BDSLab

Biomedical Data Science Lab

Course on Biomedical Data Science

Week 12 – Seminar and practical lesson

Deep learning in medical images – Convolutional Neural Networks

Instituto ITACA

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

PURPOSE

- To be familiar with CNN implementation.
- To understand a basic CNN architecture.
- To be able to modify a CNN architecture including more advanced blocks, or activation functions.
- To assess the CNN performance improvement when including changes.

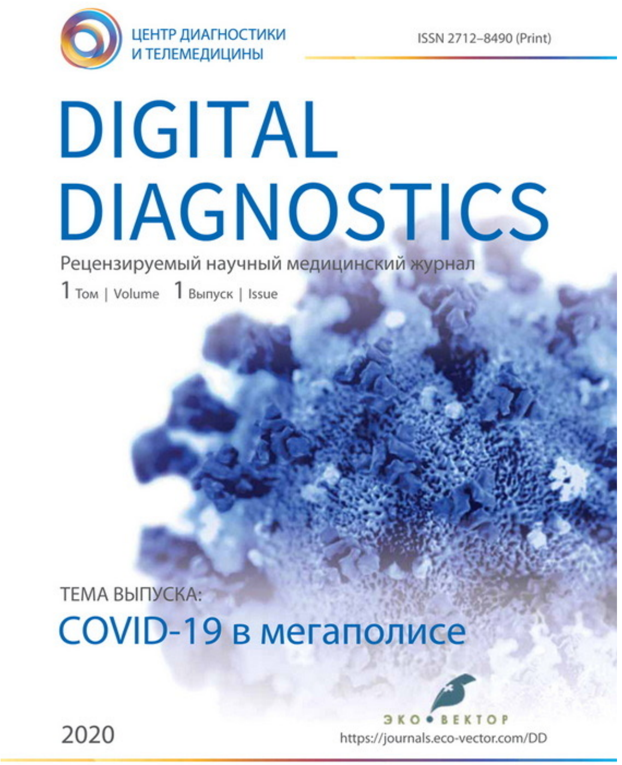
MAIN GOAL

Differenciate between severity of lung tissue abnormalities by means of a automated analysis of CT scans.

MATERIALS: MosMedData

- Anonymised human lung computed tomography (CT) scans with COVID-19 related findings, as well as without such findings.
- CT scans were obtained between 1st of March, 2020 and 25th of April, 2020.
- Provided by municipal hospitals in Moscow, Russia.

- **Reference article:** **https://jdigitaldiagnostics.com/DD/article/view/46826/pdf_3**



MATERIALS: MosMedData

Specific Objective:

- Differenciate between CT-0 and CT-[2-3] by means of a automated analysis of CT scans.

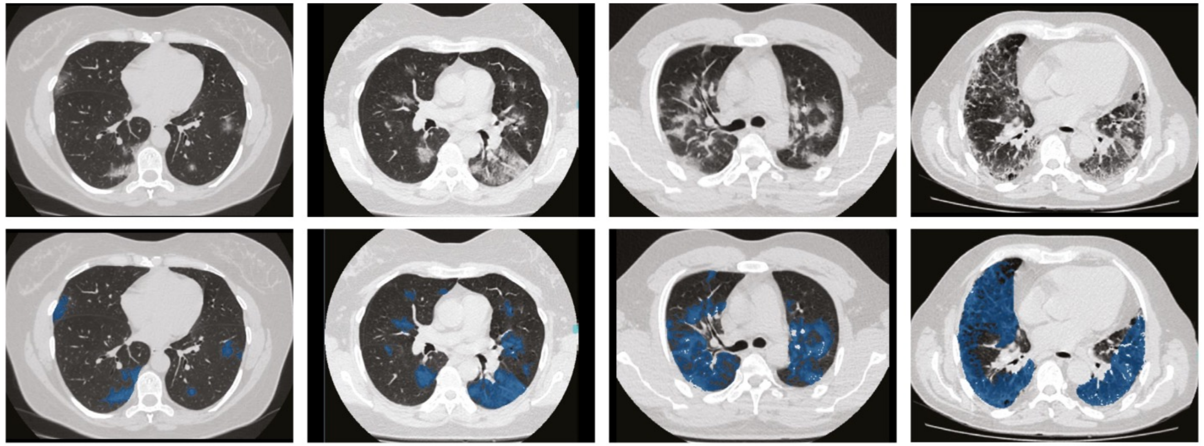


Figure 2: Examples of chest CT scans of patients with varying degrees of COVID-19 severity. Left to right, upper row: axial CT slices of patients with COVID-19 from mild (CT-1) to critical (CT-4) severity. Left to right, lower row: same CT data after tagging.

