HÔPITAL FONDATION Adolphe de ROTHSCHILD
HEAD AND NECK EXPERTISE

Rothschild Medical Development

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Setup and management of the EOSC Secretariat supporting the EOSC Governance

EOSC : AMELII Project (Assisted detection and Measurement of Lung Infection and Inflammation)

Rothschild Fondation Hospital (FR)

Founded in 1905 in Paris, the Rothschild Fondation Hospital is specialized in ophtalmology and neurosciences. The hospital has a resucitation service to manage critical patients. Number of beds for intensive care has increased from 10 to 40 to take care of COVID-19 patients during the pandemia. Imaging service has dedicated ressources to perform research. The AMELII project is born in the Imaging service in order to manage patients in emergency to evaluate if the SARS (Severe Acute Respiratory Syndrome) is due to COVID-19 or other causes.

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Research team

- J. Savatovsky (MD) is a medical graduate Physician, he is a neuroradiologist and he is deputy head of department and head of research in imaging at the A. de Rothschild Foundation Hospital. His research work has been published in numerous scientific papers. Dr J. Savatovsky, is part of a dynamic of research in the fields of the nervous system and sensory organs, he also provides his expertise in image processing and artificial intelligence in other areas of medical imaging.

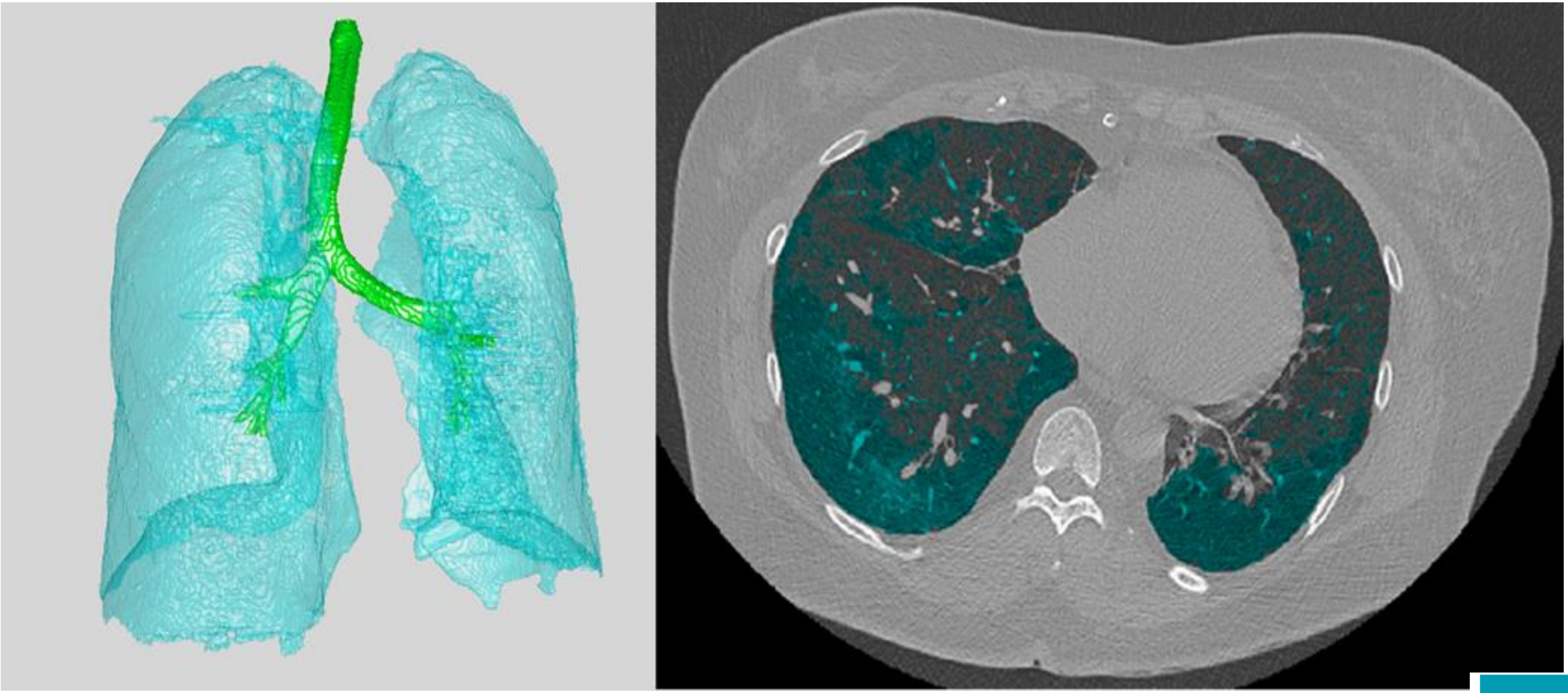
- F. Mazeroi-Eugène (PhD) is expert engineer in image processing, inventor of complex segmentation tools (pathological or non-pathological). He has worked for several years with different departments in healthcare. Specialized in the design of medical diagnostic assistance solutions, he develops softwares used by these teams in their everyday use.

