Universitat Pompeu Fabra Barcelona

# Master in Cognitive Systems and Interactive

## Syllabus

**CSIM is composed of a wide set of courses that capture the interdisciplinary nature and vocation of this master program. The table below summarises the structure of the syllabus.**

The core of the program is formed by courses that have been especially conceived for the CSIM master and some that are shared from other master programs in our department. These courses are composed into the following three groups:

- **Compulsory Courses**: These courses are meant to give a solid base and a transversal view onto Cognitive Systems and Interactive Media.
- **Main Optional Pool Courses**: These courses are meant to provide a more in depth view on specific branches of Cognitive Systems and Interactive Media.
- **Optional Expansion Pool Courses**: These courses are meant to provide an expansion into more applicative branches of Cognitive Systems and Interactive Media.
  NOTE: These courses are technically and mathematically quite demanding and are therefore only feasible for students that already have a strong background in mathematics and engineering.

| Trimester | Course | Code | Belongs to: | ECTS |
|---|---|---|---|---|
| **Compulsory Courses** | | | | |
| 1 | Cognitive Science & Psychology: Mind, Brain and Behaviour | 30846 | CSIM | 5 |
| 1 | Research Methodologies in Humanities and Science | 30845 | CSIM | 5 |
| 1 | Interaction Models | 30847 | CSIM | 5 |
| 2 | Systems Design, Integration and Control | 30863 | CSIM | 5 |
| **Main Optional Pool** (Choose minimum 3) | | | | |
| 2 | Learning Technologies (former Adaptative Behaviour) | 32630 | CSIM | 5 |
| 3 | Advanced Concepts and Methods in Cognitive Systems | 30877 | CSIM | 5 |
| 1 | Advanced Interface Design | 30853 | CSIM | 5 |

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|---|---|---|---|---|
| 2 | Cognitive Systems: Theory and Models | 30860 | CSIM | 5 |
| 3 | Education, Games and Entertainment | 30857 | CSIM | 5 |
| 2 | Real-Time Interaction | 32608 | CSIM | 5 |
| 3 | Sound Communication | 30852 | CSIM | 5 |
| **Optional Expansion Pool** (Choose maximum 1) | | | | |
| 1 | ~~Audio Signal Processing for Music Applications (not offered 2020/2021)~~ | ~~30226~~ | ~~SMC~~ | 5 |
| 2 | Autonomous Systems | 32607 | MIIS | 5 |
| ~~1~~ | ~~Machine Learning (not offered 2020/2021)~~ | ~~31645~~ | ~~MIIS~~ | ~~5~~ |
| ~~2~~ | ~~Mobile Robotics (not offered 2020/2021)~~ | ~~31643~~ | ~~MIIS~~ | ~~5~~ |
| 1 | Natural Language Interaction | 32606 | MIIS | 5 |
| **Tesi** | | | | |
| 1, 2 i 3 | Project | 30849 | CSIM | 20 |

All courses are worth 5 ECTS (European credits), while the Project is worth 20 ECTS.
To attain the masters diploma the student must get a total of 60 ECTS.
Therefore, students must choose:

- All the **Base Courses** (20ECTS)
- A minimum of 3 courses from the **Main Optional Pool Courses** (mínimum 15ECTS)
- A maximum of one course **Optional Expansion Pool Courses** (maximum 5ECTS).
- The Master Thesis Project (20ECTS)

This adds up to either: ***4x5 + (4+0)x5 + 20 = 60 ECTS*** or ***4x5 + (3+1)x5 + 20 = 60 ECTS***

# Subjects
# Cognitive Science & Psychology: Mind, Brain and Behaviour - 30846

Professor: **Paul Verschure**

**Description**

This course exposes students to the central disciplines that form traditional cognitive science (philosophy, psychology, linguistics, computer science, mathematics, anthropology) and will show how the concepts and paradigms of these disciplines bring complementary visions of mind, brain and behaviour.

**Course Objectives**

Learn about theories, methods and discoveries in cognitive science, the historical context and the philosophical roots that allowed the rising of this multidisciplinary field of studies.
To help students develop general scientific thinking and study skills that will be an important requirement for all the master courses.
To help students understand cognitive science application to real world artifacts.
To help students to develop a critical approach to scientific research and literature.

**Readings**

There is no official text book for this course. Every week two selected readings related to the topic of the lecture will be assigned and made available in the Moodle page. You are expected to read and critically comment the papers in the form of a short essay to submit through the Moodle system before each lecture.

**Class attendance**

Regular attendance to the classes is mandatory since this is the only way to learn the material.

**Research project**

As part of your training you will have to design, conduct and present a real experimental investigation related to one of the topics covered in class. Projects will be performed in small groups (max. 4 people) and they are shared with the Research Methodologies in Humanities and Science (30845) course.

**Evaluation Criteria**

1. Homework (weekly essay on selected readings): 50%
2. Research project: project proposal (30%) + project presentation and report (70%): 50%

Delays in delivering the homework assignments without a valid motivation will be penalised and the maximum mark that can then be awarded is the minimum pass mark. Plagiarism will not be tolerated in any of its forms.

**Course Structure**

**Week 1**

*Introduction to the course*

Readings:

- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: how difficulties in recognising one's own incompetence lead to inflated self-assessments. Journal of Personality and Social Psychology, 77(6), 1121-34.

**Week 2**

*Philosophical and Historical roots (part I)*

Main topics:

- The knowledge problem in science
- Science wars
- Mind vs matter

- Evolutionary aspects of brain
- The bicameral mind hypothesis of Jaynes
- The mind-body problem
- Rationalism and empiricism
- Plato's cave allegory

Readings:

- Plato, The Republic, Book VII, translated by B. Jowett

**Week 3**

*Philosophical and Historical roots (part II)*

Main topics:

- More on the mind-body problem: Socrates, Plato, Aristoteles
- Galen and the localisation of brain functions
- Fernel and the brain doctrine
- Cartesian dualism
- Physicalism
- Hume's empiricism and the problem of causality
- Evolutionism

Readings:

- Ghost in the shell (movie), Masamune Shirow, Kazunori Itō, 1995.

**Week 4**

*Structuralism and early behaviourism*

Main topics:

- The experimental study of psychology
- Fechner, Von Helmoltz, and the origins of psychophysics
- The stage model of Donders
- Wundt and the rise of structuralism
- Pavlov: reflexes and the origin of classical conditioning
- Thorndike and the laws of goal oriented learning
- Classical vs operant/instrumental conditioning
- The birth of behaviourism

Readings:

- Köhler, W. (1959). Gestalt Psychology Today. American Psychologist, 727-734.
- Watson, J. (1913). Psychology as the Behaviourist Views it. Psychological Review, 1-11.

**Week 5**

*Behaviorism*

Main topics:

- Watson's little Albert experiment
- Skinner and operant conditioning

**Week 6**

*Cognitive behaviorism*

Main topics:

- Tolman and cognitive maps
- Hull and adaptive behaviour
- More on classical conditioning
- Rescorla Wagner and the behavioural law of associative competition

Readings:

- Breland, K., & Breland, M. (1961). The misbehavior of organisms. American Psychologist.
- Lettvin, J. Y., Maturana, H. R., McCulloch, W. S., & Pitts, W. H. (1959). What the frog's eye tells the frog's brain. Proceedings of the IRE, 47(11), 1940-1951.

