Classification of spiral images of healthy individuals and with Parkinson's disease using convolutional neural networks

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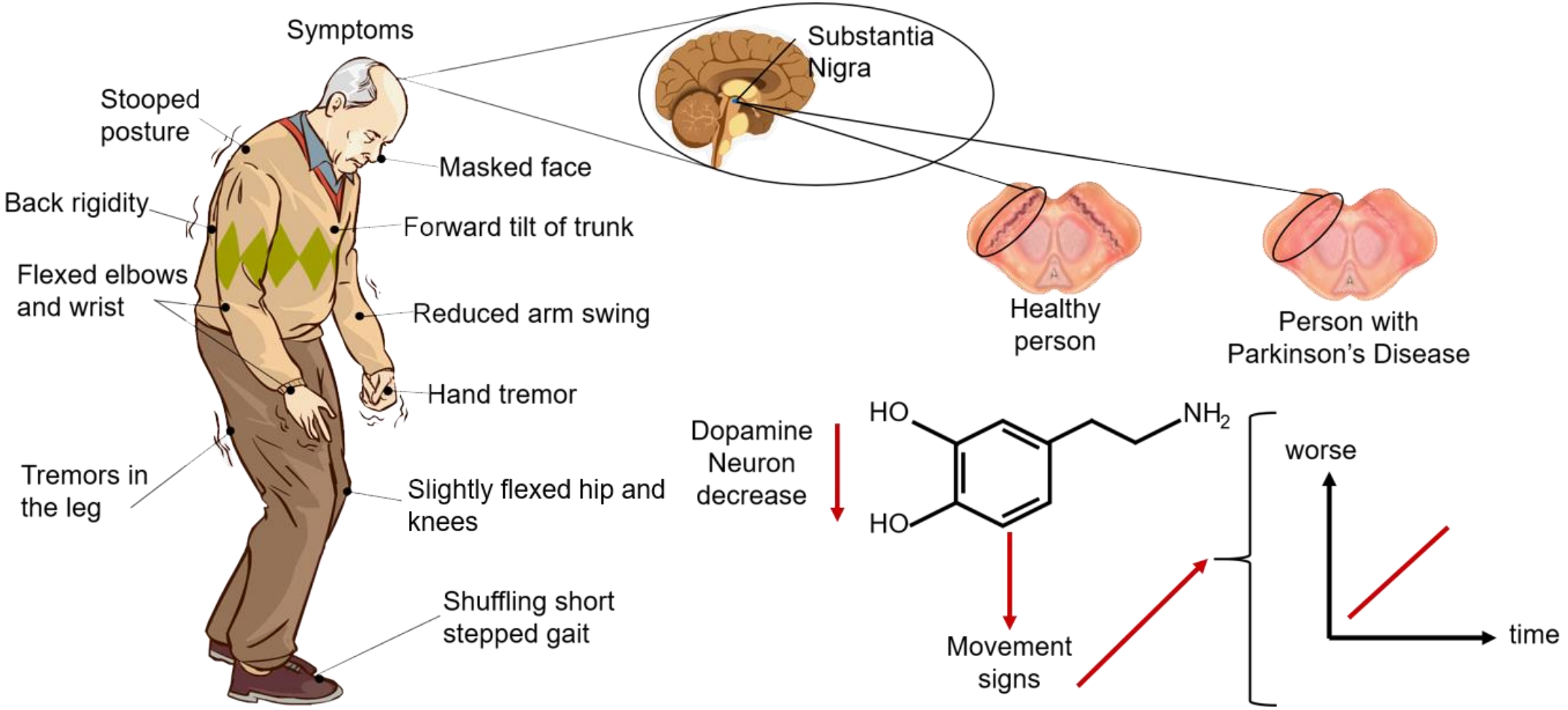
Parkinson's disease



Motivation

- Parkinson's disease (PD) is present in about 1% of the world's population over 65 years, and still remains incurable.
- PD is a disease that has a difficult diagnosis.
- Know the various symptoms is the key to the correct diagnosis and understanding of the disease.
- Techniques involving Artificial Intelligence have been applied to aid in the detection of symptoms, and techniques involving deep learning have achieved more expressive results than traditional techniques.

