

Old Syllabus

Northeastern University

**Affective Computing
Stacy Marsella**

Course Objective:

Affective Computing is computing that relates to, arises from, or influences emotions. This course overviews the theory of human emotion (how it arises from and influences cognition, the body and the social environment), computational techniques for modeling human emotion processes as well as for recognizing and synthesizing emotional behavior. We will discuss how these can be applied to application design. The graduate student will gain a strong background in the theory and practice of human-centered computing as it relates to games, immersive environments and pedagogical applications.

A special emphasis in this course is to bring together students from different disciplines to work together and learn from each other. For example, the 2015 course included students from computer science, engineering, health informatics, psychology and art, media and design.

Course Structure

Instructor: Stacy Marsella

Date/Time:

Grades: Grades determined by

- class participation 15%,
- class presentations 20%,

- final project presentation 25%,
- final project write-up 40%

Final Presentations: April 14th & April 21st

Projects: Projects are a key focus of the course. They will be developed in 2-3 person teams, with a strong preference for interdisciplinary teams. A list of prior projects is available to students to help spur their thinking. Because of the interdisciplinary nature of the class, the instructor will be quite open to a wide range of project ideas.

Project Report: The final project paper should be of a form suitable for a submission to a conference. The papers should include the following content but you can deviate from the format since the format differs depending on the conference and its associated discipline:

- **Abstract**
- **Introduction:**
 - **Motivation:** The problem/issue/question you are addressing and why it is interesting/important.
 - **Brief overview of approach** and what makes it unique from others' work
 - **Brief summary of results:**
- **Related Work:** How/whether others have addressed it, how it differs from what you are doing and in some way insufficient for fully addressing the problem/issue/question. How you used ideas from others.
- **Approach/Methodology:** Details of how you approached the problem. This may be the technology implementation or experiment description or both.
- **Evaluation/Results/Testing:** Presentation of the evaluation performed
- **Discussion/conclusion/future work**
- **Acknowledgements:** Acknowledge any help you got as you would in a paper (e.g., "we would like to thank X for their suggestions or their use of equipment, this project was supported by X)
- **References:**

Lecture Structure:

- Lectures with occasional guest lectures
- Student Presentations in interdisciplinary teams
 - Projects
 - A paper of teams choosing

- Occasional In-Class Experiment illustrating the impact of affect.

Software: Students will gain knowledge of, and as part of their projects hands-on experience with, software tools related to affective computing including :

- Emotion Recognition Techniques
- Emotion Synthesis Techniques
- Cognitive and Emotional Modeling
- Software Agents and Virtual Humans
- Algorithms that support the above methods

A list of pre-existing software tools is made available to students

Course Outline

Week 1 Course Overview. Introduction to Affective Computing

- What is affective computing?
- Broadly overview functions of affect and why of interest to computer science
- Overview applications that take advantage of these perspective
- Readings
 - Picard retrospective on field of affective computing

Week 2 Emotion Theory

- Define affective phenomena (emotion, mood, attitude/sentiment, personality)
- What is theory and why does it matter?
- Present alternative theoretical perspectives on emotion
- Readings
 - [Barrett video interview](#) (first 15min): Outlines alternative theories of emotion
 - Scherer (2010), Outlines alternative theories of emotion

Week 3 Computational Models of Emotion

- Introduce appraisal theory and the component model

- Discuss EMA
- Applications
- Reading
 - Marsella, Gratch and Petta (2010): reviews modeling research (or 2014 ACM article??)
 - Reading- Marsella and Gratch (2009), sections 1.1, 1.2, 2 and 3: describes model of “the Bird”

Week 4 Emotion’s relation to mental processes

- Emotion and decision making
- Contrast between human and rational decisions (e.g. prospect theory)
- Applications
- Reading: Lowenstein and Lerner 2003.

Week 5 Emotion’s relation to physical and physiological behavior

- Guest Lecture
- Reading: Blascovich & Mendes 2010: Reviews psychophysiological findings. Only required to read:
 - Neurophysiological systems, advantages & Indices (p199-203) &
 - Uses [affect, attitudes, emotion] (p 210-215)

Week 6 Embodiment: Emotion’s relation to social interaction

- **Presentations of Project Proposals**
- Relation of Nonverbal behavior to mental states
- Embodied theories of emotion:
 - Physical manifestation of emotion
 - Embodied theories of emotion
- Social theories of emotion
 - Theories of social emotions: leakage, social intention, social appraisal
- Reading: Niedenthal 2007: embodied approaches to emotion

Week 7 Emotion and social interaction (cont.);

- Rational perspectives on social emotions: game theory

- Theory of Mind and understanding emotion in others.
- Reading: Chapter in Whiten, *Natural Theories of Mind*.

