

Tuto N°1 : DL

ANN / CNN – exercices

Question 1. Consider a neural network that receives as input colorful images represented by matrices of $20 \times 20 \times 3$ pixels. Each of these images illustrates one of the following fruits: banana, apple, pear or pineapple. This is therefore a multi-class classification problem; the network has four output neurons.

- (a) If the network has a single fully connected hidden layer of k neurons, and If we include the bias parameters for the hidden layer and for the output layer, how many parameters will we need to optimize by gradient descent?
- (b) If the network has a first layer of m convolution filters of size $5 \times 5 \times 3$, followed by a fully connected hidden layer of n neurons, and no bias parameters, how many parameters will we have to optimize by gradient descent?
- (c) If the network has a first layer of m convolution filters of size $5 \times 5 \times 3$, followed by a MaxPooling layer with a pitch size of 4, followed by a fully connected hidden layer of n neurons, and no bias parameters, how many parameters will we need to optimize by gradient descent?
- (d) Finally, consider the following architecture:
- Network input: $20 \times 20 \times 3$ sized images ;
 - 1st layer: m_1 convolution filters of size $5 \times 5 \times 3$, without bias.
 - *MaxPooling* with step size 2
 - 2nd layer: m_2 convolution filters of size $3 \times 3 \times m_1$, without bias.
 - *MaxPooling* with step size 2
 - 3rd layer: l neurons fully connected, without bias
 - 4th layer: l neurons fully connected, without bias
 - 5th layer: 4 output neurons, with bias.

Question 2: Repeat question 2(a-d), this time considering that the images are in color. The network therefore receives as input matrices of size $20 \times 20 \times 3$.