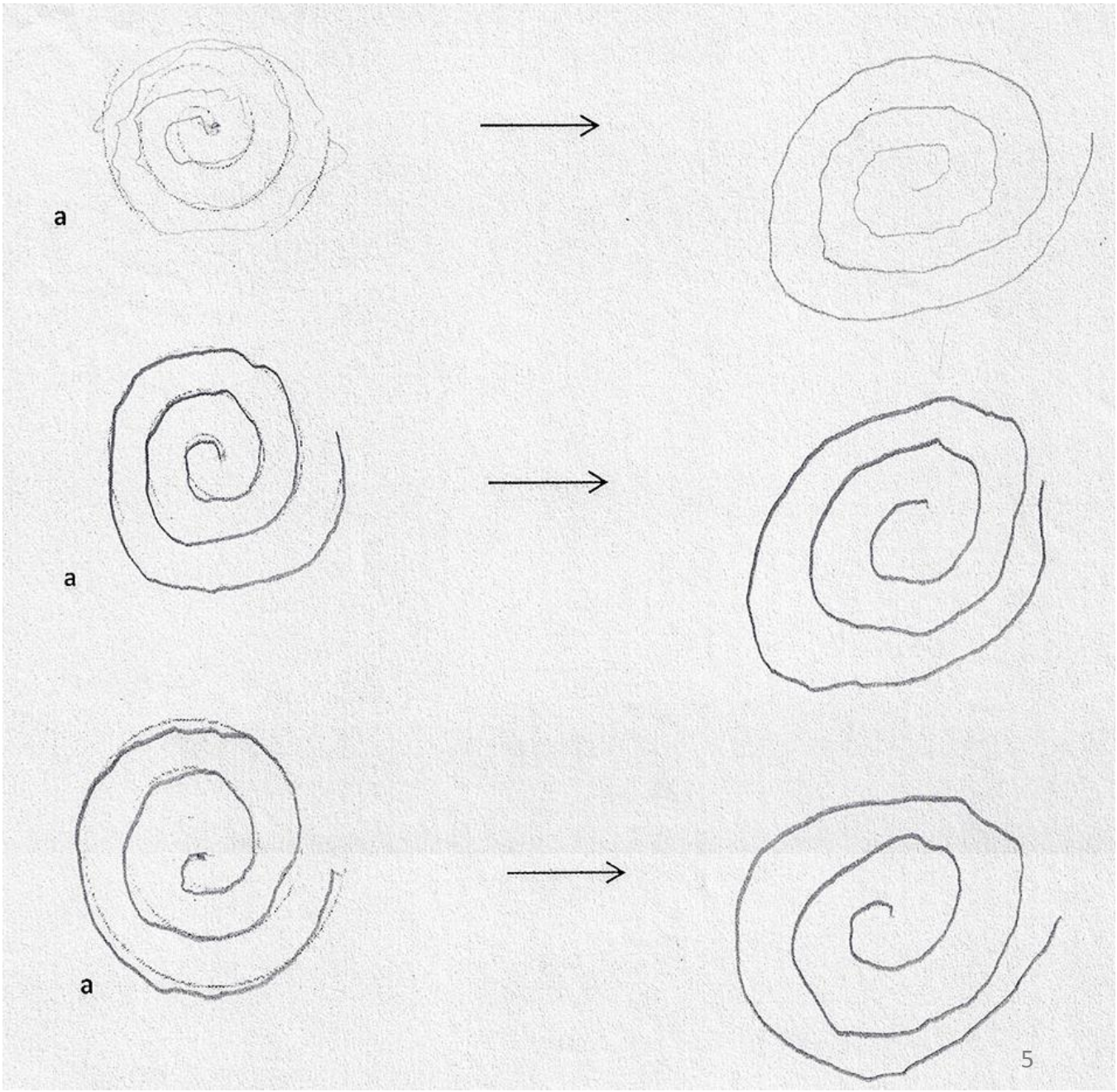
Data collection

- The Research Ethics Committee of the Federal University of Uberlândia approved the research under the number 07075413.6.0000.5152.