Week 8 Synthesis of emotional behavior

- Encoding-Decoding: realistic vs. communicative approaches
- Expression synthesis techniques
 - Procedural, Mocap, machine learning, manifolds
- Reading: Handbook of Affective Computing Chapter

Week 9 Recognition of Emotion

- Guest Lecture
- Overview
 - Signal types
 - Machine Learning techniques
- Facial Expression Recognition
- Context in emotion recognition
- Multimodal recognition
- Reading
 - Pantic and Bartlett Article
 - Handbook of Affective Computing Chapter

Week 10 Emotion recognition (continued)

- Guest Lecture
- Recognizing Emotion in speech
- From recognition to understanding
- Reading: Shri Narayanan article in Transactions on Affective Computing

Week 11 Games and serious games

- Guest Lecture
- Discuss relationship between theories we've seen (appraisal; challenge/threat; flow)
- Introduce concept of achievement goals
- Introduce the "affective loop"
- Apply these concepts to educational and entertainment games
- Readings: ISolve journal article & Paiva Chapter in Handbook of Affective Computing & reading assigned by Guest Lecturer

Week 12 Personality and Culture

- Personality computing
- Review Lens model
 - Discuss automatic personality recognition, perception, synthesis
- Personality (and motivation) in computer games
- Limitations of personality computing approach

Week 13 Final project presentations

Week 14 Final project presentations

List of Class projects from 2015

- Combining EEG and facial expression signal processing to improve emotion recognition
- Using machine learning to derive models of human negotiation behavior
- Video Game Behavior as a Tool for Personality Assessment
 - Deriving a computational model of personality from game data that predicts behavior
- Quantitative Assessment of Socio-affective Dynamics in Autism Using Interpersonal Physiology
- Accuracy in detecting emotion expressions from older faces
 - Analysis of automated facial expression recognition software accuracy on young versus old faces
- Acquiring data to learn a model of facial expression dynamics for more realistic expression synthesis
- Evaluate Facial feedback hypothesis using EEG signal
- Game to improve emotion regulation skills
- Building a Virtual Environment to Study Oppression
 - Study nonverbal influences on feelings of oppression
- SpeakWatch: Collecting Real World Affective Information via Long Duration Voice Recording
 - Tracking and analyzing user prosody over the course of the day
- Embodied cognition and the design of game mechanics

Available Software Tools

The following software tools may be available for use by students as part of their project. Some are publically available for download. Others are more restricted.

General Toolkits

□ Virtual Human Toolkit: contains a number of sensing, language and synthesis tools (<https://vh toolkit.ict.usc.edu/>)

General Behavior Generation Systems

- SmartBody – character animation system (a version is available as part of VH toolkit but ask Stacy)
- NVBG – Nonverbal Behavior Generation System (available as part of VH toolkit – also talk to Stacy)
- Cerebella – behavior generation system (talk to Stacy)

General audio annotation

- MIR toolbox for matlab - extracts several audio features – designed for music analysis but more generally applicable
- Link: <https://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/mirtoolbox>

Affective Sensing

- MultiSense – multimodal sensing framework available as part of VH toolkit
- (<http://mplab.ucsd.edu/~marni/Projects/CERT.htm>)
- OKAO – Reliable smile detector
- GAVAM – head pose estimation from webcam available as part of VH toolkit
- Open Ear – acoustic signal processing (<http://sourceforge.net/projects/openart/>)
- The AAM-FPT (Active Appearance Model-based Facial-point Tracker) can be used to track 40 characteristic

facial points (<http://sspnet.eu/2011/03/aam-fpt-facial-point-tracker/>)

- BoRMaN – detects 20 facial points (<http://ibug.doc.ic.ac.uk/resources/facial-point-detector-2010/>)

Cognitive modeling

- PsychSim multi-agent system with Theory of Mind reasoning (ask Stacy)
- microEMA – a prolog implementation of a subset of the EMA computational model of emotion

- FAtiMA – an architecture for construction appraisal-based agents

(<http://sourceforge.net/projects/fatima-modular/files/>)

- NPC-Editor-Query-answering system that can generate appropriate natural language utterances in

response to questions. (part of Virtual Human Toolkit)

Affective speech generation

- Emofilt is an open source program to simulate emotional arousal in speech written in Java It is largely customizable with an interface to develop own rules and even own modification algorithms. (<http://emofilt.syntheticspeech.de/>)
- MARY TTS is an open-source, Text-to-Speech Synthesis platform in Java. A special focus is on exploring the range of options available to control the expressivity of the synthetic voice (<http://mary.dfki.de/>)

Affect analysis

- The Social Signal Interpretation (SSI) framework offers tools to record, analyze and recognize human behavior in real-time, such as gestures, mimics, head nods, and emotional speech. It supports streaming from multiple sensors and includes mechanisms for their synchronization.

Systems

- RapportAgent – recognizes nonverbal conversational behaviors and generates positive listening behaviors (available as part of VH toolkit)

Data bases

□ Ask and we can try to track down some

Annotation Tools

- GTrace (General Trace program) allows users to play a video of a person and create 'traces' which show how the person's emotions appear to be changing over time.
<https://sites.google.com/site/roddycowie/work-resources>
- CowLog – a video annotation tool (<http://cowlog.org/download/>)
- ELAN – another video annotation tool (<http://tla.mpi.nl/tools/tla-tools/elan/>)

Scales: various psychological instruments have been developed to measure self-reported affect. I can point you to where to find these

- PANAS: measures positive/negative affect
- PCL-C: measures depression
- Ways of Coping: measures coping styles
- Emotion regulation scale
- SAM: dimensional self-reported emotion measure

- Social Value Orientation: measure of cooperative/competitive tendencies

Other resources

HUMAINE Association (<http://emotion-research.net/>): see Toolbox and Databases Social Signal Processing Network (<http://sspnet.eu/>): see especial RESOURCES tab