Impact of the technology to alleviate COVID-19 hospital saturation

Patient in → CT-scan → AMELII signal processing and diagnostic → Adapted patient journey

Gain in time regarding laboratory results 48h (PCR)
Negative patients are properly routed within 2h which permits to alleviate the overflow of COVID-19 suspected patients.
COVID-19 patients are routed in the COVID dedicated unit.
Quantitative information to assess disease severity

Segmentation of the pulmonary parenchyma to isolate ground-glass lesions



Project steps

- 300 scans have been analyzed
- 128 patients confirmed with COVID-19 infection
- Dynamic thresholding to process pictures

I_{min} : minimal intensity,

standard deviation of superior intensities I_{min} -> σ

mean of superior intensities I_{min} : μ

$I_{contrast}$ =Min(1, Abs ((((I-I_{min}) -(μ - 4* σ)) / (10 * σ)))*(I>(μ + σ)) + (I<(μ + 6* σ))

- Segmentation of parenchyma using intensity histogram and patern recognition process
- Calculation to identify ground-glass lesions

Pitfalls to tackle during the project

- ✓ Protocol to use DICOM (TELEMIS Solution) and to send parenchyma pictures
- ✓ Recognition of lung lobes to choose dedicated picture processing workstream
- ✓ Severe SARS patients have degraded tissues that leads to degraded picture that impedes algorithm performance (subset of routines to enhance results)
- ✓ Artefact of ground-glass lesions when patient inhales

  (false positive calibration to solve this issue)
- ✓ Sub-development to check with a calculation of ratio between bronchial diameter and the diameter of arterioles (not used because it needs 5 times more calculation ressources)

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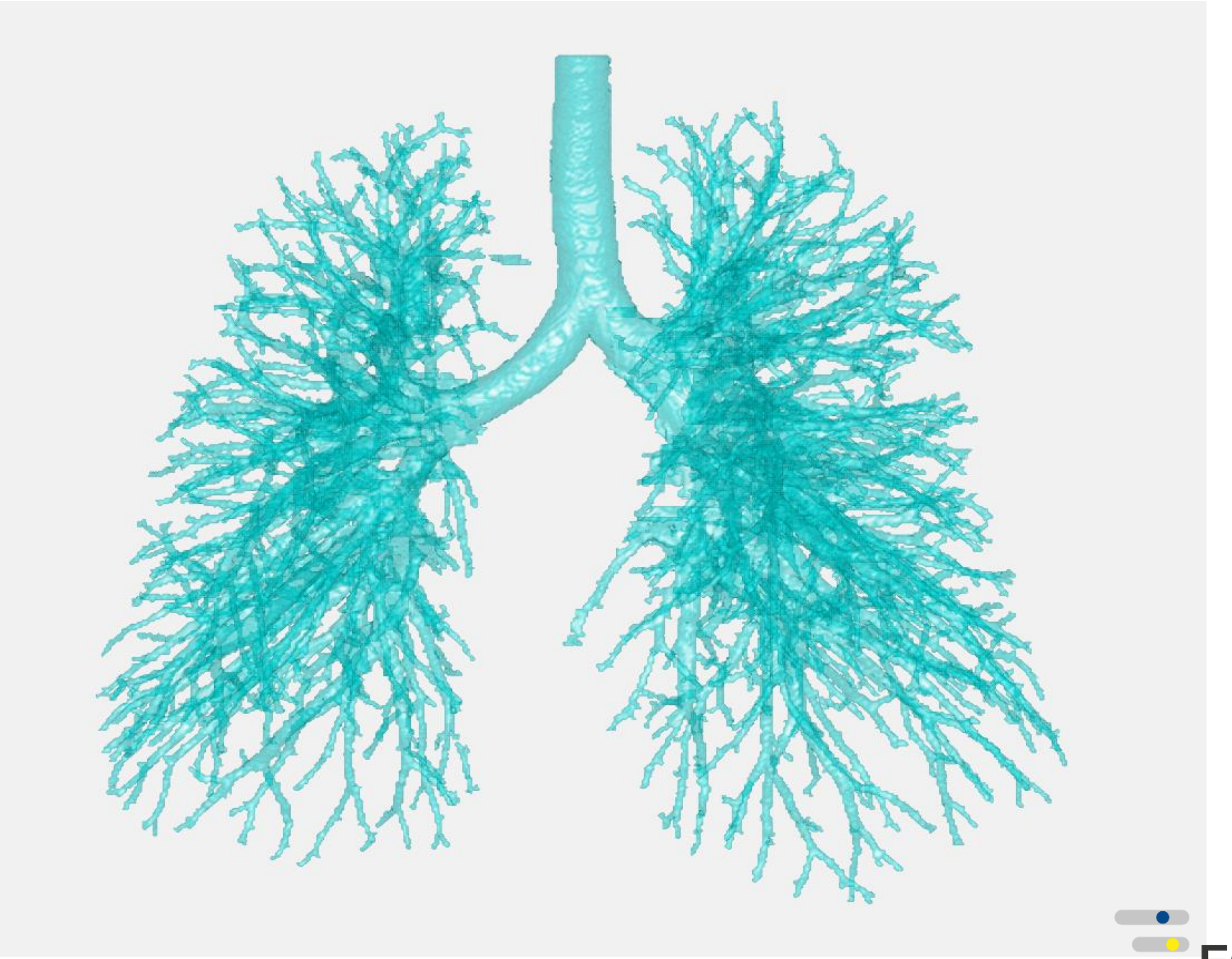
Segmentation of the bronchi