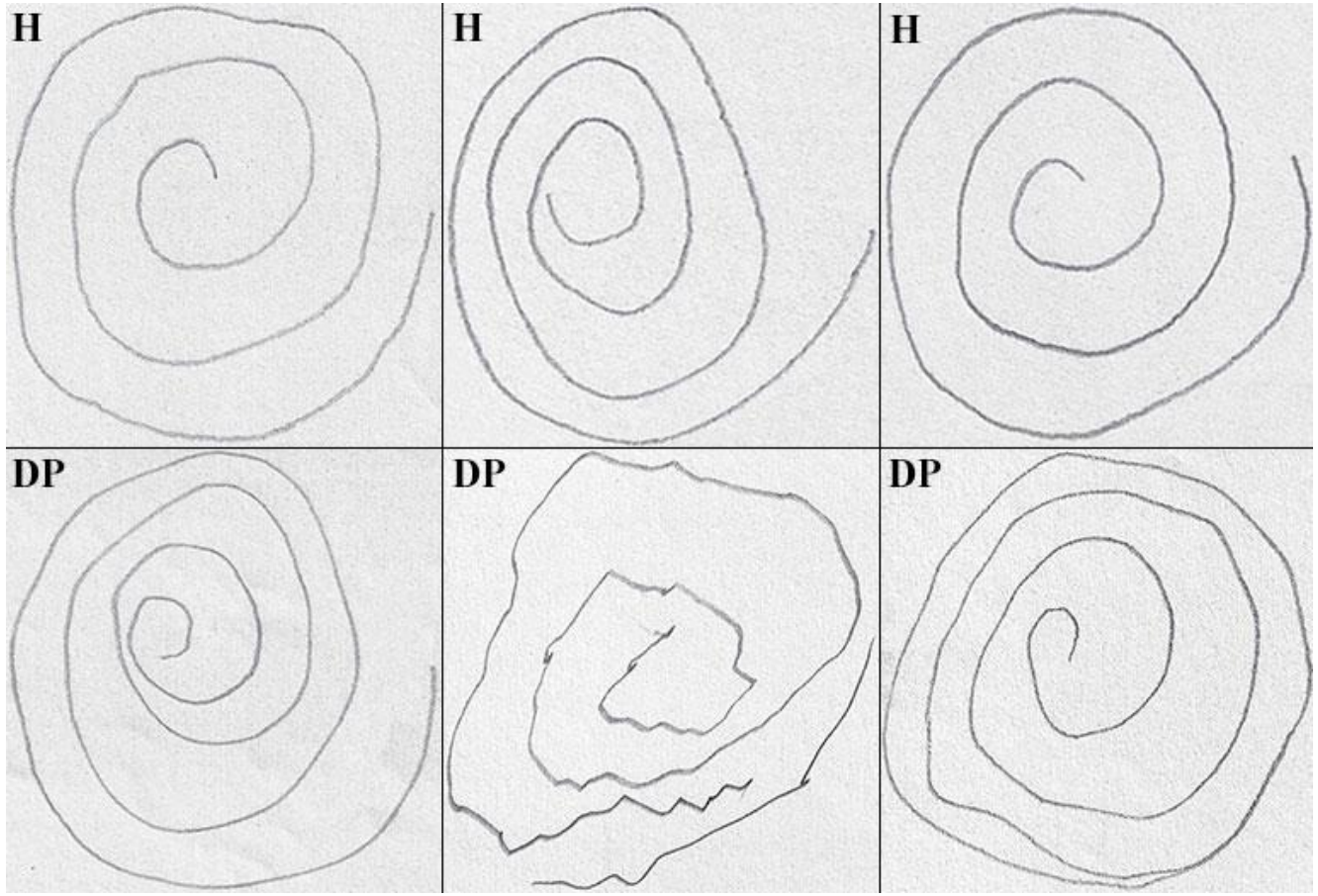
Group	Total	Sex (F/M)	Age (years)
Health	12	8/4	60,08 ± 6,13
PD	15	7/8	65,33 ± 9,17

