UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Digital Processing of Affective Signals

2627-2-F9202P011

Aims

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The course introduces theoretical foundations of affective computing, emotion models, and multimodal emotion recognition systems, with applications in human-computer interaction, healthcare, neurotechnology, and intelligent systems.

Knowledge and understanding
The student will learn the fundamentals of analog-to-digital conversion, introducing the concepts of sampling, quantization, and digital representation of signals and the main methods for processing digital signals, including filtering, artifact removal, feature extraction, time-frequency analysis, and signal characterization.
The student will understand these concepts by considering signals commonly employed in affective computing and human-machine interaction, with particular emphasis on physiological and electrophysiological signals, including electroencephalography (EEG), electrodermal activity (EDA/GSR), electromyography (EMG) , and photoplethysmography (PPG). The student will also acquire basic knowledge of facial expression, and speech signal processing as complementary modalities for multimodal affect recognition.

Applied knowledge and understanding
Through lectures and laboratory activities, students will learn how to acquire, preprocess, analyze, and interpret digital signals.
Students will implement algorithms for signal processing and feature extraction from digital signals, and will develop simple multimodal emotion recognition systems.

Making judgements
Through laboratory activities and assignments, students will learn to critically evaluate different signal processing techniques and affect recognition methods, selecting appropriate approaches according to the application and the characteristics of the acquired signals.

Communication skills
Students will be encouraged to discuss methodological choices, experimental results, and practical challenges

encountered during laboratory activities. Technical communication skills will be assessed during the oral examination and assignment discussion.

Learning skills
The integration of theoretical lectures with laboratory experiences will provide students with practical skills for independently studying new signal processing methods and affective computing applications.

Contents

The course provides the foundations for digitizing and processing digital signals used in affective computing.
It introduces the principal techniques for preprocessing, analyzing, and extracting meaningful information (e.g.) from EEG and other biosignals, together with complementary approaches based on facial expressions and speech analysis.
The course provides the methodological basis for developing multimodal emotion recognition systems and their applications in human-computer interaction.

Detailed program

1. Introduction to Digital Signals

- One-dimensional, two-dimensional and multidimensional signals
- Analog and digital signals
- Digital representation of signals

2. Analog-to-Digital Conversion

- Sampling theorem
- Aliasing and anti-aliasing filters
- Quantization
- Resolution and dynamic range

3. Digital Signal Processing

- Time-domain analysis
- Frequency-domain analysis
- Time-frequency analysis
- Filtering

4. Affective Computing and Emotion Recognition

- Introduction to affective computing
- Emotion models
- Unimodal and multimodal emotion recognition
- Signal quality and acquisition issues in affective computing systems

5. Physiological and Electrophysiological Signals

- Overview of physiological signals
- Electroencephalography (EEG)

- Electrodermal Activity (EDA/GSR)
- Electromyography (EMG)
- Photoplethysmography (PPG)

6. Computational Models for Affective Recognitions

- Artificial Intelligence for affective computing
- Applications of affective computing

Prerequisites

No prerequisite

Teaching form

The course consists of lectures (28 hours), and practical activities (24 hours). Several exercises will be carried out during the practical activities to verify the new expertise acquired. The course is taught in English.

The lectures will be delivered as follows:
21 hours of didactics, in presence.
7 hours of interactive teaching mode in presence.

24 hours of laboratory in interactive teaching mode in presence.

Textbook and teaching resource

slides published on the web site of the course

Laboratory notebooks and programming exercises

Suggested readings:
Murugappan, M. (2023). Affective computing in healthcare : applications based on biosignals and artificial intelligence. IOP Publishing. https://doi.org/10.1088/978-0-7503-5182-9[1.1][1.2][1.3]
? Picard, R. W., Affective Computing, MIT Press.
? Selected recent scientific papers on physiological signal processing and emotion recognition

Semester

second semester

Assessment method

Examination:
Oral exam + practical activities (4 mandatory)
Evaluation Type:
Final mark out of thirty

Oral exam
The exam (oral) consists of open questions. This part verifies the competencies acquired during the course and it is based on what is taught during the lessons, on the shared slides, and on the indicated teaching resources.

Assignements
TThe practical activity is a fundamental part of the course. Periodic assignments are proposed during practical activities. **Four assignments are mandatory** to pass the exam and must be submitted before the oral examination. These assignments remain valid until the oral examination completion.

Office hours

Friday from 11.00 to 12.00.

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE