hunter in 2002, originally as a patch to IPython for enabling interactive MATLAB-style plotting via gnuplot from the IPython command line. IPython’s creator, Fernando Perez, was at the time scrambling to finish his PhD, and let John know he wouldn’t have time to review the patch for several months. John took this as a cue to set out on his own, and the Matplotlib package was born, with version 0.1 released in 2003. It received an early boost when it was adopted as the plotting package of choice of the Space Telescope Science Institute (the folks behind the Hubble Telescope), which financially supported Matplotlib’s development and greatly expanded its capabilities.

One of Matplotlib’s most important features is its ability to play well with many operating systems and graphics backends. Matplotlib supports dozens of backends and output types, which means you can count on it to work regardless of which operating system you are using or which output format you wish. This cross-platform, everything-to-everyone approach has been one of the great strengths of Matplotlib. It has led to a large user-base, which in turn has led to an active developer base and Matplotlib’s powerful tools and ubiquity within the scientific Python world.

## Numpy

NumPy (short for Numerical Python) provides an efficient interface to store and operate on dense data buffers. In some ways, NumPy arrays are like Python’s built-in list type, but NumPy arrays provide much more efficient storage and data operations as the arrays grow larger in size. NumPy arrays form the core of nearly the entire ecosystem of data science tools in Python, so time spent learning to use NumPy effectively will be valuable no matter what aspect of data science interests you.

# Experimental Part

”Rock\_paper\_scissors” dataset contains 2892 colour images, each with dimensions *300x300px*. The content of the images within the dataset is sampled from 3 classes:

* Rock
* Paper
* Scissors



## Process the data

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## Build the model

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## Compile the model

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## Train the model

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## Evaluate the model

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## Make predictions

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## Conclusion

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