Universidade do Minho
Departamento de Informática
Mestrado Integrado em Engenharia Informática
Mestrado em Engenharia Informática

Intelligent Systems
Soft Computing
4º/1º Year, 2º Semester
2020/2021 Edition

Individual Practical Work

Theme	Convolutional Neural Networks on Image Classification
Learning Objectives	With the realization of this practical work, it is intended that groups learn the following procedures: • Preparation and analysis of dataset; • Training and validation of learning models, specifically Convolutional Neural Networks (CNN); • Use of Genetic Algorithms (GA) for learning model hyper parameter optimization, structure optimization and loss function optimization.
Problem Statement	This practical work intends to be the starting point for the development of a predictive model using the Python development environment. For this, it will be necessary to develop a solution to the following problem: *Classify the bird species that appear on an image based on the use of a Convolutional Neural Network model (CNN).* In this practical work, it is intended to apply the knowledge taught during the curricular unit of Soft Computing for the classification of bird specifies that appear on an image, through the implementation of CNN algorithms. In other words, each student must implement mechanisms that enable the preparation of the proposed dataset, followed by the development and optimization of the learning models. In this process, students must consider the CNN hyper parameters (e.g., learning rate and optimization function), its structure (e.g., number of filters and number of convolutional layers, kernel_size, strides, dilation_rate, among others; number of filters and number of nodes of dense layers) and loss function. For model evaluation, evaluation methodologies and metrics must be proposed, based on its relevance for the problem's resolution. Furthermore, the application of Genetic Algorithms for automatic optimization of the CNN architecture must be applied, as shown in Figure 1: Automatic Optimization Pipeline. Based on the problem's statement, a summary of the dataset features is shown: • Bird Species: 250; • Training Images: 35215 (not balanced, however has at least 100 training image files per species); • Validation Images: 1250 (5 per species); • Test Images: 1250 (5 per species); • Images Size: 224 x 224 x 3 color channels in jpg format; • Species gender: 80% of total images are of male while the remaining 20% are of female - the classifier may not perform as well on female specie images.

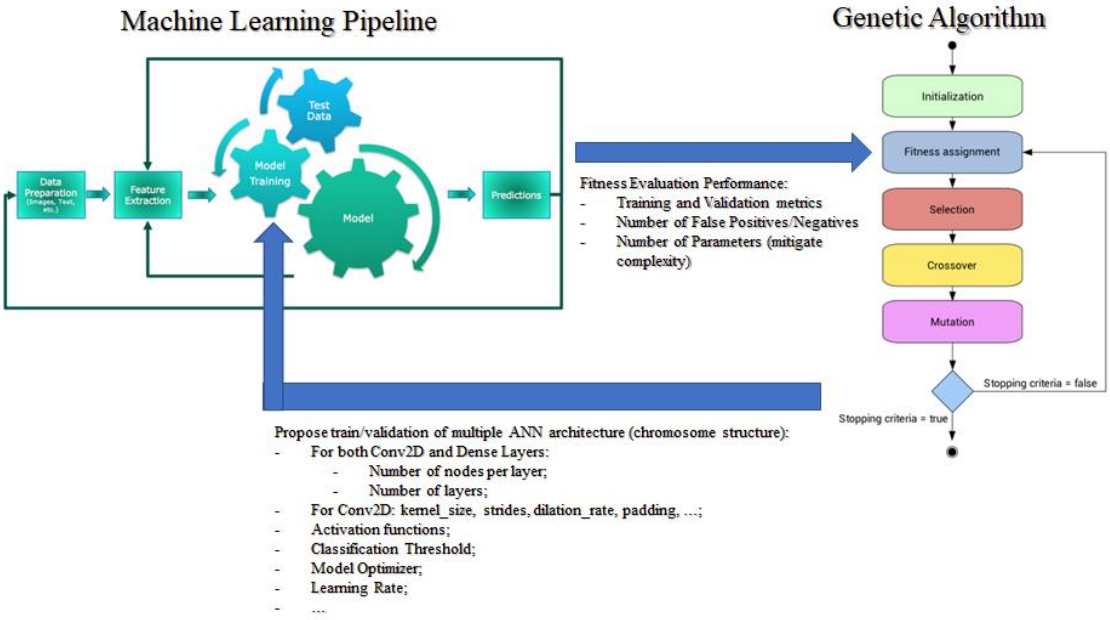

Figure 1: Automatic Optimization Pipeline

The practical work includes the delivery of the developed code and corresponding digital report, describing all the procedures applied and respective justification for its use, based on the demonstration of the results obtained.

Any open-source python library can be applied for the resolution of the exercise. However, all groups are advised to re-use code developed during the course. In addition, consider the application of mechanisms for the mitigation of standard challenges related to machine learning models (i.e., analyze dataset distribution, classification validation based on evaluation reports and confusion matrix analysis, among other techniques). Take also into account the computational resources and time required for each optimization mechanism.

The inclusion of state-of-the-art features in the proposed solution is encouraged. Such elements will never jeopardize the minimum job satisfaction but benefit the overall evaluation of the same. Satisfaction of the minimum requirements exposed in this work does not allow access to the maximum classification possible.

In addition, due to the high computational demands of the whole algorithm, it is advisable to use the platform Google Colab – more info at https://colab.research.google.com/notebooks/intro.ipynb

Delivery

The code resulting from this practical work and respective report (in digital format - PDF) must be sent via elearning platform to the respective evaluation item (found in: **Conteúdo – Instrumentos de Avaliação – Individual Practical Work**), in compressed file (ZIP format) until **19th of April 2021 – 12:00h**. The file must be identified in the form "[CNF1XXX]", in which [XXX] designates the student's identification number.

Bibliographic References

Silaparasetty, N. (2020). The Tensorflow Machine Learning Library. In Machine Learning Concepts with Python and the Jupyter Notebook Environment (pp. 149-171). Apress, Berkeley, CA.

Gibb, S., La, H. M., & Louis, S. (2018, July). A genetic algorithm for convolutional network structure optimization for concrete crack detection. In 2018 IEEE Congress on Evolutionary Computation (CEC) (pp. 1-8). IEEE.