ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

105000395 - Introduction To Bioinformatics And Biocomputing

DEGREE PROGRAMME

10II - Grado En Ingenieria Informatica

ACADEMIC YEAR & SEMESTER

2021/22 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	105000395 - Introduction To Bioinformatics And Biocomputing
No of credits	3 ECTS
Type	Optional
Academic year ot the programme	Fourth year
Semester of tuition	Semester 7
Tuition period	September-January
Tuition languages	English
Degree programme	10II - Grado en Ingenieria Informatica
Centre	10 - Escuela Tecnica Superior De Ingenieros Informaticos
Academic year	2021-22

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Paul Andrei Paun (Subject coordinator)	DIA 2201	andrei.paun@upm.es	Tu - 09:00 - 11:00 make appointment by email
Alfonso Vicente Rodriguez-Paton Aradas	DIA 2106	alfonso.rodriguez-paton@upm.es	Sin horario. make appointment by email

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

2.2. Research assistants

Name and surname	Email	Faculty member in charge
Nuñez Berrueco, Elena	elena.nunez@upm.es	Rodriguez-Paton Aradas, Alfonso Vicente

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- no previous courses needed, just not to be afraid of biological terms and notions

4. Skills and learning outcomes *

4.1. Skills to be learned

CG-1/21 - Capacidad de resolución de problemas aplicando conocimientos de matemáticas, ciencias e ingeniería.

CG-19 - Capacidad de usar las tecnologías de la información y la comunicación.

CG-2/CE45 - Capacidad para el aprendizaje autónomo y la actualización de conocimientos, y reconocimiento de su necesidad en el área de la informática.

CG-24/25/26/27 - Capacidad para trabajar en el contexto internacional, comunicándose en lengua inglesa y adaptándose a un nuevo entorno.

CG-5 - Capacidad de gestión de la información.

CG-6 - Capacidad de abstracción, análisis y síntesis

4.2. Learning outcomes

RA280 - Obtención de las competencias lingüísticas comunicativas (comprensión, expresión, etc.) habladas y escritas en entornos académicos/profesionales nacionales/internacionales.

RA286 - Experiencia de estudio y trabajo en un contexto internacional.

RA278 - Desarrollar la solución matemática y algorítmica mas apropiada a un problema informático que requiera un tratamiento especialmente complejo, analizando y exponiendo su viabilidad.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

This is a first Bioinformatics course for Computer Science audience mostly.
The course will be addressed to the students interested in Bioinformatics and research, the students will be exposed both to the basics of the Bioinformatics field and also to recent results in the area and closely related areas (Systems Biology, Biostatistics, etc.).

Research at the border of Molecular Biology and Computer Science has witnessed in recent years an explosive development, with multiple significant results in the both areas mentioned. On one hand, biological data is being produced at an astronomical rate due to improved/automated methods, supported by the ever increasing advances in biotechnology. As a consequence CS-related tools are necessary to handle this enormous amount of data, interpret it, visualize various parameters, etc. Moreover, many combinatorial problems related to the biological data require CS-specific approaches. On the other hand, the biological systems have huge capabilities for information storing, data manipulation, pattern recognition, parallelism, and energy efficiency that make them very interesting for computer scientists.

Biocomputing is often used as a catch-all term covering all this area at the intersection of Biology and Computer Science, although many other terms are used to name the same area. We distinguish and introduce in this course four (non-disjoint) sub-fields:

? Computational Biology - this includes efforts to solve biological problems with computational tools (such as modeling, algorithms, heuristics)

? Bioinformatics - this includes management of biological databases, data mining and data modeling, as well as CS-tools for data visualization

? DNA computing - this includes models and experiments to use DNA (and other) molecules to perform computations

? Computations in living organisms - this is concerned with constructing computational components in living cells, as well as with studying computational processes taking place daily in living organisms

The course will give an introduction to the field and a number of typical problems and questions will be also presented, as well as some basic models and tools used to address them.