**Week 7**

*The fall of behaviorism and the cognitive revolution*

Main topics:

- The cognitive revolution

Readings:

- Chomsky, N. (1959). A review of Skinner's verbal behavior. Language, 142-143.

**Week 8**

*Mind as computation (part I)*

Main topics:

- Wiener and the origins of Cybernetics
- Feedback and self regulating systems (Cannon, Ashby, Walters)
- From analytic engine to computers via the Turing machine
- The computer metaphor

Readings:

- Searle, J. (1980). Minds, brains, and programs. Behavioral and Brain Sciences.
- Turing, A. (1950). Computing machinery and intelligence. Mind, 1-21.

**Week 9**

*Mind as computation (part II)*

Main topics:

- Theory of mind: functionalism
- Searle's Chinese room argument

**Week 10**

*Flux and synthesis*

Main topics:

- New AI
- Embodiment and morphological computation
- Connectionism

- Synthesis: how does the brain solve the mind-brain problem?

**Projects' presentation**

## Research Methodologies in Humanities and Science - 30845

Professor: **Belen Rubio**

**Description**

This course exposes students to the essential research methods in humanities and science including quantitative and qualitative research methods and statistics

**Course Objectives**

1. Know the different research methodologies used in the ambits of humanities and science, understand their characteristics, differences and utilities.
2. Be able to apply these methodologies within the student's own research.

**Readings**

Hugh Coolican. *Research Methods and Statistics in Psychology*. Hodder Arnold publisher, 6th Edition, ISBN-10: 1444170112

Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython 1st Edition O'Reilly Media. ISBN-10:1449319793

**attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

Grades will be based on

- Regular class presence
- Assignments and Tutorial Exercises: 50%
- Project proposal (30%) and presentation (70%): 50%

**Course Structure**

**Block 1. Theory:**

**Week 1**

- Research in Humanities and Science
- Epistemiological background
- Experimental methods

**Week 2**

- True experiment and Quasi Experiment
- Barriers to Scientific Method
- Questionnaires, Attitude Scales, Test

**Week 3**

- Ethics and Subjects
- Data management

**Week 4**

- Invited Speaker
- Project proposal presentation

**Block 2. Data Science (Pyhton / Matlab)**

**Week 5**

- Descriptive Statistics

**Week 6**

- Inferential Statistics

**Week 7**

- Testing for differences
- Data visualization

**Week 8**

- Correlation and Regression
- Nonparametic Statistics
- How to write a paper

**Week 9**

- Qualitative methods in research

**Week 10**

- Final Project Presentation

**Research project**

As part of your training you will have to design, conduct and present a real experimental investigation related to one of the topics covered in class. Projects will be shared with the Cognitive Science and Psychology (30846) course and will be performed is small groups. For the practical exercises and tutorials, we will mainly use Python. Final exam at Week 12.

## System design integration and control - 30863

**Professors: Martí Sánchez-Fibla, Clément Moulin-FrierDescription**

This course exposes students to paradigms habitual within design, integration and control of autonomous systems, with a special stress on neuromorphic principles underlying biological, interactive, cognitive systems. The course will cover how to implement simple reactive behaviors and their combinations and will also address learning in synthetic agents and robots.

**Course Objectives**

1. Understand the basic principles of organization of perception and control in biological systems and its neurological substrate.
2. Learn the design principles necessary to build and analyze a biological grounded synthetic system.

**Readings**

Readings related to the topics of the lecture will be made available.

Vehicles: Experiments in synthetic psychology. Braitenberg, V. (1984).Cambridge, MA: MIT

Reinforcement Learning : An introduction. Richar S. Sutton and Andrew G. Barto. MIT Press, 2018 (link)

**Class attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

Grades will be based on:

- Regular class presence
- Part I - 50% of Total: Team project evaluation. Also the Python notebooks delivered will be taken into consideration.
- Part II - 50% of Total with a 100% splitted in: Research paper presentation (20%), Quizz (10%), Research Project (70%).

**Course Structure**

**Week 1**

- Introduction to Cognitive Architectures

**Week 2**

- From Simple to Complex Reactive Behaviors
- Practical Sessions with Python

**Week 3**

- Combined Behaviors. V-Rep Simulation Environment
- Practical Sessions with Python and V-Rep Simulator

**Week 4**

- Learning: Supervised, Unsupervised, Reinforcement

**Week 5**

- Reinforcement Learning Introduction

**Week 6**

- Environments, OpenAI-Gym, Reactive Behaviors
- Practical Sessions with Python, OpenAI-Gym

**Week 7**

- Learning Algorithms Q, SARSA Learning
- Practical Sessions with Python, OpenAI-Gym

**Week 8**

- Function Approximation, Neural Networks
- Practical Sessions with Python, OpenAI-Gym

**Week 9**

- Extensions: Policy Gradient, Partial Observability
- Practical Sessions with Python, OpenAI-Gym

**Week 10**

- SDIC Presentations or Challenge

**Research project**

As part of your training you will have to implement reactive and learning behaviors on an agent and an environment of your choice or design.

## Cognitive Systems: theory and models - 30860

Professor: **Riccardo Zucca**

**Description**

This course presents a panorama of theories and models on cognition, emotion and personality in combination with methods for evaluation and testing.

**Course Objectives**

1. Theoretical and practical knowledge on artificial neural networks
2. Theoretical and practical knowledge on reward based learning
3. Theoretical and practical knowledge on control architectures in particular the Distributed Adaptive Control (DAC) Architecture

**Readings**

- David Kriesel: A Brief Introduction to Neural Networks (online_ http://www.dkriesel.com/_media/science/neuronalenetze-en-zeta2-2col-dkrieselcom.pdf)
- Richard S. Sutton and Andrew G. Barto: Reinforcement Learning:An Introduction (online_ http://webdocs.cs.ualberta.ca/~sutton/book/the-book.html?)
- Paul F.M.J. Verschure: Distributed Adaptive Control: A theory of the Mind, Brain, Body Nexus (online_ http://www.sciencedirect.com/science/article/pii/S2212683X12000102)

**Class attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

Grades will be based on

- Regular class presence
- Performance on the assignments
- Research project: paper presentation

**Course Structure**

**Week 1**

- Introduction to Artificial Neural Networks

**Week 2**

- Advanced Concepts of Artificial Neural Networks

**Week 3**

- Application in Artificial Neural Networks

**Week 4**

- The physiology of Reward

**Week 5**

- Introduction to Reinforcement Learning

**Week 6**

- Applications of Reinforcement Learning

**Week 7**

- Introduction to Control Architectures

**Week 8**

- Distributed Adaptive Control (DAC): Reactive Layer

**Week 9**

- Distributed Adaptive Control (DAC): Adaptive Layer

**Week 10**

- Distributed Adaptive Control (DAC): Contextual Layer

## Advanced concepts and methods in cognitive science - 30877

Professor: **Xerxes Arsiwalla**

**Brief Description**

This course will address the current state and open questions in consciousness research. This topic lies at the intersection of neuroscience, computer science, linguistics, philosophy and physics. We will discuss important insights from these disciplines in order to understand various facets of the problem. The course will consist of lectures and mini-projects.

