Artificial Intelligence in radiology and microscopy

Academic Year: (2023 / 2024) **Review date: 28-04-2023**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: MUÑOZ BARRUTIA, MARIA ARRATE

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is recommended to have passed or to have previous background in the subjects of Biomedical Image Processing, Machine Learning, and Deep Learning.

OBJECTIVES

The 'Artificial Intelligence in Radiology and Microscopy' course explores the intersection of AI, radiology, and microscopy, teaching students to apply machine learning and computer vision techniques to medical image analysis. Covering topics such as segmentation, classification, and automated diagnosis, students will engage in hands-on exercises and interdisciplinary collaboration to gain practical skills and address the ethical implications of AI-driven medical imaging.

The particular objectives of the course are:
- To provide a comprehensive understanding of the principles, techniques, and applications of AI in the fields of radiology and microscopy.
- To familiarize students with the latest advancements in AI technologies, such as deep learning, machine learning, and computer vision, and their role in improving the accuracy and efficiency of radiological and microscopy image analysis.
- To develop proficiency in using AI tools and algorithms for the identification, segmentation, and classification of medical images, including X-rays, CT scans, MRI scans, and microscopic slides.
- To equip students with the skills required to critically evaluate the strengths, limitations, and ethical implications of AI applications in radiology and microscopy.
- To encourage interdisciplinary collaboration between computer scientists, engineers, radiologists, and pathologists, fostering a deeper understanding of the potential synergies between these fields.
- To promote a culture of innovation and research in the application of AI to radiology and microscopy, inspiring students to contribute to the development of new algorithms, techniques, and solutions that address existing challenges and emerging needs in these fields.
- To prepare students for careers in AI-driven medical imaging, providing them with the knowledge and skills needed to excel in research, industry, and clinical settings.

DESCRIPTION OF CONTENTS: PROGRAMME

1. AI in Biomedical Imaging
- Historical background
- Recent developments
- Impact of methods on research and clinical practice

2. Evaluation of AI-based methods
- Public databases
- Challenges

3. AI-based methods in microscopy
- Noise reduction and preprocessing
- Segmentation
- Object detection and tracking
- Practical considerations and existing solutions

4. AI-based methods in radiology and radiotherapy
- Segmentation
- Classification and automatic diagnosis
- Treatment response prediction
- Practical considerations and existing solutions

5. Ethical considerations and data protection

LEARNING ACTIVITIES AND METHODOLOGY

AF3 Theoretical practical classes
AF4 Laboratory practices
AF6 Team work
AF7 Student individual work
AF8 Partial and final exams

Activity code	total hours number	presencial hours number	non-presencial hours number
AF3	84	84	0
AF4	63	63	0
AF6	90	0	90
AF7	222	0	222
AF8	9	9	0
TOTAL MATERIA	468	156	312

ASSESSMENT SYSTEM

SE1 Participation in class
SE2 Individual or team homework or partial exams
SE3 Final exam

SE1 and SE2: 100%

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

BASIC BIBLIOGRAPHY

- Chen, P. M., Deep learning: an update for radiologists, Radiographics, 41(5), 1427-1445, 2021
- Ronneberger, O., Fischer, P., Brox, T. U-net: Convolutional networks for biomedical image segmentation, In: Navab, N., Hornegger, J., Wells, W., Frangi, A. (eds) Medical Image Computing and Computer-Assisted Intervention ¿ MICCAI 2015. MICCAI 2015. Lecture Notes in Computer Science, vol 9351. Springer, Cham. https://doi.org/10.1007/978-3-319-24574-4_28, 2015
- Volpe, G. Roadmap on deep learning for microscopy, ArXiv, 2023
- Zhou, S., Greenspan, S.K., Shen, D. Deep learning for medical image analysis, Academic Press, 2017

ADDITIONAL BIBLIOGRAPHY

- Chan, H.P., Samala, R.K., Hadjiiski, L. J., Zhou, C. Deep learning in medical image analysis, Adv Exp Med Biol, 1213:3-21, 2020
- Cohen, S. Artificial intelligence and deep learning in pathology, Elsevier Health Sciences, 2020

BASIC ELECTRONIC RESOURCES

- . MICCAI 2023: https://conferences.miccai.org/2023/en/
- . MIDL 2023: https://2023.midl.io/
- . ISBI 2023: https://2023.biomedicalimaging.org/en/
- . SPIE Medical Imaging 2023: https://spie.org/conferences-and-exhibitions/medical-imaging?SSO=1