5.2. Syllabus

1. 1. Basic notions of Biotechnology and Bioinformatics
    1.1. 1.1. Elementary notions for Biology, Cellular Biology, Genetics, Biochemistry
    1.2. 1.2. Sequence alignment algorithms and their impact in the field: optimal algorithms for global or local alignment Smith-Waterman, Needleman-Wunsch.
    1.3. 1.3. Heuristical algorithms for alignment: BLAST and variations, Fasta, PatternHumnter and PatternHunter II
    1.4. 1.4. Evolutionary Biology introduction: Affine alignment, substitution matrices Blosum50, PAM150, multiple alignment
2. 2. Biocomputing
    2.1. 2.1. Adleman's Experiment for solving an NP complete problem using DNA and tools from Biochemistry
    2.2. 2.2. Lipton's experiment for solving SAT and other results about calculability using DNA and RNA
    2.3. 2.3. Autossembly of DNA: experiments from E. Winfree, Ned Seeman, Paul Rothemund, etc.
    2.4. 2.4. Abstract models of calculability with DNA and cells: H systems and P systems
    2.5. 2.5. SNP systems and recent results

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	**Teaching topic 1** Duration: 01:30 Lecture **Exercises Topic 1** Duration: 00:30 Problem-solving class		**Teaching topic 1** Duration: 01:30 Lecture **Exercises Topic 1** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:30
2	**Teaching topic 2** Duration: 01:30 Lecture **Exercises Topic 2** Duration: 00:30 Problem-solving class		**Teaching topic 2** Duration: 01:30 Lecture **Exercises Topic 2** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
3	**Teaching topic 3** Duration: 01:30 Lecture **Exercises Topic 3** Duration: 00:30 Problem-solving class		**Teaching topic 3** Duration: 01:30 Lecture **Exercises Topic 3** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
4	**Teaching topic 4** Duration: 01:30 Lecture **Exercises Topic 4** Duration: 00:30 Problem-solving class		**Teaching topic 4** Duration: 01:30 Lecture **Exercises Topic 4** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
5	**Teaching topic 5** Duration: 01:30 Lecture **Exercises Topic 5** Duration: 00:30 Problem-solving class		**Teaching topic 5** Duration: 01:30 Lecture **Exercises Topic 5** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
6	**Teaching topic 6** Duration: 01:30 Lecture **Exercises Topic 6** Duration: 00:30 Problem-solving class		**Teaching topic 6** Duration: 01:30 Lecture **Exercises Topic 6** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00

7	**Teaching topic 7** Duration: 01:30 Lecture **Exercises Topic 7** Duration: 00:30 Problem-solving class		**Teaching topic 7** Duration: 01:30 Lecture **Exercises Topic 7** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
8	**Teaching topic 8** Duration: 01:30 Lecture **Exercises Topic 8** Duration: 00:30 Problem-solving class		**Teaching topic 8** Duration: 01:30 Lecture **Exercises Topic 8** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
9	**Teaching topic 9** Duration: 01:20 Lecture **Exercises Topic 9** Duration: 00:30 Problem-solving class		**Teaching topic 9** Duration: 01:20 Lecture **Exercises Topic 9** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
10	**Teaching topic 10** Duration: 01:20 Lecture **Exercises Topic 10** Duration: 00:30 Problem-solving class		**Teaching topic 10** Duration: 01:20 Lecture **Exercises Topic 10** Duration: 00:30 Problem-solving class	**Class participation and homework** Individual work Continuous assessment Not Presential Duration: 02:00
11	**Teaching topic 11** Duration: 01:20 Lecture **Exercises Topic 11** Duration: 00:30 Problem-solving class		**Teaching topic 11** Duration: 01:20 Lecture **Exercises Topic 11** Duration: 00:30 Problem-solving class	**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Group presentation Continuous assessment Not Presential Duration: 03:00
12	**Teaching topic12** Duration: 01:20 Lecture **Exercises Topic 12** Duration: 00:30 Problem-solving class		**Teaching topic12** Duration: 01:20 Lecture **Exercises Topic 12** Duration: 00:30 Problem-solving class	**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Group presentation Continuous assessment Not Presential Duration: 03:00
13	**Teaching topic 13** Duration: 01:20 Lecture **Exercises Topic 13** Duration: 00:30 Problem-solving class		**Teaching topic 13** Duration: 01:20 Lecture **Exercises Topic 13** Duration: 00:30 Problem-solving class	**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Group presentation Continuous assessment Not Presential Duration: 03:00
14	**Teaching topic 14** Duration: 01:20 Lecture **Exercises Topic 14** Duration: 00:30 Problem-solving class		**Teaching topic 14** Duration: 01:20 Lecture **Exercises Topic 14** Duration: 00:30 Problem-solving class	**Review of recent paper** Individual work Continuous assessment Not Presential Duration: 05:00

15	**Class presentations** Duration: 01:30 Problem-solving class		**Class presentations** Duration: 01:30 Problem-solving class	**Exam** Written test Continuous assessment Presential Duration: 01:00 **Only exam option** Written test Final examination Not Presential Duration: 02:00
16				
17				

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Class participation and homework	Individual work	No Presential	02:30	4%	3 / 10	
2	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
3	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
4	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
5	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
6	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
7	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
8	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
9	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
10	Class participation and homework	Individual work	No Presential	02:00	4%	3 / 10	
11	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Group presentation	No Presential	03:00	7%	5 / 10	
12	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Group presentation	No Presential	03:00	7%	5 / 10	
13	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Group presentation	No Presential	03:00	7%	5 / 10	

14	Review of recent paper	Individual work	No Presential	05:00	20%	5 / 10	
15	Exam	Written test	Face-to-face	01:00	19%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
15	Only exam option	Written test	No Presential	02:00	100%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

Continuous evaluation

The students are expected to attend all the classes or in case of missed class to make-it up and learn the material by themselves. There will be 10 assignments in the class (one each week) that will be submitted through moodle.

The students will give an in class presentation in the course at the end of the period (November/December) and submit a term paper. Class participation will also be counted into the final grade. The weights of the aforementioned elements into the final grade are the following:

Assignments (10): 30%

Class Presentation: 30%

Term paper/exam/quizzes: 30%

Class Participation/attendance: 10%

Evaluation only with final exam:

There will be an exam of 2 hours covering the topics presented in the course. It will be worth 100% of the final grade.

Only the students that received 50% of the points of the assignments and term paper will be allowed to take the exam

Repesca in january: there will be an opportunity in January to make-up homeworks or term paper as well as the exam.

The rules for the course remain the same for all examinations:

To pass the class one needs to receive 50% of the points of the assignments and 50% of the points for the term paper. Finally the final average needs to be above 5.

Evaluation in the exceptional session in July:

There will be an exam of 2 hours covering the topics presented in the course. It will be worth 100% of the final grade.

Only the students that received 50% of the points of the assignments and term paper will be allowed to take the exam

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Bioinformatics and Functional Genomics by Jonathan Pevsner	Bibliography	Jonathan Pevsner, 2003, Wiley-Liss ed, ISBN: 0471210048.
Discovering Genomics, Proteomics, and Bioinformatics	Bibliography	by Malcolm Campbell & Laurie Heyer, 2003, Benjamin-Cummings ed., ISBN 0805347224.
Introduction to Bioinformatics	Bibliography	Arthur Lesk, 2002, Oxford University Press, ISBN 0199251967
Various websites	Web resource	Will be provided in class
Site moodle of the course	Web resource	

9. Other information

9.1. Other information about the subject

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.

The 17 SDGs are integrated?they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

In UPM the relevant text about SDGs is at: https://sostenibilidad.upm.es/wp-content/uploads/sites/759/2021/03/Sostenibilidad-estudios-oficiales-UPM-2020.pdf

The SDGs covered incidentally or partially by this class are: 3, 4, 5, 6, 9, 11, 12, 13, 14, 15