**Description**

One of the major challenges that scientific research is now facing is understanding the nature of consciousness. In this module we will consider this problem from several perspectives and analyse the various solutions proposed within different theoretical frameworks.
We will not try to address the question merely from a philosophical point of view but we'll try to gain a better understanding of consciousness form a perspective of modern science.
We will initially face the epistemological issues related to the study of consciousness (the

hard/easy problem) and what is the function of consciousness. We will then learn how these questions have been addressed by evolutionary, experimental, clinical, computational and synthetic studies and what are the solutions they provided. Finally, we'll provide an integrative approach about consciousness in the context of the Distributed Adaptive Control theory of mind, brain and body.
Every week two articles will be selected for open discussion and critically evaluated in a typical journal club format.

**Readings**

There is no official text book for this course. Every week two selected readings related to the topic of the lecture will be assigned and made available in the Moodle page. Students will have to read the literature provided and submit a critical review of the article in the form of a short essay before each class through the Moodle system.

**Class attendance**

Regular attendance to the classes is mandatory given the open discussion format of the lectures. Every week one of the students will prepare a keynote presentation of a selected reading that will open the discussion.

**Evaluation Criteria**

Grades will be based on

- Regular class presence
- Homeworks: 60%
- Class presentation: 40%

Delays in delivering the homework assignments without a valid motivation will be penalised and the maximum mark that can then be awarded is the minimum pass mark.
Plagiarism will not be tolerated in any of its forms

## Advanced interface design - 30853

**Professor: Martí Sánchez Fibla Description**

This course focuses on paradigms, methods and tools used in the construction of complex multimodal interfaces between users and artefacts

**Course objectives**

Students will learn to build and use interfaces and artefacts that can engage subjects during perceptual/behavioural task and will be given the tools to be able to capture and measure different characteristics of the performed tasks and deliver feedback.
Covering the different phases of this closed loop experience we will learn:

- the basics of sensing technologies and we will learn how to use existing devices and how to build our own
- how transfer data through communication protocols and how to process it with examples of measures that we can extract
- how to deliver feedback through actuation using motors, displays, leds

Robots are great tools to learn and practice sensor actuator loops. We will learn basic principles of robotic systems using a mobile Arduino based robotic platform that we developed at SPECS group.

**Readings and materials**

In the course we provide tutorials for each weekly session as well as source example code.
We will also provide hardware material to use.
The main hardware tools that will be covered in the course are Arduino, RaspberryPi, Kinect, Console Devices like the Wiimote, Eye tracking, Physiological signals.
Processing and Python will be the main programming languages used during the course.
The course is project oriented: from an early stage a project will be structured and developed in accordance with the teacher

**Class attendance**

Regular attendance to the classes is mandatory.

**Evaluation Criteria**

Evaluation of the progress of the students is carried on during the different phases of the project development.

- Initial project draft: 15 %
- Work in class, group: 15%
- Final presentation, group: 40%
- 4-page final report, one per group: 30%

Individual contributions have to be indicated explicitly.

**Course Structure**

**Week 1 and Week 2**

*Introduction and Arduino / Processing basics*

We will give a broad overview of the state of the art in interface technologies. Arduino electronics and programming will be introduced.
The Processing programing is also used for rapid prototyping of applications interfacing with sensors and actuators which may need basic visualization capabilities. The advantage of using processing is that programs can be very easily transferred to Android mobile phones.

**Week 3 and Week 4**

*Raspberry Pi, Communication protocols*

Project guidelines will be presented and students will need to start focusing on which direction they want to take. During week 4 projects start to be developed.
Raspberry Pi is a linux based mini computer with the capability of interfacing with sensors and actuators and Arduino itself. We will introduce it in the course so that we realize the similarities and differences with Arduino.
Communication protocols are the basic tools to plug together sensors of different nature or systems.For this purpose we introduce TUIO and OSC.
An example is developed through the class which consists of a video sequencer and controller that can be interfaced with Arduino sensor data.

**Week 5**

*Robotic and control applications*

We will learn the basics of robotic systems through different examples.
We will use an Arduino/RaspberryPi robotic platform developed in SPECS.
We will also explain a case study of an Arduino self-balancing robot that can be controlled via bluetooth through processing.
Projects will be developing through the rest of the weeks with feedback and support.

**Week 6**

*Computer Vision and RGB-D Applications*

We will deal in this class with a variety of camera sensing technologies including use of normal cameras and Kinect devices.

**Week 7**

*Interfacing with physiology signals: Arduino E-Health Sensor board*

This is a class dedicated to learn how to interface with physiology signals and how to compute arousal and valence measures from them. The class covers a diverse variety of physiological signals : from complex EEG recordings to heart rate and galvanic skin response.

**Week 8**

*Audio Processing*

We deal with several audio processing applications like beat detection, frequency based analysis and others. We will learn how to control interfaces with different audio extracted parameters. Projects start reaching

**Week 9**

*Acquiring and sharing data through internet and the internet of things*

Examples of how to share sensor data through internet applications are provided. Being the last class before the presentations the main part of the class will be devoted to finalizing projects.

**Week 10**

*Project Presentations*

Project presentations include a demo of the built device. Examples of previous years projects:

- A sonar sensor based sensitive stick with haptic feedback for blind navigation.
- The vibrating belt : an 8 motor vibrating belt based on Arduino
- A learning gestural frequency selector and filtering system
- An arduino sensing skate used for monitoring skateboard tricks
- A fitness system using multimodal interfaces

## Interaction models - 30847

Professor: **Narcis Parés**

**Brief summary**

This course will present a range of different views on interaction that are represented by structures and properties, design cycles and strategies, mediation and communication flows and modes, interface configurations, user approaches, etc., that constitute, either explicitly or implicitly, models for each type of interaction. These interaction models show how different interaction can be across the range, so as to actually represent different media with distinct specificities and application adequacy. However, despite the broad range, we will focus on real-time interaction media such as Virtual, Augmented, Mixed and Artificial Reality. Therefore, this is not a typical course on Human Computer Interaction. We expect the students to be able to think critically on technologies, their justified use and application, and their impact in science and society.

**Description**

In all fields we tend to talk of "Interaction" as if it were one single concept or technological option. However, there are many configurations of human-computer interaction technology that lead to very different relationships between the users and the "system". This implicit uniformisation leads, on the one hand, to confusion of terms used in interaction design, interface design, evaluation, etc. On the other hand, it ignores the huge differences in potential that these

different configurations provide.
In this course we will first introduce this problem and start looking at some differences between configurations of technology in VR and more standard interactive applications, such as those based on the Internet. We will then move from a purely technological view to a communicational view to try to understand the specificities of the different configurations as interactive "media". We will then focus and explore Virtual Reality in depth and the notion of Presence. This will lead on to the analysis of AMVR their common specificities.
Finally, the course will close with an comparative analysis of all the exposed interactive media to understand where they stand with respect to each other.

