Deep Learning approach to Covid-19 detection using HyperTuningSK algorithm for hyperparameter tuning

Pedro Rici[1], André Luiz Carvalho Ottoni[1], Marcela Silva Novo[2]
[1] Universidade Federal do Recôncavo da Bahia, Cruz das Almas, Bahia, Brasil
[2] Universidade Federal da Bahia, Salvador Bahia, Brasil

Abbreviated abstract: Deep Learning techniques are studied for application in the detection of Covid-19 through x-ray images of the patient's lung. One of the challenges in this area is training Convolutional Neural Network models and hyperparameter optimization for the available databases. This work apply a methodology for tuning of hyperparameters for the classification of lung X-ray images in Covid-19 detection with Deep Learning, with four optimizers and six learning rates.

Related publications:
– Rici et al., CBIC, (2021)
– Ottoni et al., The Visual Computer, (2022)

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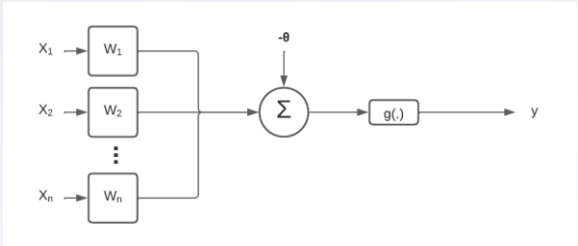
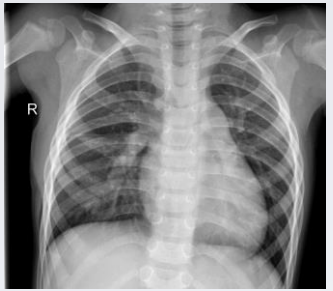
Introduction

- In the literature, there are already studies of Deep Learning techniques applied to Covid-19 detection.
  - But the literature lacks studies that analyze methodologies to adjust the learning rate of optimizers
  - Present an experimental methodology for defining optimizers and learning rates in the classification of x-ray images for Covid-19 detection with Deep Learning
  - Use the methods proposed by Ottoni et al. (2022) that use Convolutional Neural Networks (CNN), which in turn are based on Artificial Neural



Methods

- The database was obtained in Kaggle and the images were reorganized into an experimental group, Covid-19 versus Pneumonia.
- The methodology consists of using 4 optimizers and 6 learning rates, totaling 14 combinations.
- In the Training and Validation step, the 14 combinations were simulated in 5 runs of 5 epochs.
- The evaluation criterion is accuracy (A_C) $$A_C = \frac{T_P - T_N}{T_P + T_N + F_P + F_N}$$
- The HyperTuningSK algorithm (Ottoni et al, 2022) is used, where the ANOVA test of variance and the Scott-Knott clustering algorithm are used. With the combinations recommended by the HyperTuningSK algorithm, 3 runs with 20 epochs each.



Combination	Optimizer	Learning Rate
1	adagrad	0,001
2	adagrad	0,005
3	adagrad	0,010
4	adagrad	0,015
5	adagrad	0,020
6	adagrad	0,025
7	sgd	0,001
8	sgd	0,005
9	sgd	0,010
10	sgd	0,015
11	sgd	0,020
12	sgd	0,025
13	adam	0,001
14	adamax	0,001

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Results and Conclusions

- Of the 14 combinations simulated in the Training and Validation stage, two passed to the Test stage after using the HyperTuningSK algorithm.

Step	Combination	1	2	3	Average
Validation	adam001	100.0	100.0	100.0	100.0
	adamax001	100.0	100.0	100.0	100.0
Test	adam001	96.9	71.9	93.8	87.5
	adamax001	84.4	93.8	90.6	89.6

Group	Combination	Average (%)
A	adam001	79.0
A	adamax001	77.0
B	adagrad01	68.0
B	sgd015	67.1
B	sgd025	66.6
B	adagrad005	65.7
B	sgd02	65.4
B	adagrad025	65.2
B	sgd005	62.8
B	sgd01	62.1
B	adagrad015	60.8
B	adagrad02	60.4
C	adagrad001	56.1
C	sgd001	52.0

- The main contributions of this work were the application of a Deep Learning model in the Covid-19 detection process and the proposal of a methodology for the selection of hyperparameters of optimizers and learning rates

- For future work, it is suggested to apply the analysis to other Convolutional Neural Network models. As well as analyze the influence of other optimizers and learning rates.