ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

105000395 - Introduction to bioinformatics and biocomputing

DEGREE PROGRAMME

10II - Grado En Ingenieria Informatica

ACADEMIC YEAR & SEMESTER

2018/19 - 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	2018-19

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.

3. Skills and learning outcomes *

3.1. 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-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

3.2. 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.

4. Brief description of the subject and syllabus

4.1. 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.

4.2. 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

5. Schedule

5.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
2	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
3	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
4	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
5	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
6	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30

7	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
8	**Teaching of the first topic** Duration: 01:20 Lecture **Exercises for the first topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
9	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
10	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Class participation and homework** Individual work Continuous assessment Duration: 00:30
11	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Individual presentation Continuous assessment Duration: 00:30
12	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Individual presentation Continuous assessment Duration: 00:30
13	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.** Individual presentation Continuous assessment Duration: 00:30
14	**Teaching of the second topic** Duration: 01:20 Lecture **Exercises for the second topic** Duration: 00:30 Problem-solving class			**Review of recent paper** Individual work Continuous assessment Duration: 01:00

15	**Class presentations** Duration: 01:30 Problem-solving class			**Exam** Written test Continuous assessment Duration: 01:00 **Only exam option** Written test Final examination Duration: 02:00
16				
17				

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

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 subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

6. Activities and assessment criteria

6.1. Assessment activities

6.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
2	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
3	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
4	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
5	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
6	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
7	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
8	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
9	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	
10	Class participation and homework	Individual work	Face-to-face	00:30	4%	3 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27
11	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Individual presentation	Face-to-face	00:30	7%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27
12	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Individual presentation	Face-to-face	00:30	7%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27

13	Presentations on topics related to Bioinformatoics. Each student will give a presentation in front of his/her peers.	Individual presentation	Face-to-face	00:30	7%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27
14	Review of recent paper	Individual work	Face-to-face	01:00	20%	5 / 10	CG-6 CG-19 CG-1/21 CG-5 CG-24/25/26/27
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

6.1.2. 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

6.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

6.2. 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

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

7. Teaching resources

7.1. 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	