Automatic report

Fondation Ophtalmologique Adolphe de Rothschild

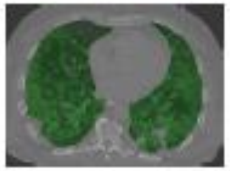
AMeLII

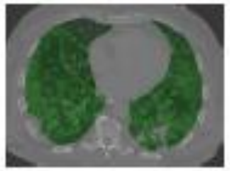
Assisted detection and Measurement of Lung infections &
Designed by F.Malzerol-Eugene et J.Savatovsky
(Imaging Department, Fondation Rothschild Hospital, Paris France)

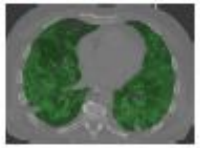
Fondation Ophtalmologique Adolphe de Rothschild

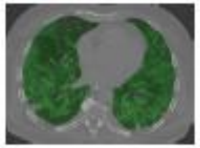
Nom Patient :   Age :
Exam Date :   Institution Name :FONDATION
Blood Diameter (mm) :8   Bronchus Diameter (mm):6

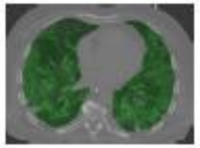
Normal Lung	Ground-Glass	Consolidation
532.6801 cm3	3481.02 cm3	63.6764 cm3
13 %	87 %	2 %

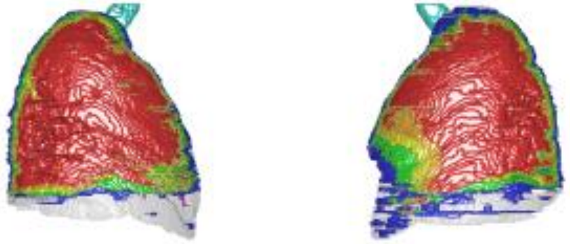


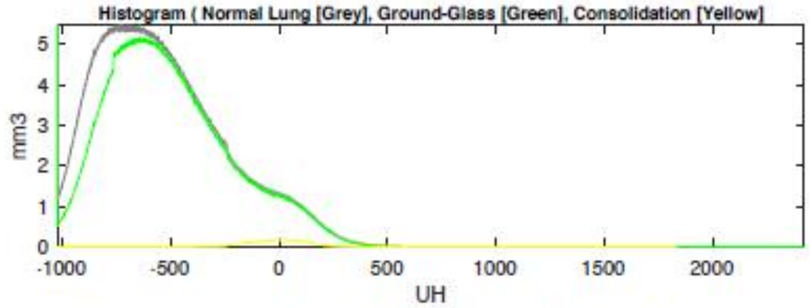












Disclaimer : this diagnostic tool is provided on an « as is » basis. The first versions are developed without using any machine learning technology to allow a free usage during the Covid19 pandemics for hospitals. Further improvements will be be published

