Updated: March 12, 2025

Affective Computing CSCI534: An interdisciplinary approach

Spring 2025

Course Objective:
This course provides a comprehensive and interdisciplinary introduction to Affective Computing: i.e., computing that relates to, arises from, or deliberately influences emotions. It overviews the theory of human emotion (how it arises from and influences cognition, the body, and the social environment), techniques for recognizing and synthesizing emotional behavior, and illustrates how these can be applied to application design. The course is suitable for non-computer science students with some familiarity with computational methods. Students will gain a strong background in theory and practice in human-centered computing as it relates to decision-making, health, entertainment and pedagogy.

Instructor:	Jonathan Gratch
TA:	James Hale <jahale@usc.edu)
Date/Time:	Mon, Wed 2:00-3:50p (DMC 156); "office" hours, Thur 230-330
Piazza:	https://piazza.com/usc/spring2025/csci534
Grades:	Grades determined by class participation 10%, mid-term project presentation 15%, homework 40%, final project presentation. 15%, final project writeup 20%
	See Late homework policy. See Policy on the use of GenAI

Class participation is expected and part of the grade. Lectures frequently involve participatory demonstrations and exercises. Thus, students are expected to attend class and participate in in-class activities. **Lectures are not recorded.** You will lose participation grade if you miss these exercises unless you inform me in advance.

The course is project-based. Students are expected to work in teams (of approximately 5 students) to develop, execute, and present a research project. Students are encouraged to build upon existing tools. A list of some pre-existing software tools available to students and summaries of some prior student projects built with these tools can be found HERE. Project guidelines can be found HERE.

Source book: Oxford Handbook of Affective Computing (OHAC): useful but becoming dated.

Other useful books: ACM Handbook on Social Agents (AHSIA); Oxford Handbook on Affective Science and ACM's Applied Affective Computing

Software: Students will gain knowledge and/or hands-on experience with the following software tools related to affective computing including:

- Emotion Recognition Techniques
- Emotion Synthesis Techniques
- Cognitive and Emotional Modeling
- Algorithms and tools that support the above methods
- Human-subjects experimental design and analysis
- Ethical issues in AI

Note to Instructors: Other instructors are welcome to use these course materials. Please acknowledge the original source in footer of slides. Note some slides have been borrowed from other instructors as noted in the footers of presentation material.

Course Outline

(WARNING: This may change throughout the semester). Most current version will be HERE. Don't get more than 1 week ahead on readings. The same topics will be presented but changes to reading lists and homework may occur.)

Lecture 1 (Mon, Jan 13) Course Overview. Introduction to Affective Computing

- Review the structure of the course
- What is affective computing? Overview of applications
- Broadly overview functions of affect and why of interest to computer science
- Discussion of Ethics / AI Act
- **Homework 1**: **Emotion prediction (all homework will be posted on brightspace):** Estimated time, 30-40 min, Due Wed, Jan 15th, 11:59p (encouraged to complete before Lecture 2)
- Readings:
  - Gratch 2021: The field of Affective Computing: An Interdisciplinary Perspective
- Optional background readings:
  - OHAC, Chapter 1. Summarizes major topics in affective computing
  - The rise of *affectivism*. article illustrating the growing importance of affective science
  - Tutorial on the EU's AI Act and consequences for affective computing
- Lecture slides

Lecture 2 (Wed, Jan 15) Emotion Theory:

- Define affective phenomena (emotion, mood, attitude/sentiment, personality)
- What is emotion theory and why does it matter? Review alternative theories
- **Homework 2 (part 1): Short appraisal experiment** (Due Thur, Jan 16th,11:59pm): Estimated time, <10minutes
- Suggested Reading:
  - OHAC, Chap 3. Short history of psychological perspectives on emotion
- Optional reading:
  - The science of 'Inside Out': Short piece by Dacher Keltner and Paul Ekman about the Pixar movie
- Lecture slides

Martin Luther King's Birthday (Mon, Jan 20th)

PART I: EMOTION ELICITATION

Lecture 3 (Wed, Jan 22) Theories of emotion elicitation (what triggers emotion?)