Table. Classification of the severity of lung tissue abnormalities with COVID-19 and routing rules

Severity	CT	Clinical Data	Decision
Zero	**CT-0** Not consistent with pneumonia (including COVID-19).	–	Inform the attending physician. Refer to a specialist.
Mild	**CT-1** Ground glass opacities. Pulmonary parenchymal involvement =<25% OR absence CT signs in typical clinical manifestations and relevant epidemiological history.	A. t^0 <38.0^{0}C B. RR <20/min C. SpO_2 >95%	Follow-up at home using telemedicine technologies (mandatory telemonitoring)
Moderate	**CT-2** Ground glass opacities. Pulmonary parenchymal involvement 25-50%.	A. t^0 >38.5^{0}C B. RR 20-30/min C. SpO_2 95%	Follow-up at home by a primary care physician
Severe	**CT-3** Ground glass opacities. Pulmonary consolidation. Pulmonary parenchymal involvement 50-75%. Lung involvement increased in 24–48 hours by 50% in respiratory impairment per follow-up studies.	One or more signs on the background of fever: A. t^0 >38,5^{0}C B. RR ≥30/min C. SpO_2 ≤95% D. Partial pressure of oxygen (PaO_2)/ Fraction of inspired oxygen (FiO_2) ≤300 mmHg (1 mmHg=0,133 kPa)	Immediate admission to a COVID-specialized hospital. In a hospital setting: immediate transfer to the intensive care and resuscitation unit. Emergency computed tomography (if not done before).
Critical	**CT-4** Diffuse ground glass opacities with consolidations and reticular changes. Hydrothorax (bilateral, more on the left). Pulmonary parenchymal involvement >=75%.	Signs of shock, multiple organ failure, respiratory failure.	Emergency medical care. Immediate admission to a specialized hospital for patients diagnosed with COVID-19. In a hospital setting: immediate transfer to the intensive care and resuscitation unit. Emergency computed tomography (if not done before and when patient status allows for it).

PREPARING THE SETUP

1. Download the “3D_CNN_for_medical_image_classification.ipynb” file from Poliformat
2. Analyze the code and identify the different parts of the code and their function.
3. Import it to google Colab
4. Activate GPU in Colab: Edit –> Notebook Settings to use GPUs
5. Adjust the number of epoch to 2 for the fist run to check that all works as planned.
6. Run the training again but using at least 10 epoch to see some training performance.

METHODS

1. Go into the network architecture and try to include some modifications based on what we explained in the theorical session. Examples:
    1. Add an extra Dense layer before the output including 100 units and ReLu activation function
    2. Add a second convolutional layer at each level
    3. Change ReLu activation functions by Sigmoids
    4. Change MaxPooling by AveragePooling
    5. Define a Residual Block and replace the convolutional layers by Residual Blocks
    6. Define a Residual Inception Block and replace the convolutional layer by Residual Inception Blocks
2. Run again the training process and check the performance again.
3. Once at home you can try to repeat it but using a larger number of epoch 100-200.

Evaluation and submission

- This practice consists in the improvement of a basic CNN model to differenciate between severity of lung tissue abnormalities by means of a automated analysis of CT scans.
- The deliverable of this practical lesson (i.e. a report) will be a report in pdf format with the main results obtained, and the code of the implementation.
- Alternatively, the report can be presented in colab notebook format with detailed comments on each of the steps and results obtained. In case of submitting the report in colab notebook format, the code and the printout of its execution in pdf format must be included.

Thank you for the attention

Your feedback is value to improve our teaching – elfusgar@upv.es

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