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THANK YOU for your attention and to EOSC secretariat for supporting this research program

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BACKUP : Calculation of ground-glass lesions

- We calculate the empirical value $\pitchfork$ which is the result of the ratio of statistical values "variance / mean" of the set of voxels related to the outside air surrounding the patient's body. $\pitchfork_{\text{outside air}}$
- We then adjust a maximum intensity threshold on the parenchyma voxels so that all the parenchyma voxels below this threshold have a "variance / mean" equal to = 1.5 * $\pitchfork_{\text{outside air}}$. The thresholding the airways present in the parenchyma with is defined with the maximum threshold $I_{\text{airways threshold}}$
- We define an intensity interval greater than $I_{\text{airway threshold}}$ and less than $I_{\text{threshold for ground-glass lesions laxe}}$ by adjusting this threshold such that $\pitchfork_{\text{axis ground-glass lesion threshold laxe}}$ = $\pitchfork_{\text{outside air}}$.
- We define an intensity interval greater than $I_{\text{threshold for ground-glass lesions laxe}}$ Is less than $I_{\text{threshold for ground-glass lesions}}$ by adjusting this threshold such that $\pitchfork_{\text{threshold for ground-glass leions}}$ = 2 * $\pitchfork_{\text{outside air}}$.
- We define an intensity interval greater than $I_{\text{threshold for frosted glass lesions}}$ and lower than $I_{\text{high intensity threshold}}$ by adjusting this threshold such that $\pitchfork_{\text{threshold for frosted glass lesions}}$ = 3 * $\pitchfork_{\text{outside air}}$.

BACKUP : AMELII Project scope

Among people infected with covid-19, respiratory symptoms are the most common. Respiratory damage is linked to lung damage induced both by the virus and by the cytokine storm. Due to the physical changes in lung tissue and its use in routine care in pulmonary pathologies, the X-ray scanner has been identified as one of the diagnostic tools for covid-19. Especially that with the scanner it is possible to obtain immediate results (against several hours for the viral PCR test), and the number of false negatives of the scanner is significantly lower than that of viral tests.Currently, scanners performed in patients are systematically evaluated manually by radiologists, who have good performance in establishing the diagnosis, but do not have a reliable tool to quantify the lung damage, which limits the interest of the examination to predict the risk of each patient to develop a serious form.The wide availability of a tool allowing, from the images of the scanner, the detection of anomalies and their quantification will improve the service rendered by the scanner and will help to adapt the care of patients according to the severity of their pulmonary involvement.

We offer a technological solution for rapid and precise detection of the disease from pulmonary scanners. Our technology will add the “quantification” dimension to the diagnosis not yet available. It is a standalone technological tool, integrated into PACS Telemis, allowing to make a virtual dissection of the imaging patterns characteristic of Covid-19 such as ground-glass opacities, in the different stages of the disease.The segmentation of the lesions is carried out by a continuation of treatment based on the pulmonary scanner allowing initially to segment the pulmonary parenchyma, then to isolate the lesions in ground-glass.The software needs no user interaction. The image set is simply sent to a specific address within the establishment (computer on which the software is installed), this step can be carried out automatically as soon as a pulmonary image is produced. It generates in ten minutes a quantitative report and a series of images where the detected anomalies are apparent. These elements are automatically pushed onto the image distribution software used by radiologists and, in hospitals, to prescribers.The rapid implementation of the proposed solution will be beneficial for the care system as well as for the patients and indirectly for the economy in general.For medical teams, the solution saves time and provides a more reliable, quantitative and objective diagnosis, which facilitates decisions on hospitalization or invasive treatments. The patient will thus benefit from personalized care according to the severity of the disease.At the population level and in terms of public health: The availability of the solution will help, by identifying healthy patients, to rationalize the deconfinement process.

This project will be rolled out by the Rothschild Foundation’s Medical Imaging department with an engineer expert in image processing, inventor and patent holder for a segmentation process for a complex structure (pathological or non-pathological).The solution developed in the context of this project would be offered free of charge to any French or European site that requests it.The artificial intelligence tools currently being developed by various players who feed on current cases of the epidemic phase will only be available in a few months. Technically these solutions need to accumulate a lot of data which is in itself time consuming. The implementation of our tool, meanwhile, not using a machine learning technique immediately, would be very quickly and easily deployable. The software can be made available to French centers at the end of April and internationally for the month of May. Validation and feedback can be collected for sharing with the scientific and medical community from June.

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