**Class attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

Grading will be done through participation in class, assignments in the form of small analytical work as short texts and/or class presentations.
The final grade will be calculated as per the following formula:

- Prof. Narcis Parés:
  - VR Technologies – Oral Pres - 10%
  - VR Definitions – Oral Pres - 15%
  - VR Applications – Oral Pres - 10%
  - Critical Analysis on AMVR Experiences – Paper - 20%
  - Critical Analysis on AMVR Experiences – Oral Pres - 15%
- Prof. Laia Pujol:
- Presence Court Trial - 20%
- Critical Models - Assignment - 10%
- Prof. Roc Parés:

**Course Structure**

**Week 1**

*Interaction Models Introduction (Narcis Parés)*

We will introduce the topic and the course structure. Our goal will be to understand what is specific of the different types of interaction, how they can be modelled and how are interactive experiences mediated.
We will then understand why models might be important in interaction study and design by unfolding the different aspects of the different types of interaction.
We will focus on two main types of interactions, namely AMVR & Tangible.
We will then enter the realm of Virtual Reality and will review a brief historical overview and the related Terminology.
Finally we will discuss on what is Augmented Reality, how it differs from VR and also what the original concept of Mixed Reality was and the notion of the Reality-Virtuality Continuum.

Recommended readings:

- Kalawsky, R. (1993) The Science of virtual reality and virtual environments: a technical, scientific and engineering reference on virtual environments

- Burdea, G. (1994),Virtual reality technology
- Rogers, Yvonne (2011),Interaction design : beyond human-computer interaction

- Augmented Reality: A class of displays on the reality-virtuality continuum (Milgram, Takemura, et al)

**Week 2**

*Virtual Reality: Technology (Narcis Parés)*

- We will see an overview of VR technology.
- We will see the main categories, their technical properties and how we can use them in developing our artifacts such as those analysed in the master.
- These will be addressed by presentations by students
- The professor will fill in the gaps left by the presentations.

Recommended readings:

- Rogers, Yvonne (2011),Interaction design : beyond human-computer interaction
- Kalawsky, R. (1993), The Science of virtual reality and virtual environments: a technical, scientific and engineering reference on virtual environments
- Burdea, G. (1994) Virtual reality technology

**Week 3**

*Virtual Reality: Definitions (Narcis Parés)*

- We will turn into conceptual aspects of VR.
  - We will apply critical thinking to definitions of VR made by researchers and people around VR through history
  - We will be critical with hype and cliches
  - These will be addressed by presentations by students
- Later we will have a look at Artificial Reality technologies and their importance

Recommended readings:

- Sutherland, I., The Ultimate Display (1965).
- Myron W. Krueger, Thomas Gionfriddo, and Katrin Hinrichsen. 1985. VIDEOPLACE—an artificial reality. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '85). ACM, New York, NY, USA, 35-40. DOI=10.1145/317456.317463
- Kalawsky, R. (1993) The Science of virtual reality and virtual environments: a technical, scientific and engineering reference on virtual environments
- Gigante, M.
- Steuer, J. (1992) Defining Virtual Reality: Dimensions Determining Telepresence
- Biocca, F. (1995) Communication in the Age of Virtual Reality (Chapter 1)

- Parés, N.; Altimira, D. Analyzing the Adequacy of Interaction Paradigms in Artificial Reality Experiences. Human-computer Interaction 2013; 28: 77-114.

**Week 4**

*Virtual Reality: Applications (Narcis Parés)*

- Now we will study the application potential of VR.
  - We will analyse categories of applications of VR
  - We will analyse their qualities and the types of technologies used
  - We will study their impact and how can it be measured
  - We will be critical with hype and cliches
  - These will be addressed by presentations by students

- Later we will have a look at Tangible Interaction, its definition, origin and examples of it.

Recommended readings: (those that have no link may be searched through the UPF Library Services)

- Sutherland, I., The Ultimate Display (1965).
- Myron W. Krueger, Thomas Gionfriddo, and Katrin Hinrichsen. 1985. VIDEOPLACE—an artificial reality. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '85). ACM, New York, NY, USA, 35-40. DOI=10.1145/317456.317463
- Kalawsky, R. (1993) The Science of virtual reality and virtual environments: a technical, scientific and engineering reference on virtual environments
- Gigante, M.
- Steuer, J. (1992) Defining Virtual Reality: Dimensions Determining Telepresence
- Biocca, F. (1995) Communication in the Age of Virtual Reality (Chapter 1)
- Parés, N.; Altimira, D. Analyzing the Adequacy of Interaction Paradigms in Artificial Reality Experiences. Human-computer Interaction 2013; 28: 77-114.

**Week 5**

*Virtual Reality: PRESENCE (Laia Pujol)*

Court Trial on PRESENCE

- In this class we will perform a Court Trial to analyse the controversy around the notion of PRESENCE in AMVR research and development and hence determine whether we may consider it a valid concept or not.
- Students must decide which role they want to portray during the Court Trial. They must choose between:
  - Being one of three Judges
  - Being part of the Defence
  - Being part of the Prosecution

Recommended readings:

- Steuer, J. (1992) Defining Virtual Reality: Dimensions Determining Telepresence
- Ellis, S., “Presence of Mind. A reaction to Thomas Sheridan's ‘Further Musings on the Psychophysics of Presence’”, Presence: Teleop erators and Virtual Environments, MIT Press, 1996, 5, 247-259
- Lombard, M., & Ditton, T., “At the heart of it all: The concept of presence”, Journal of Computer Mediated Communication, 3(2), 1997. Available online: http://jcmc.indiana.edu/vol3/issue2/lombard.html
- Slater, M., Wilbur, S., “A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments”, Presence: Teleoperators and Virtual Environments, 1997, 6(6), 603–616.
- Witmer, B. G., Singer, M. J. “Measuring Presence in Virtual Environments: A Presence Questionnaire”, Presence: Teleoperators and Virtual Environments, 1998, 7, 225-240
- M. Slater, “Measuring Presence: A Response to the Witmer and Singer Presence Questionnaire”, Presence: Teleoperators and Virtual Environments, 8, 5, (1999)
- Pertaub, D.P., Slater, M., Barker, C., An Experiment on Public Speaking Anxiety in Response to Three Different Types of Virtual Audience, Presence: Teleoperators & Virtual Environments 2002 11:1, 68-78
- Slater, M., Brogni, A. and Steed, A. (2003) Physiological Responses to Breaks in Presence: A Pilot Study, Presence 2003: The 6th Annual International Workshop on Presence, Aalborg, Denmark,2003. http://www.cs.ucl.ac.uk/staff/m.slater/Papers/physbips.pdf
- M. Slater, “How Colourful was Your Day? Why Questionnaires Cannot Assess Presence in Virtual Environments”, Presence: Teleoperators and Virtual Environments, 13, 4, (2004).
- Slater M, Antley A, Davison A, Swapp D, Guger C, Barker, C., Pistrang, N., Sanchez-Vives, M.V. (2006) A Virtual Reprise of the Stanley Milgram Obedience Experiments. PLoS ONE 1(1): e39.
- The RAVE (Real Action Virtual Environments) Manifesto (2008), http://www.upf.edu/enoticies/0708/_pdf/RAVE.pdf
- Sheridan, T. B., “Musings on telepresence and virtual presence”, Presence: Teleoperators and Virtual Environments, MIT Press, 1992, 1, 120-126

**Week 6**

*VR as a Medium (Narcis Parés)*

- We will analyze the specificities of Virtual Reality as seen from a Media Studies standpoint.
- We will understand the importance of the notion of "Real-Time Generation" of stimuli.
- We will also see and compare two main interaction design strategies.