Data collection

- Original drawings done by the participants
- First, the participant followed the model of Archimedes' spiral and then performed the drawing freely
- The images were scanned and preprocessed (Gimp software was used in this step)

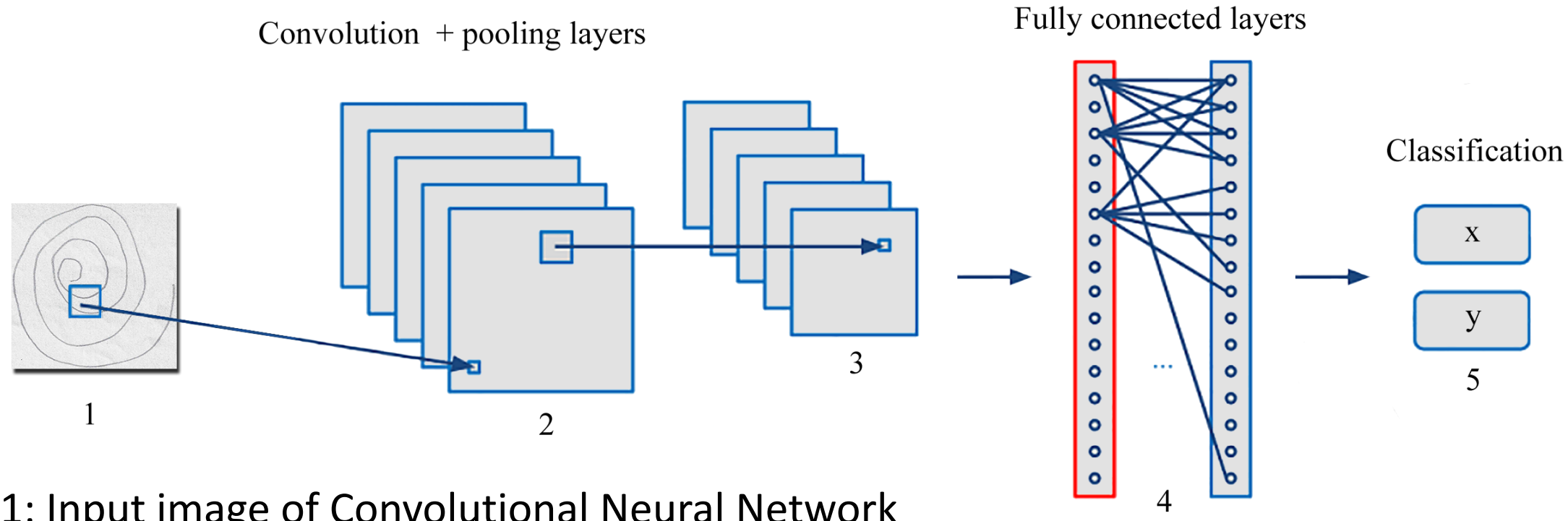


Data collection



- Each individual drew about 3 (three) or 4 (four) spirals
- The spirals were resized to width and height of 256 x 256 pixels.
- **51 images was collected from each group, totalizing 102 images.**

Convolutional Neural Network (CNN)



1: Input image of Convolutional Neural Network

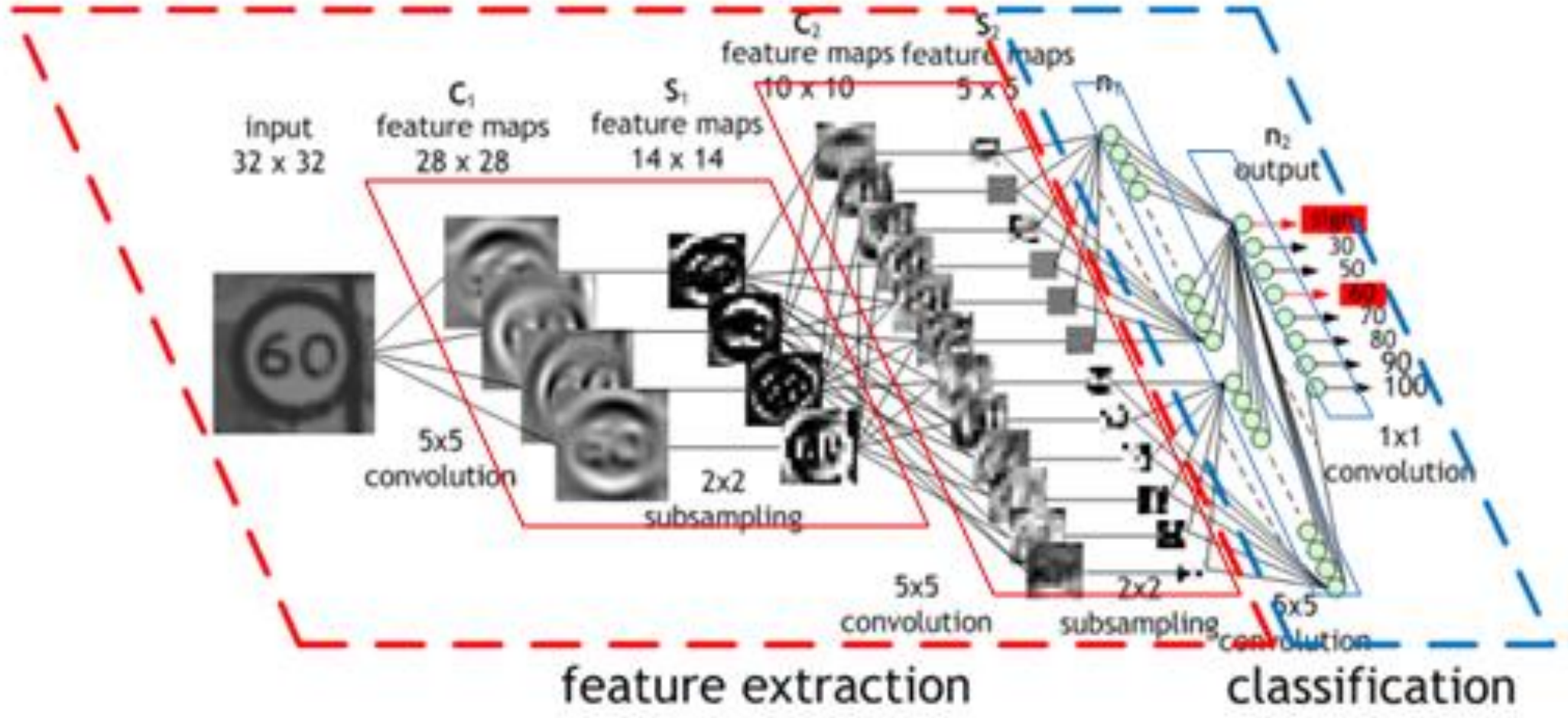
2: Convolution layer that yields the feature maps

3: Pooling layer is used to dimensionality reduction

4: The Fully connected layer represents a vector with all features to classify the images (it looks like a multilayer perceptron network - MLP)

