

804254 - XJO - Networks and Online Games

Coordinating unit:	804 - CITM - Image Processing and Multimedia Technology Centre	
Teaching unit:	804 - CITM - Image Processing and Multimedia Technology Centre	
Academic year:	2019	
Degree:	BACHELOR'S DEGREE IN VIDEO GAME DESIGN AND DEVELOPMENT (Syllabus 2014). (Teaching unit Compulsory) BACHELOR'S DEGREE IN VIDEO GAME DESIGN AND DEVELOPMENT (Syllabus 2014). (Teaching unit Compulsory)	
ECTS credits:	6	Teaching languages: Catalan, English

Teaching staff

Coordinator:	Díaz García, Jesús Abadal Cavallé, Sergi
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Opening hours

Timetable:	Monday from 12:00 to 13:00 Friday from 12:30 to 13:30 or hours to be agreed upon
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Prior skills

To be able to programme and develop computer applications
To know and be the main Internet tools and services at user level

Degree competences to which the subject contributes

Specific:

- CEVJ 5. (ENG) Utilizar lenguajes de programación, patrones algorítmicos, estructuras de datos, herramientas visuales de programación, motores de juego y librerías para el desarrollo y prototipado de videojuegos, de cualquier género y para cualquier plataforma y dispositivo móvil.
- CEVJ 13. (ENG) Implementar y gestionar proyectos de diseño y desarrollo de videojuego incluyendo la planificación, dirección, ejecución y su evaluación.

Generical:

- CGFB5VJ. (ENG) Interpretar l'estructura, funcionament i interconnexió dels sistemes informàtics, així com els fonaments de la seva programació.

Transversal:

- 05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
- 07 AAT. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
- 04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

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Teaching methodology

The teaching methodology is divided in four parts:

- Sessions for the contents exposition at classroom
- Practical working sessions at classroom (training for the use of the tools, presentations and use case debates)
- Practical development of applications/games in C++ and Unity where the concepts learnt during the course will be applied
- Autonomous work to study and carry out exercises and activities

Learning objectives of the subject

- To show understanding and application capacity in the on-line game development, about foundations of telematics networks, their capacities and limitations
- To be able to identify the problems related to online games caused by the network limitations and propose solutions
- To show knowledge and be able to use network game engines, for the development of online games
- To show knowledge of game servers and to know how to use them for the development and implementation of online games
- To show knowledge of protocols at the application layer, as well as of protocols in lower layers to a lesser extent

Study load

Total learning time: 150h	Hours large group:	18h	12.00%
	Hours medium group:	30h	20.00%
	Hours small group:	0h	0.00%
	Guided activities:	12h	8.00%
	Self study:	90h	60.00%

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Content

<p>1. Introduction</p>	<p>Learning time: 10h Theory classes: 2h Guided activities: 2h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> 1.1 Presentation of the subject and evaluation criteria 1.2 A brief history of networks and on-line games 1.3 Architectures and metrics 1.4 On-line games seen as distributed systems <p>Related activities: Programming with threads</p> <p>Specific objectives: To obtain basic knowledge about the history of the Internet and on-line games, about the basic types of network architectures and the metrics used to measure their performance, as well as to understand an on-line game as a distributed system.</p>	
<p>2. The OSI Protocol Stack</p>	<p>Learning time: 45h Theory classes: 10h Guided activities: 8h Self study : 27h</p>
<p>Description:</p> <ul style="list-style-type: none"> 2.1 Introduction. The physical and link layers 2.2 The network and transport layers (TCP/IP) 2.3 Other relevant protocols 2.4 Putting it all together: Wireshark <p>Related activities: 2. Sockets and the Client-Server architecture</p> <p>Specific objectives: To understand the layered structure used in networks, the process of encapsulation, as well as the usefulness of it all. To learn about the functionality of each layer of abstraction, as well as to know the classical protocols in each layer, paying special attention in those that are relevant for the programming of on-line games (IP, TCP/UDP, NAT) To learn about the use of packet sniffers, and to employ them to observe the packet structure in real networks</p>	