Required readings:

- Parés, N., Parés R., "Interaction-driven virtual reality application design. A particular case: 'El Ball del Fanalet or Lightpools'." PRESENCE: Teleoperators and Virtual Environments. Cambridge, MA: MIT Press, Vol 10.2. Pag. 236-245, 2001

**Week 7**

*Virtual Subjectiveness (Narcis Parés)*

- We will analyse the paper referenced below to try to understand the steps taken towards a model that explains mediation of a VR experience.

Required readings

- Parés, N., Parés, R. (2001) Towards a Model for a Virtual Reality Experience: the Virtual Subjectiveness.
- Ellis, S.R. (1991). Nature and Origins of Virtual Environments: a Bibliographical Essay. In Computing Systems in Engineering, Vol. 2, No. 4, pp. 321-347.
- Latta, J.N., & Oberg D.J. (1994). A Conceptual Virtual Reality Model. In IEEE Computer Graphics & Applications, vol. 14 January, p. 23-29.

**Week 8**

*Critical models (I) (Roc Parés)*

In these two sessions we will discuss how new media art is questioning the ways in which the conventional uses of interactive technologies determine our lives as individuals in our contemporary societies. A critical analysis model will be presented and used in several short class assignments.

Required readings:

- Realtime art manifesto, Auriea Harvey & Michaël Samyn, Directors, Tale of Tales, 2006

**Week 9**

*Critical models (II) (Roc Parés)*

In these two sessions we will discuss how new media art is questioning the ways in which the conventional uses of interactive technologies determine our lives as individuals in our contemporary societies. A critical analysis model will be presented and used in several short class assignments.

Required readings:

- Realtime art manifesto, Auriea Harvey & Michaël Samyn, Directors, Tale of Tales, 2006

**Week 10**

*Interaction Models Student's Works (Narcis Parés)*

- This class will be dedicated to presentations of the students' assignments on the critical analysis of an AMVR experience according to interaction models.

# Education, Games and Entertainment - 30857

Professor: **Narcis Pares**

**Brief summary**

The full updated title of this course could be “Embodied Interaction in Learning, Play, Entertainment and Culture”. In this course we will have a look at why and how Embodied Interaction can have an impact in our developmental processes; how it can generate playful experiences for us to learn and gain experience of abstract concepts; or how it allows us to incorporate body gestures, space navigation and socialization in high end technological entertainment or in museums. We will have a bit of historical travel through the theories that have had an impact on how interactive technology has gradually incorporated the body and will get to know key actors in this path. We will also analyse many embodied interaction experiences developed through the years, many of which have been conceived for the public space, and will design new ones to understand the theories and methodologies that can be applied.

**Description**

This course focuses on a number of application areas: Learning, Public Space Entertainment, Playgrounds, Exergames, Culture, and Heritage. These areas are analysed from three main transversal research fields: Play, Embodiment and Technology. This means that we will analyse how these three latter research fields inform the former application areas. We will focus on Interaction Design for these application areas and will especially try to understand how Embodied Interaction can provide very interesting benefits for them.

The course will therefore concentrate on how Embodied Interaction informs and helps in:

- Technology Enhanced Learning such as Manipulatives and Full-Body Interaction Learning Environments (FUBILEs)
- Large Scale Interaction for Location-Based Entertainment (LBE) and Theme Parks
- Interactive Playgrounds and Exergames
- Museums, Cultural Heritage & ICT

We will cover theoretical aspects, technological solutions, as well as hands on interaction design strategies to achieve rich interaction and entertaining experiences to help users learn and have fun.

**Class attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

This course will be evaluated using a mix of class presentations and hands-on approach:

- Assignment on Manipulatives and Categories: 15%
- Assignment on Constructivism/Constructionism: 15%
- Assignment on Embodied Interaction: 15%
- Assignment on Design and Evaluation of a Full-Body Interaction Learning Experience: 20%
- Assignment on Design of a Large-scale Interactive Experience:
  - Concept & paper prototype: 10%
  - Final presentation and high fidelity functional prototype: 25%

NOTE: These works will be done in teams of 3 or 4 students to foster brainstorming, collaborative work, critical thinking and creativity.

**Course Structure**

**Week 1**

- Presentation
- Course Evaluation Criteria
- Introduction to Play & Game
- Brief Introduction to: Manipulatives
- *Assignment on Manipulatives and Categories for next class*

Recommended readings:

- Salen, K & Zimmerman, E., "Rules of Play. Game design fundamentals", MIT Press, Cambridge MA, 2004
- Wixon, D., "What is a Game?", Interactions ACM, 13-2, pag 37., 2006
- Djaouti, D., Alvarez, J., Jessel, J.P., Rampnoux, O. (2011) Origins of Serious Games, Serious Games and Edutainment Applications, Ma, M., Oikonomou, A., Jain, L.C. (eds.), Springer, pp.25-43
- Michael, D., & Chen, S. (2005). Serious Games: Games That Educate, Train, and Inform (1st ed.). Course Technology PTR
- Blythe, M. A., Overbeeke, K., Monk, A. F., and Wright, P. C.(eds.). Funology. Form Usability to Enjoyment, Kluwer Academic Publishers, 2004
- Resnick, M. (2004) Edutainment? No thanks. I prefer playful learning, Associazione Civita Report on Edutainment
- Zuckerman, O., Arida, S., Resnick, M. (2005) "Extending Tangible Interfaces for Education: Digital Montessori-inspired Manipulatives" In Proceedings of CHI 2005, April 2–7, Portland, OG, USA
- Zuckerman, O., (2006) Flowness + FlowBlocks Uncovering the Dynamics of Everyday Life through Playful Modeling, PhD Dissertation, MIT Media Lab

**Week 2**

- Presentations & Discussion on Manipulatives and Categories
- Brief Introduction to: Constructivism & Constructionism (Piaget, Vygotsky, Papert, Ackermann & Resnick)
- *Assignment on Constructivism/Constructionism for next class*

Recommended readings:

- Papert, S. (1980) Mindstorms: Children, Computers, and Powerful Ideas. Basic Books, Inc., New York, NY, USA.
- Papert, S. (1987) Microworlds: transforming education, In Artificial intelligence and education, Vol. 1, pp. 79–94
- Papert, S., & Harel, I. (1991). Situating constructionism. Constructionism, 36, 1-11

- Resnick, M. 2002. Rethinking Learning in the Digital Age. In The Global Information Technology Report: Readiness for the Networked World, edited by G. Kirkman. Oxford University Press
- Resnick, M. (2007) All I really need to know (about creative thinking) I learned (by studying how children learn) in kindergarten. In Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition (C&C '07). ACM, New York, NY, USA, 1-6
- Resnick, M. and Silverman, B. (2005) Some reflections on designing construction kits for kids. In Proceedings of the 2005 conference on Interaction design and children (IDC '05). ACM, New York, NY, USA, 117-122
- Ackermann, E. (2004) Constructing Knowledge and Transforming the World. In M. Tokoro & L. Steels (Eds.), A learning zone of one's own: Sharing representations and flow in collaborative learning environments (pp. 15–37). IOS Press
- Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge,MS: Harvard University Press

**Week 3**

- Presentations & Discussion on Constructivism/Constructionism
- Brief Introduction to:
  - Space & Body
  - Embodied Cognition
  - Embodiment & Learning
  - Interaction and Embodiment
- *Assignment on Embodied Interaction for next class*

Recommended readings:

- Buxton, B. (1986) There's More to Interaction than Meets the Eye: Some Issues in Manual Input. In Norman, D. A. and Draper, S. W. (Eds.), User Centered System Design: New Perspectives on Human-Computer Interaction. Lawrence Erlbaum Associates, Hillsdale, New Jersey, 319-337.
- Grudin, J. (1990). The computer reaches out: the historical continuity of interface design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Vol. Seattle, W, pp. 261–268). New York, NY, USA: ACM
- Merleau-Ponty, M. (2005) Phenomenology of Perception, Trans: Colin Smith, Routledge, London
- Gibson, J. J. (1979) The Ecological Approach to Visual Perception, Boston: Houghton Mifflin. ISBN 0898599598
- Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion" Personality and Social Psychology Bulletin 9(3), 184-211
- Barsalou, L. W. (2008). Grounded cognition. Annual Review of Psychology, 59, 617–645
- Gallese, V. (2000). The Inner Sense of Action: Agency and Motor Representations. Journal of Consciousness Studies 7/10:23-40
- Lakoff, G. and Johnson, M. Metaphors We Live By. University of Chicago Press, Chicago, IL, USA, 1980.

- Johnson, M. The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason, Chicago Press, Chicago, IL, USA, 1987
- Varela, F., Thompson, E., & Rosch, E. (1991). The Embodied Mind: Cognitive Science and Human Experience. MIT Press
- Papert, S. (1980) Mindstorms: Children, Computers, and Powerful Ideas. Basic Books, Inc., New York, NY, USA
- Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Cambridge,MS: Harvard University Press
- Nardi, B. A. (1996). Activity theory and human computer interaction In B. A. Nardi (Ed.), Context and Consciousness: Activity Theory and Human-Computer Interaction (pp. 1-8). Cambridge, Massachusetts: The MIT Press
- Goldin-Meadow, S. (2011). Learning through gesture. Wiley Interdisciplinary Reviews: Cognitive Science, 2(6), 595–607
- Wilson, M. (2002). Six views of embodied cognition. Psychonomic Bulletin & Review, 9(4), 625–36
- Dourish, P. (2001). Where the Action Is: The Foundations of Embodied Interaction. Cambridge: MIT Press


**Week 4**

- Brief Introduction to:
  - Participatory Design
  - Designing with/for children
  - Full-Body Interaction Learning Environments
  - Embodied Design Techniques
  - FUBImethod
- Assignment: Definition of requirements for the design of a FBInt learning experience in the context of a science museum (Stages 1 and 2 of the FUBImethod)

Recommended readings:

*Participatory Design*


- Bravo, E. 1993. The Hazards of Leaving Out the Users. In Participatory design: Principles and practices, D. Schuler, & A. Namioka (eds.) (p. 3-12). Hillsdale, NJ: Lawrence Erlbaum
- Druin, A., (1999) Cooperative inquiry: developing new technologies for children with children, In Proceedings of the SIGCHI conference on Human Factors in Computing Systems (CHI '99), ACM, New York, NY, USA, pp. 592-599
- Iversen, O.S., Dindler, C., 2013. A Utopian agenda in child-computer interaction. Int. J. Child-Computer Interact. 1, 24–29.
- Scaife, M., Rogers, Y., Aldrich, F., & Davies, M. (1997). Designing for or designing with? Informant design for interactive learning environments. In Proceedings of the SIGCHI conference on Human factors in computing systems - CHI ’97 (pp. 343–350). New York, New York, USA: ACM Press. doi:10.1145/258549.258789

- Schuler, D, and Marnioka, A. 1993. (eds.) Participatory Design: Principles and Practices. Lawrence Earlbaum, Hillsdale, NJ.


*Full-Body Interaction Learning Environments*


- Carreras, A., & Parés, N. (2004). Designing an Interactive Installation for Children to Experience Abstract Concepts. In New Trends on Human-Computer Interaction (pp. 33–42)
- Lindgren, R., & Moshell, J.(2013). Supporting children's learning with body-based metaphors in a mixed reality environment. In T. Moher & C. Quintana (Eds.), Proceedings of the 10th International Conference on Interaction Design and Children (pp. 177– 180). New York, NY: ACM.
- Mora-Guiard, J., Pares, N., 2014. "Child as the measure of all things": The Body as a Referent in Designing a Museum Exhibit to Understand the Nanoscale, in: Proceedings of the 2014 Conference on Interaction Design and Children - IDC '14. ACM, New York, NY, USA, pp. 27–36.
- Price, S., Sakr, M., Jewitt, C., 2015. Exploring Whole-Body Interaction and Design for Museums. Interacting with Computers. Interact. Comput. 28, 569–583.
- Schaper, M.-M., Santos, M., Malinverni, L., Zerbini Berro, J., Pares, N., 2018. Learning about the Past through Situatedness, Embodied Exploration and Digital Augmentation of Cultural Heritage sites. Int. J. Hum. Comput. Stud. 114, 36–50.