5: The last layer has one neuron (unit) to classify between two kinds of classes

Example of a CNN

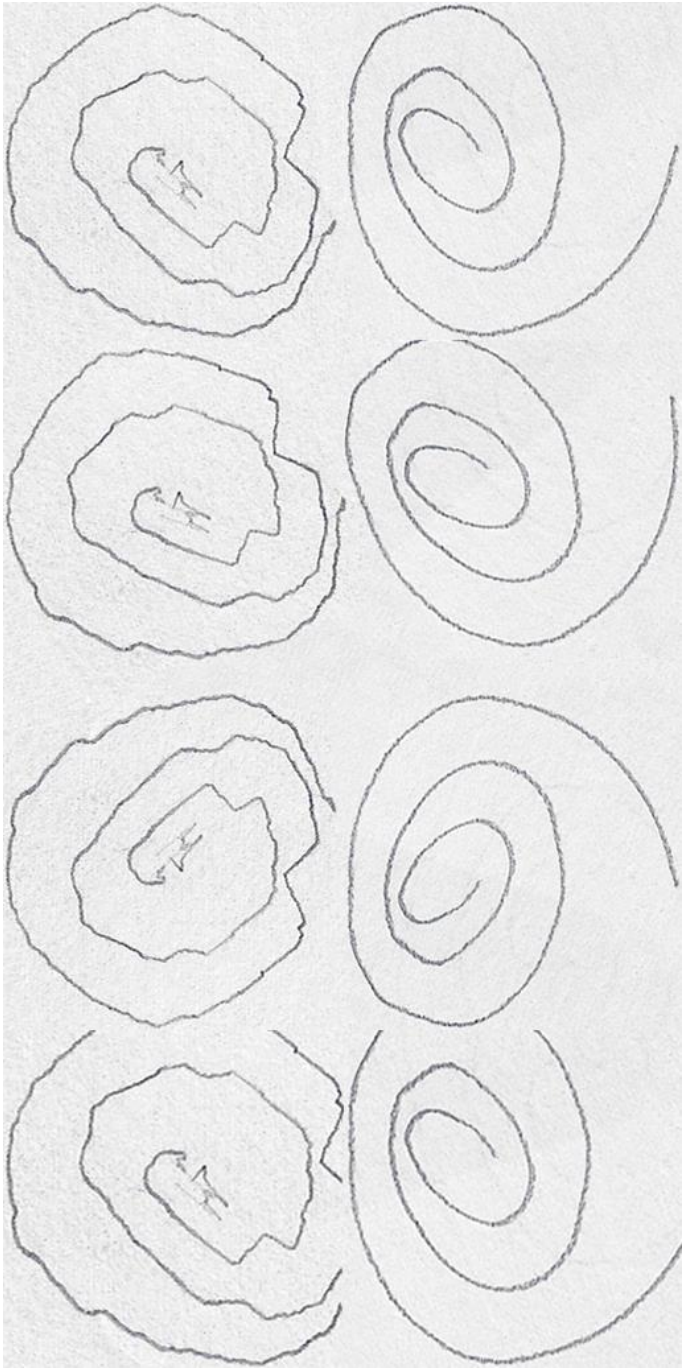


Reference: https://developer.nvidia.com/discover/convolutional-neural-network

Data augmentation

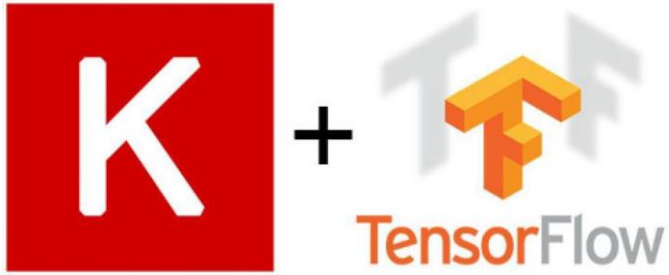
A **technique to increase the data**, there is the increase of the number of samples modifying the original sample and then apply it in CNN

- Rotation (*rotation_range=20°*)
- Vertical flipping (*vertical_flip=true*)
- Shear (*shear_range=0.2*)
- Horizontal shifting (*width_shift_range=0.2*)
- Zoom (*zoom_range=0.2*)
- Rescale (*rescale=1./255*)