- Discuss theories of what causes emotion in people
- Appraisal theories, Constructivist theories
- **Homework 2 (part 2): Appraisal modeling** (Due Jan 27th, 11:59pm)
- Suggested Reading
  - OHAC, Chap 5. Discussion of appraisal theory and its influence over computational models.
- Lecture slides

Lecture 4 (Mon, Jan 27) Models of emotion elicitation I

- Discuss computational approaches to predict and model emotion elicitation
- Suggested Reading:
  - Marsella and Gratch (2009), sections 1.1, 1.2, 2 and 3: describes model of "the Bird"
- Optional reading:
  - Emotional Calculator: a short description of how the Emotion Calculator (HW1) was created
  - Emotion Profiler: a published paper describing how the emotion profiler works (here they call it the "Emotion Analyst" but it is the same thing).

- Lecture slides

Lecture 5 (Wed, Jan 29) Models of emotion elicitation II

- Discussion of reinforcement learning and LLM approaches to appraisal modeling
- Discuss framework for evaluating success of a computational model
- **Homework 3 (part 1): Short experimental survey to motivate Lecture 6** (Due Jan 30th, 11:59p)
  chance to earn some extra credit
- **Homework 4 (part 1): Short decision-making experiment** (Due Feb 2nd, 11:59p)
- Suggested Reading:
  - Marsella, Gratch and Petta (2010): reviews modeling research. Focus on pp. 31-40.
- Optional reading:
  - Moerland et al. (2018): Survey of Emotion in Reinforcement Learning
  - Tak and Gratch (2023): Is GPT a computational model of emotion?
- Lecture slides

Lecture 6 (Mon, Feb 3) Experimental Design, Methodology and Analysis

- Reading:
  - SparkNotes reading on Research Methods in Psychology, a good summary of research methods. You have to click through each section separately to read.
- **Homework 3 (part 2): Experimental design** (Due Feb 6, 11:59p)
- Recommended Reading
  - AHSIA, Chapter 2: Introduction to empirical methods for social agents
  - Its only a computer: This study will be discussed as part of lecture
- Lecture slides

PART II: CONSEQUENCES OF EMOTION

Lecture 7 (Wed, Feb 5) Cognitive consequences of emotion

- Review rational choice theory (decision theory)
- Contrast between rational models and human decision-making
- Suggested Reading:
  - Lowenstein and Lerner 2003, p620-633. You should understand figure 31.1
- Strongly encouraged:
  - Watch NOVA's "Mind over Money"
- Optional Reading:
  - Lerner video interview: Outlines alternative theories of emotion
  - Mellers et al 1999: A model of how emotions shape decisions – we will discuss in class
- Lecture slides

Lecture 8 (Mon, Feb 10) Physical consequences of emotion I (the brain)

- Overview of physiological and brain Computing
- Focus on some affective computing approaches to brain measurement
- **Homework 4 (part2): Decision modeling** (Due Feb 17th, 11:59p)
- Suggested Reading:
  - Fairclough 2009 – Fundamentals of Physiological Computing
- Optional Reading:
  - OHAC, Chap 15: Discusses affective brain-computer interfaces
  - Davidson et al. 2003: Reviews some neuroanatomy of emotion
  - Arani et al., 2015: Example of using fNIRS for affective computing.
- Outside resource: Brain-Computer Interface Tutorial
- Lecture slides

Lecture 9 (Wed, Feb 12) Group project discussion

- **Project Descriptions Due:** 1 paragraph project description and final team list (Due Feb 19, 11:59pm)
- Discussion of group projects. Explore topics and tentative teams
- Expect students to sit in tentative groups. Use class time to develop your ideas. I will meet each group during class. I expect short "pitches" and will give feedback

President's Day (Mon, Feb 17)