*Methods and Design Techniques for children*


- Bekker, M., Beusmans, J., Keyson, D., Lloyd, P. (2003) KidReporter: a user requirements gathering technique for designing with children. Interacting with Computers 15 (2), 2003, p. 187-202.
- Dindler, C., Eriksson, E., Iversen, O.S., Lykke-Olesen, A., and Ludvigsen, M. 2005. Mission from Mars: a method for exploring user requirements for children in a narrative space. In Proceedings of the 2005 conference on Interaction design and children (IDC '05). ACM, New York, NY, USA, 40-47
- Landry, P., Pares, N., Minsky, J., Pares, R., 2012. Participatory design for exertion interfaces for children, in: Proceedings of the 11th International Conference on Interaction Design and Children - IDC '12. ACM Press, New York, NY, USA, pp. 256–259.
- Malinverni, L., Ackermann, E., Pares, N., 2016. Experience as an Object to Think with: from Sensing-in-action to Making-Sense of action in Full-Body Interaction Learning Environments. Proc. Int. Conf. Tangible, Embed. Embodied Interact. 332–339.
- Malinverni, L., Schaper, M., Pares, N., 2016. An Evaluation-Driven Design approach to develop Learning Environments based on Full-Body Interaction. Educ. Technol. Res. Dev. 1–24.
- Schaper, M.-M., Santos, M., Pares, N., 2018. Orchestrating experts' assumptions and children's values in the design of Virtual Heritage experiences. Int. J. Child-Computer Interact. 17, 5–15.
- Wilde, D., Vallgårda, A., Tomico, O., 2017. Embodied Design Ideation Methods, in: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17. ACM, New York, NY, USA, pp. 5158–5170.
- Van Mechelen, M., Derboven, J., Laenen, A., Willems, B., Geerts, D., Vanden Abeele, V. (2017) The GLID method: Moving from design features to underlying values in co-design, International Journal of Human-Computer Studies, Volume 97, January 2017, Pages 116-128.

**Week 5**

- Presentation of design requirements (each team has 10 min)
- Brief summary of FUBImethod
- Introduction to evaluation methods in Full-Body Interaction design
- Clase Work:
  - Each team designs a paper prototype for their Full-Body interactive learning experience
  - Presentation on designs
  - Each team tests the prototype of another team and evaluates the embodied experience
- The design project will be graded according to the following aspects:
  - Presentation of project requirements (40%): Justification for the definition of the requirements, research methods and appropriateness of learning goals chosen in the context of Full-Body Interaction design
  - Presentation on designs (40%): Adequacy of prototype to convey the design goals
  - Evaluation of embodied experience (20%): How do other users experience your prototype

**Week 6**

- Presentations and Discussion on Embodied Interaction
- Interaction in Public Spaces
- Theme Parks & Interaction

Recommended readings:

- Schell, J., and Shochet, J. (2001) Designing Interactive Theme Park Rides, IEEE Comput. Graph. Appl. 21, 4 (July 2001), 11-13. DOI=10.1109/38.933519 http://dx.doi.org/10.1109/38.933519.
- Reynolds, R. (1999) Roller Coasters, Flumes, and Flying Saucers: the Story of Ed Morgan & Carl Bacon, Ride Inventors of the Modern Amusement Parks. Jupiter, FL: Northern Lights Pub., 1999.

**Week 7**

- Interactive Playgrounds
- Exergames
- Special Needs and Embodied Interaction

Recommended readings:

- Mueller, F., Agamanolis, S. and Picard, R. Exertion interfaces: sports over a distance for social bonding and fun. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems CHI '03. ACM Press (2003), 561-568

- Mueller, F., Agamanolis, S., Gibbs, M. R., and Vetere, F. 2008. Remote Impact: Shadowboxing over a Distance. In CHI '08 Extended Abstracts on Human Factors in Computing Systems (Florence, Italy, April 05 - 10, 2008). CHI '08. ACM, New York, NY, USA, 2291-2296
- Bianchi-Berthouze, N. (2013) Understanding the role of body movement in player engagement. Human Computer Interaction 28(1), 42-75
- Barnett, A., Cerin, E., and Baranowski, T. (2011) Active videogames for youth: a systematic review, JPhys Act Health. 8(5), 724-773.
- Peng, W., Lin, J., and Crouse, J. (2011) Is Playing Exergames Really Exercising? A Meta-Analysis of Energy Expenditure in Active Video Games, Cyberpsychology, Behavior, and Social Networking. 14(11), 681-688
- Soute, I., (2013) Head Up Games,On the design, creation and evaluation of interactive outdoor games for children , PhD Thesis, Supervisor Prof. Panos Markopoulos, Technical University Eindhoven, Netherlands, ISBN: 978-90-386-3393-0


**Week 8**

- Interaction for Culture & Heritage
  - Cultural Heritage
  - Embodied Interaction and CH
  - Presentations of concept & paper prototype of LSIE

Recommended readings:


- Falk, J. H., & Dierking, L. D. (2013). The Museum Experience Revisited. Walnut Creek, CA: Left Coast Press.
- Cameron, F. & Kenderdine, S. (2007). Theorizing Digital Cultural Heritage: A Critical Discourse. Cambridge, MA: MIT Press.
- Simon, N. (2010). The participatory Museum. Santa Cruz, CA: Museum 2.0.
- The London Charter: http://www.londoncharter.org/
- The Seville Principles: http://sevilleprinciples.com/


**Week 9**

- Class work on Large-Scale Interactive Experiences
  - During the class students will generate a high-fidelity functional prototype of the LSIE based on the paper prototype presented in the previous class.
  - This high-fidelity prototype can use Wizard of Oz methodologies and does not require to be fully functional. The idea is to simulate as well as possible the user experience and have a deep analysis of the full-body interaction properties explored in the FUBImethod, and the properties of interaction for Public Space.

**Week 10**

- Final Presentations of Large-scale Interactive Attractions

## Sound Communication - 30852

Professor: **Rafael Ramirez**

**Brief summary**

This course will study methods, concepts and practice of artificial intelligence, machine learning, music, sound and sonic therapies with particular emphasis on practical applications. The main goals are to develop the student's understanding of the main trends in artificial intelligence and its application to music and sound processing and production, as well as to health and well-being. Students will gain experience in designing intelligent music systems and conducting research projects in related areas.

**Description**

**1. PROPOSAL**

The objective of this course is to present concepts, methods and practice of machine learning, and their application to music/sound processing and sonic therapies, letting the students to formulate their own projects.

**1.1 Concept**

Artificial Intelligence

Machine learning

Music processing

Interactive Sound Systems

**1.2 Applications**

Interactive Performances

Soundscape Installations

Sonic Therapies / Music and well-being

New Music Interfaces

**Class attendance**

Regular attendance to the classes is mandatory

**Evaluation Criteria**

**3 EVALUATION**

Groups of 3-4 students. Each group is going to choose a theme based on more than one **Concept** and one **Application**. The project consists of a) description and concepts and b) implementation. The grade for each project is: 30% for (a) + 70% for (b).

Students will do a presentation describing both the concepts involved in their project as well as the implementation. Demonstration of their implementation is required to be included in the presentation.

**Course Structure**

**Week 1**

- Introduction to artificial intelligence, machine learning and applications to sound communication

**Week 2**

- Regression for sound communication

**Week 3**

- Classification for sound communication

**Week 4**

- Clustering for sound communication

**Week 5**

- Generative Music Systems

**Week 6**

- New Music Interfaces

**Week 7**

- Music and well-being

**Week 8**

- Interactive Sonification

**Week 9**

- Soundscape installations

**Week 10**

- Project presentations

## Real-Time Interaction - 30876

Professor: **Daniel Pacheco, Diogo Pata (SPECS)**

**Description**

The Real-time Interaction course focuses on the study of real-time interaction from several perspectives, both conceptual and technological, covering interaction in Virtual Reality and Interfaces and its applications to experimental psychology. The course is divided in two parts: one covering the conceptualization, design and implementation of Virtual Reality scenarios for human experiments (introducing tools like Unity), and the other that covers interfaces, wearables and integration in Virtual Reality. The second part is project oriented.

**Course Objectives**

*Theoretical sessions*

The theory part starts discussing the concepts of "interactivity" and "real-time interaction" showing how relative and subjective both concepts can be. Intreaction in Virtual Reality with the design and conceptualization of scenarios with an application to experimental psychology.

**Class attendance**

Regular attendance to the classes is mandatory.

**Evaluation Criteria**

Development of project assignments, project presentation & participation in class.

**Course Structure**

**Week 1**

Environmental feedback.
The role of action-perception couplets to navigate the world.

**Week 2**

Spatial memory and the cognitive map.
Literature review, example experiments.

**Week 3**

Associative learning, conjunctive representations, and models of
place and grid cells. Students form groups to work on the course project.

**Week 4**

Project mid-term presentation.

**Week 5**

Tools for setup development (Unity)

**Week 6**

Tools for setup development II (Processing, ml5, Firebase)

**Week 7**

Spatial- and memory-related data processing and analysis.
Behavioral and unsupervised learning.

**Week 8**

Work on projects: evaluating interaction and corrections

**Week 9**

Work on projects: statistics and data analysis

**Week 10**

Final project presentations

## Adaptive Behavior - 30864

**Professors**: **Davinia Hernández-Leo (TIDE, course coordinator), Patricia Santos (TIDE), Marc Beardsley (TIDE)**

**Description**

In this course we build on notions in human adaptive behaviour, learning sciences and interactive and intelligent learning technologies, as we look at design for fruitful learning experiences. The course is at the cross-section of cognitive neuroscience, education and computer science.

The course starts with a definition of adaptive behavior that refers to the collection of conceptual, social, and practical skills that all humans learn in order to function in their daily lives. We explore the biological underpinnings of human adaptive behaviour, the risks associated to maladaptive behavior (e.g. stress), and the role of our learning system from a biological and evolutionary social context. Special attention is put to how learning happens in humans and the most accepted frameworks and methods in the learning sciences, helpful to design effective learning experiences.

The course then focuses on how technological approaches and tools can be used to enhance learning scenarios or to facilitate learning scenarios that won't be possible without technologies. We cover advances in learning technologies and their applications, including innovative online learning systems; collaborative learning tools; learning with mobile devices; wearable devices for learning; adaptive learning systems; tools for formative and summative assessment; educational data science and learning analytics; learning design and authoring tools; social networks and infrastructures for learning and knowledge sharing.

**Course Objectives**

By the end of the course, students will be able to design effective learning experiences through utilizing learning technologies, knowledge of learning sciences, and data analytics.

**Class attendance**

Regular attendance to the classes is mandatory.

**Evaluation Criteria**

Group project, short individual assignments, class participation.

**Course Structure**

There is no official textbook for this course. There will be suggested readings related to each of the topics of the course. Class format will include workshop-like activities, discussion about readings and assignments, and lectures. The course has a project-based component; students will be able to select their project topic based on their interests.

*This is an approximate course structure:*

1. Overview of the course, introduction to the main course concepts, to assignments, and to design thinking as the methodology to apply in the group project.
2. Design for learning. Learning Design technology.
3. Science of Learning Primer: Cognitive Learning.
4. Social & Emotional Learning: Non-Cognitive Learning.
5. Next-generation digital learning environments, adaptive learning systems, blended learning.
6. Active learning. Computer-supported collaborative learning. Technologies for classroom orchestration.
7. Learning analytics, design analytics, and community analytics to support teaching and learning.
8. Situated learning, ubiquitous learning and mobile learning.
9. Technology-supported summative and formative assessment.
10. Project presentations.

This a sample of the proposed readings, to choose, for an individual assignment:

Dillenbourg, P., & Jermann, P. (2010). *Technology for classroom orchestration.* In New science of learning (pp. 525-552). Springer, New York, NY.

Hascher, T. (2010). Learning and Emotion: perspectives for theory and research. *European Educational Research Journal*, 9(1), 13-28.

Herodotou, C., Aristeidou, M., Sharples, M., & Scanlon, E. (2018). Designing citizen science tools for learning: lessons learnt from the iterative development of nQuire. *Research and Practice in Technology Enhanced Learning*, 13(1), 4.

Kelley, P., & Whatson, T. (2013). Making long-term memories in minutes: a spaced learning pattern from memory research in education. *Frontiers in Human Neuroscience*, 7, 589.

Laurillard, D., Kennedy, E., Charlton, P., Wild, J., & Dimakopoulos, D. (2018). Using technology to develop teachers as designers of TEL: Evaluating the learning designer. *British Journal of Educational Technology*, 49(6), 1044-1058.

Margaryan, A., Bianco, M., & Littlejohn, A. (2015). Instructional quality of massive open online courses (MOOCs). *Computers & Education*, 80, 77-83.

Martinez-Maldonado, R., Kay, J., Buckingham Shum, S., & Yacef, K. (2019). Collocated collaboration analytics: Principles and dilemmas for mining multimodal interaction data. *Human–Computer Interaction*, 34(1), 1-50.

Mor, Y., Craft, B., & Hernández-Leo, D. (2013). The art and science of learning design: Editorial. *Research in Learning Technology*, 21.

Nguyen, Q., Huptych, M., & Rienties, B. (2018). Using Temporal Analytics to Detect Inconsistencies between Learning Design and Student Behaviours. *Journal of Learning Analytics*, 5(3), 120-135.

Pijeira-Díaz, H. J., Drachsler, H., Järvelä, S., & Kirschner, P. A. (2019). Sympathetic arousal commonalities and arousal contagion during collaborative learning: How attuned are triad members?. *Computers in Human Behavior*, 92, 188-197.

Rienties, B., Cross, S., Marsh, V., & Ullmann, T. (2017). Making sense of learner and learning Big Data: reviewing five years of Data Wrangling at the Open University UK. *Open Learning: The Journal of Open, Distance and e-learning*, 32(3), 279-293.

Schwendimann, B. A., Rodriguez-Triana, M. J., Vozniuk, A., Prieto, L. P., Boroujeni, M. S., Holzer, A., & Dillenbourg, P. (2017). Perceiving learning at a glance: A systematic literature review of learning dashboard research. *IEEE Transactions on Learning Technologies*, 10(1), 30-41.

Spikol, D., Ruffaldi, E., Dabisias, G., & Cukurova, M. (2018). Supervised machine learning in multimodal learning analytics for estimating success in project-based learning. *Journal of Computer Assisted Learning*, 34(4), 366-377.

Tsai, F. H., Tsai, C. C., & Lin, K. Y. (2015). The evaluation of different gaming modes and feedback types on game-based formative assessment in an online learning environment. *Computers & Education*, 81, 259-269.

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