VNIVERSITAT DE VALÈNCIA

Course Guide
44697 Image analysis techniques

COURSE DATA

Data Subject	
Code	44697
Name	Image analysis techniques
Cycle	Master's degree
ECTS Credits	2.5
Academic year	2017 - 2018

Study (s)

Degree	Center	Acad. year	Period
2224 - Master's Degree in Research and Development in Biotechnology and Biomedicin	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2224 - Master's Degree in Research and Development in Biotechnology and Biomedicin	1 - New technology	Obligatory

Coordination

Name	Department
PERTUSA GRAU, JOSE FRANCISCO	357 - Cellular Biology, Functional Biology and Physical Anthropol.

SUMMARY

The Image Analysis Techniques (IAT) are a clear example of what is assuming the arrival of new technologies in the training of future professionals of Biology. There is no doubt that the aforementioned new technologies provide powerful tools for data collection and tools for analysis, but also pose new difficulties in designing the training of students.

The TAI matter is presented as an introductory course on the techniques of digital image processing. In 2'5 credits in duration, we go over from classical quantitative morphometric techniques and basic concepts of the structure of the digital image, until the image restoration, including the treatment of cells confocal images, through the latest techniques application to the quantification and molecular kinetics.

The course is conceived as a fundamentally practical package, so that each of the theoretical concepts that are introduced during the course, has its immediate practical application in the following sessions.

Our experience in the field of image analysis has confirmed the usefulness that this matter is taking for new graduates: quite often we receive requests for support and technical consultation from colleagues working in different fields, not only Cellular Biology, to apply the knowledge acquired in AIT sessions in their work.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

There are none

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2224 - Master's Degree in Research and Development in Biotechnology and Biomedicin

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Be able to integrate new technologies in their professional and/or research work.
- Utilizar adecuadamente las herramientas informáticas, métodos estadísticos y de simulación de datos, aplicando los programas informáticos y la estadística a los problemas biomédicos y biotecnológicos.
- Adquirir destrezas en el manejo de las metodologías avanzadas empleadas en las biociencias moleculares y en el registro anotado de actividades.
- Aprendizaje del uso de la instrumentación y equipamientos empleados en los laboratorios de biotecnología y biomedicina.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

Understand mathematical principles underlying for obtaining stereological and morphometrical measures applicable to microscopy.

Understand the principles of operation of the digitization of the image and its implications in the processing and obtaining information of biological image.

To provide the student a set of simple tools to get effectively morphometrics measures, in the field of Molecular and cellular biology.

Introduce the student to the digital image processing techniques.

To relate the knowledge of the statistic, the microscopic techniques and the instrumental techniques of analysis with the quantitative techniques that are taught in IAT.

Train the students in the use of free distribution programs for Image Analysis.

DESCRIPTION OF CONTENTS

0. Image analysis techniques

Features of the fluorescence microscopy: the image quality and main aberrations.
Properties of digital imaging. Image file formats.
Noise treatment in the digital image.
Basic procedures for image enhancement and restoration.
The binary image: segmentation strategies and Boolean operations.
Parameters and quantification of two-dimensional image.
Three-dimensional reconstruction: treatment of images stacks.
FRET fluorescent proteins. Specific techniques for digital analysis evaluable: FIS, FRAP, Co-location, Cells Tracking.
Automatic processing, plugins routines, and specific software.

1. Introduction and basic concepts

Biological image: the determining factor representing the microscope as imager. The characteristics of image analysis in biology. Why we measure in biology: what to measure and how.

2. The digital image: image analysis conventions

Image capture: analogic-digital transformation. The pixel. Depth. Resolution. indexed color. Color spaces. Format image files. Factors that determine the quality of the image. overall work plan in assisted image analysis computer to obtain quantitative data: image analysis system calibration

3. Parameters in digital image analysis

Field parameters and object parameters. Morphometric parameters: quantifying the size and shape. Densitometric parameters.

4. Correction, enhance and image restoration.

Point to point operations: normalization, equalization and application of arithmetic operations. mathematical operations beetwen neighboring pixels : smoothing filters (low-pass), enhancing filters (high-pass), edge detectors (Laplacian operators). Some problems induced by image manipulation for subsequent quantification.

5. Regions Selection and digital image segmenting.

Manual region selection, search thresholds, other segmentation techniques. Neighbourhood criteria and their application to segmentation. The resulting binary image and its properties.

6. Manipulation of binary images.

bBasic operations of mathematical morphology. Boolean operations with binary images. Applications of logical operations. Determining errors in operations with binary images. Reconstruction of degraded images. Skeletonized; analysis branched structures. Euclidean distances maps and related operations.

7. Automation of processes and analysis.

Macroinstructions desing . Discussion of results and development of practical examples. Study of some availables plugins for users.

8. Stacks of images and 3D reconstruction.

Fluorescence microscopy and confocal microscopy; the optical section; depth of field. Treatment of image stacks. The voxel and its quantification. Handling stacks of bright field images. Photomontage. Deconvolution.

9. Detection techniques based on the presence of marked pixels.

Molecules Colocalization: double marking. FRET. FISH. FRAP. FLIP. FLIM. Tracking and monitoring images of interval cinematography . New Challenges: High-content screening, Super-resolution.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	25,00	100
Development of individual work	20,00	0
Study and independent work	7,00	0
Preparation of evaluation activities	10,50	0
TOTAL	**62,50**	

TEACHING METHODOLOGY

The development of the course is structured around three axes: the theory sessions, the practical sessions and the presentation of working models by professionals with experience in the application of digital processing techniques.

The theoretical classes alternate with practical sessions so that first the concepts of the image analysis technique will be explained, and then put into practice.

Practical classes will be developed following two different strategies: in some sessions will apply the knowledge gained in previous session theory, by a number of problems-type. In other sessions integrators exercises, which serve to relate the knowledge gained so far will be made. The role of the practical sessions will rest primarily on the student, as it will be he who will have to solve similar problems of greater complexity. Students will be distributed in groups of two, and the teacher will handle guide and help at all times. Once the work is completed, the problems will be corrected and analyzed by the same students in the classroom.

Each student will have a personal copy of the work programs to be used in class, and so they can continue to work individually also outside the computer room of the Faculty. During the first sessions we will take special care to train the students in the use and installation of software, to prevent that the use of this material they have an additional cost.

EVALUATION

The evaluation of student learning will take place in three different stages:
1. continuous evaluation of the progress and the work developed throughout the course, which will be based largely on questions and problems carried in the practical sessions. The note obtained in this section will constitute 20% of the final grade.
2. An additional 40% will be obtained through the completion and submission of a final paper per student.
3. Finally, the acquired knowledge will also be assessed by examination at the end of the course, which

contribute 40% to the final mark. The test is composed of a first part of practice questions, dedicated to those outcomes considered quite basic, and a second, more general part will assess the technical contributions that students make to solving a problem related techniques Image Analysis.

REFERENCES

Basic

- Pertusa J.F. (2003). Técnicas de análisis de imagen. Ed. Universitat de Valencia. Valencia.

Russ J.C (2015) The Image Processing Handbook, Seventh Edition 6th Edition CRC Press. London.

Burger W. and Burge M.J. (2016).Digital Image Processing: An Algorithmic Introduction Using Java (Texts in Computer Science) 2nd ed. Edition Springer. Berlin.