Lecture 10 (Wed, Feb 19) Physical consequences of emotion II (physiology)

- Overview psychophysiological impacts of emotion
  - Review biopsychosocial model of challenge / threat
  - Review physiological manifestation of coping responses
  - Discuss cardiovascular measures of emotion and coping
- Reading:
  - Blascovich & Mendes 2010: Reviews psychophysiological findings**.** Only required to read following sections:
    - Neurophysiological systems, advantages & Indices (p199-203)
    - Uses [affect, attitudes, emotion] (p 210-215)
- Optional Reading:
  - OHAC, Chap 14: Reviews physiological sensing of emotion
- Lecture slides

Lecture 11 (Mon, Feb 24) Physical consequences of emotion III (Motor system)

- How emotion is manifest in observable signals.
- How these signals can feedback (Embodied theories of emotion)
- Reading: Niedenthal 2007: Discusses embodied approaches to emotion
- Optional Reading:
  - Mahfoudi et al. 2023. A survey of automatic emotion recognition based on body movement analysis
  - Olugbade et al 2022: List of human movement datasets
- Lecture slides

Lecture 12 (Wed, Feb 26) Emotion Regulation

- How people regulate their own emotions and AI methods to improve this
- **Homework 5: Physiological analysis** (Due Mar 3rd, 11:59p)
- Reading: Emotion regulation for HCI (Slovak et al. 2022)
- Lecture slides

Lecture 13 (Mon, Mar 3) Group Project Proposal Presentations

- Students will give 5min presentations of their project

PART III: Machine Emotion

Lecture 14 (Wed, Mar 5) Machine expression of emotion

- How, why (and should) machines convey they are experiencing emotion
- Segue to social emotions: Distinguish realistic vs. communicative approaches
- Expression synthesis techniques
- **Homework 6: Facial expression analysis** (Due Mar 13th, 11:59pm)
- Suggested Reading:
  - The social function of machine emotional expressions
  - OHAC, Chapter 18, Section 2 only; Digital expression synthesis

    - OHAC, Chapter 21, Section 3 only; Robotic expression synthesis
- Optional Reading:
    - OHAC, Chapter 20; Emotional speech synthesis
    - OHAC, Chapter 19; Gesture & postures synthesis
- Lecture slides

Lecture 15 (Mon, Mar 10) Emotion Recognition I: Emotion in Text Lecture 14 (Wed, Mar 1)

- Reading: OHAC, Chapter 13; Recognizing affect from text
- Lecture slides

Lecture 16 (Wed, Mar 12) Emotion Recognition II: Emotions in the face and body

- Impact of context in emotion recognition
- Reading: OHAC, Chapter 10; Face expressions
- Optional Reading: Bin Lu, Web Data Mining Chap11
- Optional Reading: Barrett et al 2011; Contextual influences on emotion perception
- Lecture slides

SPRING BREAK (Mar 16-23)

Lecture 17 (Mon, Mar 24) Emotion Recognition III: Emotion in speech

- **Homework 7 (part 1): Game theory experiment** (Due Mar 25, 11:59p)
- Emotion in speech
- Reading: OHAC, Chapter 12; recognizing affect from speech
- Lecture slides

Lecture 18 (Wed, Mar 26) Emotion Recognition IV: Multimodal recognition

- Multimodal techniques and machine learning
- **Homework 7 (part 2): Behavior game theory and emotional manipulation** (Assigned March 27, Due Apr 1, 11:59p)
- Recommended Reading: Baltrušaitis et al 2018: Survey of Multimodal ML approaches
- Optional Reading: D'Melo et al 2015: Another survey of MM ML approaches
- Lecture slides

PART IV: SOCIAL EMOTIONS

Lecture 19 (Mon, Mar 31) Emotion and Social Interaction I

- How social goals shape emotion elicitation and consequences
- Review behavioral game theory as a computational framework
- Consider how AI can shape social goals (AFOSR)
- Reading: Game Theory Introduction, p1-11
- Optional Reading:
    - Behavioral Game Theory (from handbook on judgment and decision-making)
    - Fehr and Schmidt on other-regarding preferences
- Lecture slides

