XXVI Congresso Brasileiro de Engenharia Biomédica

Armação de Búzios – RJ – Brasil

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MINI-CURSO

Advanced Techniques for Medical Image Processing

Part 1: Medical Image Processing Applied to Large Datasets

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Part 2: Deep Learning Applied to Medical Imaging: An Overview and Gentle Introduction

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Público-alvo: This mini-course target audience is students and researchers that aim to apply medical imaging processing and machine learning techniques to their own research project, or just get to know this area. The course is specifically targeted to individuals who are interested in using large datasets.

Pré-requesitos: There is no requirement to do this mini-course.

Ementa (Summary and Goals):

Part 1: Medical Image Processing Applied to Large Datasets (2 hours)

Image processing is performed to extract clinically useful quantitative information from medical images, such as magnetic resonance (MR) imaging. It is an interdisciplinary research field attracting expertise from engineering, physics, medicine and computer sciences among others. Computer aided diagnosis tools (a subfield of image processing) already have important roles in clinical settings supporting diagnosis and treatment evaluation during the course of a disease. In the current era of 'big data' with access to larger datasets of different imaging modalities and higher computing power, extracting clinically relevant high-quality information from images poses significant challenges in the different approaches to process and analyze a significant volume of images.

The principal objective of this course is to provide an introduction to basic concepts and techniques for medical image processing, particularly applied to large and heterogeneous MR datasets. Two 2-hour modules will be presented. The first module will focus on MR image acquisition parameters and image reconstruction. Some pitfalls and trade-offs for acquisition and potential sources of artefacts will be discussed. In addition, an overview of the data and metadata present in clinical image formats (DICOM) and their counterpart research formats will be introduced. The importance of complete and incomplete metadata and their impact on heterogeneous datasets will be addressed. The second module will elaborate on the importance of standardized image pipelines. It will briefly describe state-of-the art algorithms for image pre-processing, and the importance of understanding the source of the image to select the best techniques. It will also describe commonly used image processing techniques, application of these techniques to MR data, and possible pitfalls when dealing with large and heterogeneous MR datasets.

Participants will learn image processing techniques, come to understand how the specifics of processing medical images affect machine learning approaches (quality control, 2D vs 3D processing, etc .), and develop their own medical imaging processing pipeline. It is expected that participants will expand their knowledge and understanding in the following subfields of medical image processing: image storage and file conversion tools, image file formats, anonymization, image registration and segmentation, and processing of large and heterogeneous datasets. In addition, participants will be introduced to the challenges and limitations of the field with hands-on exercises, such as quality control on multi-site datasets, brain white matter lesions segmentation and longitudinal lesion analysis and identification of brain biomarkers related to neuropathologies using tools developed by the Calgary Image Processing and Analysis Centre (CIPAC).

Course Syllabus / Program: MR acquisition (parameters; sequences; k-space; reconstruction and artefacts); medical images (file formats and meta-data); image anonymization, quality control and archiving; pre-processing in medical imaging (non-uniformity correction; image normalization, noise filtering); image registration (non-rigid registration for three-dimensional images); image segmentation (atlases and templates) and image visualization.

Part 2: Deep Learning Applied to Medical Imaging: An Overview and Gentle Introduction (2 hours)

Machine learning, especially deep learning methods in recent years, has been largely used in medical imaging. Starting with compressed sensing image reconstruction and moving to image analysis problems such as segmentation and classification. Machine learning quickly became the state-of-the-art on these fields.

In this second part of the mini-course, we are going to present some background information about machine learning and applications in the medical imaging field. In both modules, some programming examples will be shown, giving a sense of "where to start" for the participants with no previous experience in the area. These examples will also provide some further and topical content for those with previous experience. After the course the participants should have acquired a basic understanding of machine learning, how to design experiments and understand the results. Also, the participants should be able to apply the techniques illustrated in the mini-course in their own imaging application. It is expected that participants will learn the basics of machine learning: what is it; its main goals and subareas; and training, validation and testing of methods; overfitting and regularization. It is also expected for the participants to have access to medical imaging applications: compressed sensing (teaching a neural network to do the inverse discrete Fourier Transform); image segmentation (automatic methods to delineate brain structures using MR images); image classification (using machine learning to distinguish images acquired in different scanner vendors).

Course Syllabus /Program: Python programming and machine learning using Keras and scikit libraries; Linear Regression; Neural Networks; Convolutional Neural Networks; Application to MRI segmentation and classification.

Número máximo de participantes: 60.

Carga horária: 4h (Two Modules – 2h each).

Língua: Inglês**.**

Aferição de presença: The participants will be asked to sign a list to confirm their presences in each module.

Métodos de avaliação: Participants will be required to fill a form that evaluates the course, overall content and presenters. No formal evaluation will be performed with the participants, just informal questions and exercises during the course.

Bibliografia sugerida:

References - PART 1: Kahn CE, Carrino J, Flynn M, Peck D, Horii S. DICOM and radiology: past, present, and future. Journal of the American College of Radiology 4:652-657 (2007); Udupa, J.K. and Herman, G. T., 3D Imaging in Medicine, 2nd Edition, CRC Press, 2000; Tustison, N. J. and Avants, B. B. and Cook, P. A. and Zheng,Y. and Egan, A. and Yushkevich, P. A. and Gee, J. C. N4ITK: improved N3 bias correction. IEEE Transactions on Medical Imaging 29(6): 1310

- 1320 (2010); Lu, Q. and Gobbi, D. and Frayne. R. and Salluzzi, M. Cerebra-WML: A Stand-Alone Application for Quantification of White Matter Lesion. In: Proceedings of Imaging Network Ontario Symposium , 2014; Gonzalez RC and Woods RE. Digital Image Processing, 4th Edition. Pearson Press, 2017; Birkfellner W. Applied Medical Image Processing, Second Edition: A Basic Course, 2 nd Edition. CRC Press, 2014;

References – PART 2: https://github.com/rmsouza01/ML101; https://keras.io/; https://www.scipy.org/scikits.html