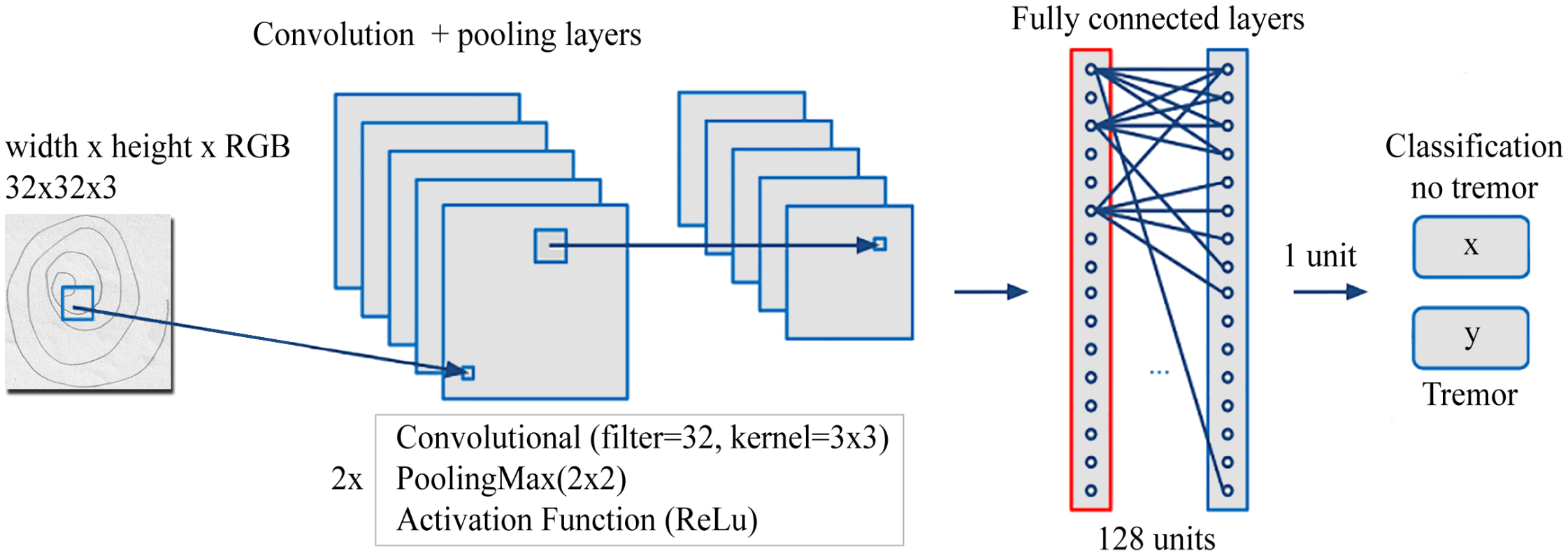
Development environment

- API Keras, a library to explore the machine learning techniques
- Program language Python 3.5
- TensorFlow 1.2, a engine to work with machine learning
- The CPU and GPU process all the calculus in parallel by the library CUDA from NVidia
- Intel i7 2.4 GHz + 8 GB RAM DDR 3 + Video board de 2GB Nvidia GT 650