Lecture 20 (Wed, Apr 2) Emotion and Social Interaction II

- How expressions of emotion shape emotion elicitation and consequences
    - Emotion as contagion
    - Emotion as social information (Reverse Appraisal Theory)

- Computational Models: Affect Control Theory
- **Homework 8 (part 1): Negotiation experiment** (Due Apr 3, 11:59pm)
- Reading: de Melo et al 2014, introduction, exp1, and general discussion: describes "reverse appraisal"
- Optional Reading: Affect Control Theory
- Optional Reading: Keltner and Haidt 1999: discusses social functions of emotions
- Lecture slides

Lecture 21 (Mon, Apr 7): Emotion and Social Interaction III

- Social regulation and Social-functional theories of emotion expression
- Emotional Labor
- Role of affective computing in emotional labor
- **Homework 8 (part 2): Emotion and Negotiation** (Due Apr 13th, 11:59pm)
- Optional Reading: Scarantino, 2017: Gives nice review of theories of facial expressions and proposed model of emotion displays as "speech acts"
- Lecture slides

Lecture 22 (Wed, Apr 9): Emotion and Social Interaction IV: Persuasion and Deception

- Negotiation as a challenge problem for affective computing
- Manipulative emotions
- Optional Reading:
  - Chawla et al 2023: Survey of Social Influence dialog systems
  - Okekalns2015: How emotions shape negotiation
  - Gratch et al 2015: the misrepresentation game
- Lecture slides

PART V: INTERACTION AND OTHER TOPICS

Lecture 23 (Mon, Apr 14): Rapport and Social Interactivity

- Emotional feedback and attunement
- Rapport agent. Review learning approaches.
- Optional Reading: Gratch 2023: Discusses how virtual humans can help study interaction
- Optional Reading: Parkinson 2014: reviews theories of social emotions
- Optional Reading: Tutorials on nonlinear methods
- Lecture slides

Lecture 24 (Wed Apr 16) 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
- Sacred values and Moral decision making
- **Homework 9: Algorithmic Bias** (Due Apr 21st, 11:59pm)
- Optional Reading:
  - Haidt and Graham 2007: review of moral foundation theory
  - Vinciarelli and Mohammadi 2014: survey of personality computing
  - Yee et al 2011: expression of personality in World of Warcraft
  - Connelly and Ones 2010: Discusses limits of personality approach
- Lecture slides

Lecture 25 (Mon, Apr 21) Aesthetic Emotions

- Discuss techniques to classify the "emotion" of music. Recommender systems
- Optional Reading: Juslin 2013: Unified theory of musical emotions
- Optional Reading: Yang and Chen 2012: Review of emotion recognition in music
- Optional Reading: Renfrow et al 2011: Five-factor labeling scheme for music
- Lecture slides

Lecture 26 (Wed, Apr 23) Bias and Ethics of Affective Computing

- Discuss theories of how social machines might help or hinder human social interactions
- Potential for Bias
- Discuss ethical frameworks
- Reading: OHAC, Chapter 14
- Optional Reading: Robot sex: discusses ethics of building robots that have relations with people
- Optional Reading: Turkle 2010: Discussion of robot companions
- Lecture slides

Lecture 27 (Mon, Apr 28) Final Project Presentations

Lecture 28 (Wed, Apr 30) Final Project Presentations

May 5: Final project writeup due

Late Homework Policy

Homework is expected to be turned in on time. Many of the assignments elicit data needed by the class for subsequent assignments. I remove 10% if an assignment is late and an additional 10% for every two days it is still not turned in. If you enroll in the class late (after an assignment is due), there is no penalty but coordinate with me on new due dates. I will waive penalties if you have a verified emergency or inform me in advance of a complication (e.g., job interview).