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<p>3. Impact of the network on the programming of on-line games</p>	<p>Learning time: 75h Theory classes: 10h Guided activities: 20h Self study : 45h</p>
<p>Description:</p> <ul style="list-style-type: none"> 3.1 Introduction and general aspects. Object serialization and replication 3.2 Latency, jitter, and reliability 3.3 Latency hiding techniques 3.4 Scalability and massive multiplayer <p>Related activities:</p> <ul style="list-style-type: none"> 3. Data serialization 4. Multiplayer game in C++ 5. Networked games in Unity <p>Specific objectives:</p> <ul style="list-style-type: none"> To understand how the network impacts on the programming of on-line games through the study of problems related to the loss of information or delays To learn about techniques used to hide the network problems, minimizing their impact so that the game performance is not affected To learn about widespread techniques in nowadays games, be them with a few or many simultaneous players 	
<p>4. Graphs and neural networks</p>	<p>Learning time: 20h Theory classes: 8h Self study : 12h</p>
<p>Description:</p> <ul style="list-style-type: none"> 4.1 Graph theory 4.2 Algorithms over graphs 4.3 Neural network fundamentals <p>Specific objectives:</p> <ul style="list-style-type: none"> To learn about the fundamentals of graph theory and algorithms that operate over graphs, which are common to networks and many other domains To understand a few concepts related to the neural networks fundamentals, as well as their relation with graphs and computer networks 	

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Planning of activities

<h3>1. Threads</h3>	Hours: 5h Guided activities: 2h Self study: 3h
<p>Description: Learning how to use parallel code execution mechanisms (threads) and the necessary tools to maintain a proper synchronization amongst them, and to safely access shared memory regions in a concurrent fashion.</p> <p>Support materials: Instructions for the exercise and template code.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - Threads (mechanisms for parallel/concurrent code execution) - Mutex objects (mechanism for safe concurrent data access) - Condition variables (mechanism for synchronization among threads) 	
<h3>2. Sockets and Client-Server architecture</h3>	Hours: 20h Guided activities: 8h Self study: 12h
<p>Description: Learning the main mechanisms to use TCP and UDP sockets to transmit and receive data between two or more machines over the network.</p> <p>Support materials: Instructions for the exercise and code template.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - Sockets TCP (connection oriented) - Sockets UDP (non-connection oriented) - Non-blocking usage of sockets functions (non-blocking mode, select). 	
<h3>3. Data serialization</h3>	Hours: 5h Guided activities: 2h Self study: 3h
<p>Description: Here we will see the importance of data serialization to transmit objects in memory that may be potentially complex, as these objects could not be represented contiguously in memory, and can contain pointers to other objects, thus making impossible copying them directly from memory at once.</p> <p>Support materials: Instructions for the exercise and code template.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - Sequential and ordered data access. - MemoryStream objects. 	

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4. Multiplayer videogame in C++	Hours: 20h Guided activities: 8h Self study: 12h
<p>Description: We will put in practica all concepts learnt so far (threads, sockets and data serialization) to develop a multiplayer videogame in C++.</p> <p>Support materials: Instructions for the exercise and code template.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> . Client-server architecture. - Authoritative server. - Game state replication. - Messages among hosts. 	
5. Networked games in Unity	Hours: 25h Guided activities: 10h Self study: 15h
<p>Description: In this part of the subject we will learn how to develop a multiplayer game at a higher level using the tools provided by the Unity games engine. Instead of programming all the data serialization manually, we will use the existing pieces of this engine in order to send commands and game state among several PCs over the network.</p> <p>Support materials: Instructions for the exercise and code template.</p> <p>Specific objectives:</p> <ul style="list-style-type: none"> - Main architecture of multiplayer games in Unity - Main networking components - Data synchronization mechanisms (commands, syncvars and hooks, client RCPs, etc). 	

Qualification system

Lab sessions: 40%
 Partial exam: 20%
 Final exam: 30%
 Contribution and learning attitude of the student: 10%

In case the subject is not passed through the continuous evaluation there is the option to perform a re-evaluation exam of the theoretical part, corresponding to 50% of the subject's mark.

Regulations for carrying out activities

The evaluation activities are individual
 For the practices it is allowed to use all learning material and their submission must be done on the indicated deadline with no option for extension
 Exams will be done with no access to any learning material



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Bibliography

Basic:

Tanenbaum, A.S.; Wetherall, D.J. Computer networks. 5th ed. Boston: Pearson, 2011. ISBN 9780132126953.

Glazer, Josh; Madhav, Sanjay . Multiplayer game programming: Architecting networked games. Addison-Wesley Professional, 2015. ISBN 9780134034331.

Others resources:

Additional readings that will be published in the Campus Virtual during the course