Results

75% training and 25% validation



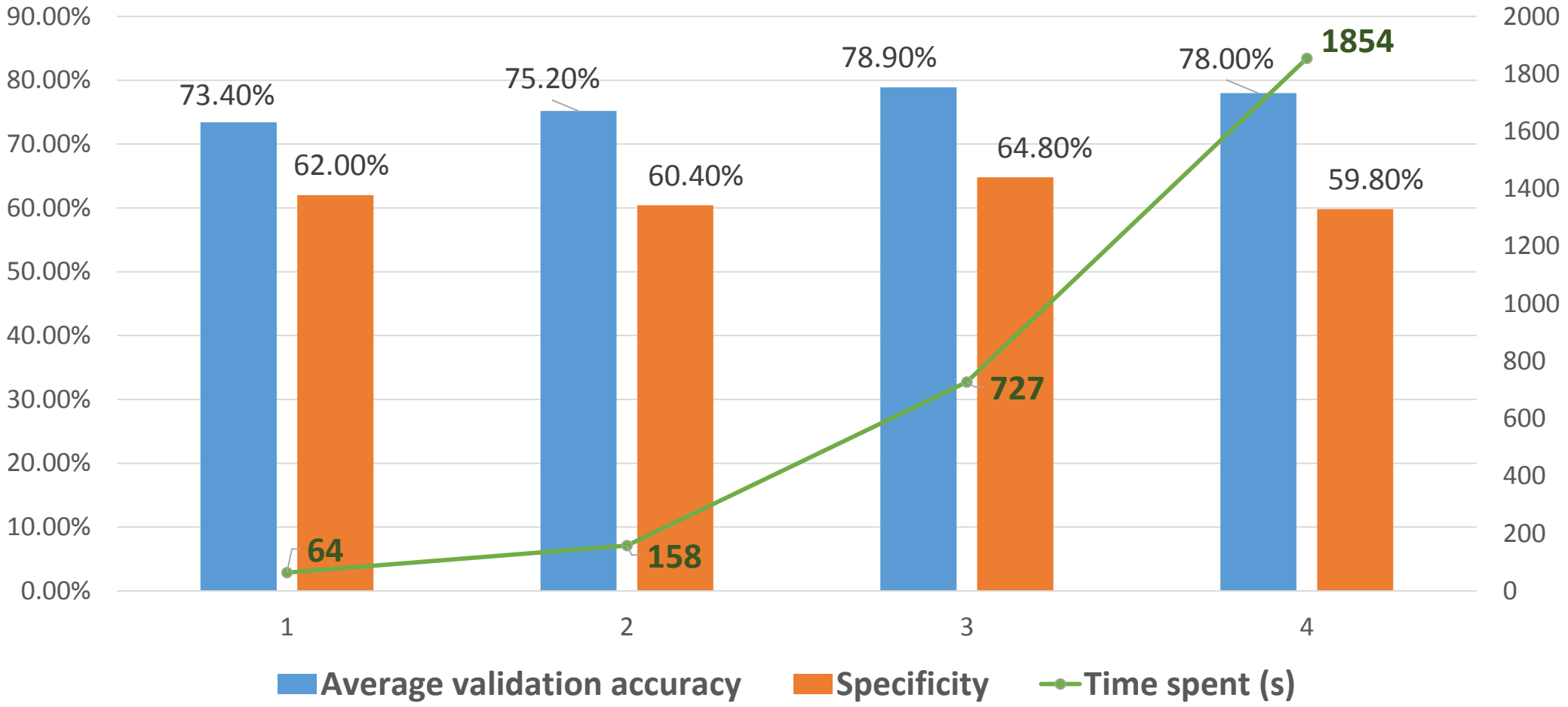
Results

Accuracy is expected to measure how well the test predicts both categories

Specificity the ability of the system to accurately predict the absence of the condition for cases that do not actually have it.

Test	Steps per epoch	Epochs	Nº of convolution layers	Average validation accuracy	Specificity	Time spent (s)
1	100	10	2	73.4 %	62.0 %	64
2	200	10	2	75.2 %	60.4 %	158
3	800	10	2	**78.9 %**	**64.8 %**	727
4	1000	10	2	78.0 %	59.8 %	1854

Results



Discuss and conclusion

- The classic configuration of CNN obtained a satisfactory classification (average of 76.3%) in the identification of healthy individuals and Parkinson's disease spirals.
- Larger data volume is required to perform other tests and get better results
- We need **refine the network parameters,** test other error calculation functions other than the mean squared error, etc**.**
- Test another architecture CNNs
- A simple CNN network with few images brought a satisfactory result illustrating the high performance of the Deep Learning techniques

Acknowledgements

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