

Affective Computing: An interdisciplinary approach

Summer 2023

Course Objective:

This course provides a comprehensive and interdisciplinary introduction to the topic of Affective Computing: i.e., computing that relates to, arises from, or deliberately influences emotions. This course 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 adopts an interdisciplinary perspective and is suitable for non-computer science students with some familiarity in computational methods. Students will gain a strong background in the theory and practice in human-centered computing as it relates to decision-making, health, entertainment and pedagogy.

Instructor: [Jonathan Gratch](#)

TAs Seoyoung Kang <sy1009kang@kaist.ac.kr>, Seonji Kim <mikosun97@kaist.ac.kr>

Date/Time: Mon-Fri 09:00-12:00

Location: : N25 3229 백남준홀 (Offline)

Class participation is expected. Lectures often involve demonstrations and exercises that involve group participation. I will occasionally give take-home exercises that will serve as discussion points in class. Thus, students are expected to attend class and participate in class activities.

Source book: [Oxford Handbook of Affective Computing](#) (OHAC): useful but not required.

Other useful books: ACM [Handbook on Social Agents](#) (AHSIA); Oxford [Handbook on Affective Science](#)

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 based on feedback from earlier lectures**). Most current version will be [HERE](#).

Homework 1: Emotion exercise. To be completed in advance of first class ([DOWNLOAD HERE](#))

Lecture 1a (Mon, Jul 24): Course Overview. Introduction to Affective Computing

(NOTE: As this is a condensed course, each day consists of 2 lectures separated by a brief intermission. Each lecture has its own topic, slides, and readings. Slides will be posted before the start of class)

- Review the structure of the course
- What is affective computing?
- What is theory and why does it matter?
- Broadly overview functions of affect and why of interest to computer science
- Overview applications that involve affective computing
- Suggested reading:
 - Gratch 2021: [The field of Affective Computing: An interdisciplinary Perspective](#)
- Optional readings:
 - [OHAC, Chapter 1](#). Summarizes major topics in affective computing
 - [The rise of affectivism](#). article illustrating the growing importance of affective science
 - [OHAC, Chap 3](#). Short history of psychological perspectives on emotion
 - [The science of 'Inside Out'](#): Short piece by Dacher Keltner and Paul Ekman about the Pixar movie
- [Lecture slides](#)

INTERMISSION: emotion elicitation experiment (Click [THIS LINK](#) when prompted in class. Not before)

Lecture 1b: Experimental Design, Methodology and Analysis

- Review of basic experimental design and analysis methods
- Annotation, interrater reliability
- Suggested Reading:
 - SparkNotes reading on [Research Methods in Psychology](#), a good summary of research methods. You have to click through each section separately to read.
- Optional readings:
 - [AHSIA, Chapter 2](#): Introduction to empirical methods for social agents
 - [Its only a computer](#): This study will be discussed as part of lecture
 - [Can Large Language Models Transform Computational Social Science?](#)
- [Lecture slides](#)

PART I: EMOTION CAUSES

Lecture 2a (Tue, Jul 25): Theories of what triggers emotion

- **Homework 2: Decision-making exercise to be completed before start of lecture 3 ([CLICK HERE](#))**
- **IN CLASS EXERCISE 1:** ([CLICK HERE](#) when prompted)
- Appraisal theories
- Dual-process theories of emotion
- Constructivist theories
- Optional Reading
 - [OHAC, Chap 5](#). Discussion of appraisal theory and its influence over computational models.
 - [Barrett \(2006\)](#). Discussion of constructivist theories
- Lecture slides

INTERMISSION:

- **IN CLASS EXERCISE 2:** ([CLICK HERE](#))

Lecture 2b: Computational models of emotion causes

- Discuss ways to make machines “have” emotions
- Introduce Computational Appraisal Theory
- Suggested reading:
 - [Marsella, Gratch and Petta \(2010\)](#): reviews modeling research. Focus on pp. 31-40
- 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).
 - [Moerland et al. \(2018\)](#): Survey of Emotion in Reinforcement Learning
 - Tak and Gratch (2023): Is GPT a computational model of emotion?
- Lecture slides

PART II: EMOTION CONSEQUENCES

Lecture 3a (Wed, Jul 26): 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
- Optional reading:
 - Watch NOVA’s “[Mind over Money](#)”
 - [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 3b: Physical consequences of emotion I (the brain)

- Overview of physiological and brain Computing
- Focus on some affective computing approaches to brain measurement
- 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 4a (Thur, Jul 27) Physical consequences of emotion II (peripheral 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
- Suggested reading:
 - [Blascovich & Mendes 2010](#): Reviews psychophysiological findings. Only 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 4b: Physical consequences of emotion III (Motor system)

- How emotion is manifest in observable signals.
- How these signals can feedback (Embodied theories of emotion)
- Suggested reading: [Niedenthal 2007](#): Discusses embodied approaches to emotion
- Optional Reading:
 - [Zacharatos et al. 2014](#). A survey of automatic emotion recognition based on body movement analysis
- Lecture slides

Lecture 5a (Fri, Jul 28) Emotion Regulation

- **Homework 3: due Monday night: Game theory**
- **IN CLASS regulation exercise**
- Gross' Process model' Computational methods to measure or shape regulation
- Suggested reading:
 - Emotion regulation for HCI: <https://arxiv.org/abs/2204.00118>
- Lecture slides

PART III: Machine Emotions

Lecture 5b: Emotion Recognition in text, face and body

- Suggested Reading:
 - [OHAC, Chapter 13](#); Recognizing affect from text
 - [OHAC, Chapter 10](#); Face expressions
- Optional Reading:
 - Bin Lu, [Web Data Mining Chap11](#)
 - [Barrett et al 2011](#); Contextual influences on emotion perception
- Lecture slides

Lecture 6a (Mon, Jul 31): Emotion Recognition in speech and multiple modalities

- Suggested Reading:
 - [OHAC, Chapter 12](#); recognizing affect from speech
 - [Baltrušaitis et al 2018](#): Survey of Multimodal ML approaches
- Lecture slides

Lecture 6b: Emotion Generation

- How (and why) machines can convey that they experiencing emotion
- Segue to social emotions: Distinguish realistic vs. communicative approaches
- Expression synthesis techniques
- Suggested Reading:
 - [OHAC, Chapter 18](#), Section 2 only; Digital expression synthesis
 - [OHAC, Chapter 21](#), Section 3 only; Robotic expression synthesis
- Optional Reading:
 - [Parkinson2008](#): Emotions in social interactions
 - [OHAC, Chapter 20](#); Emotional speech synthesis
 - [OHAC, Chapter 19](#); Gesture & postures synthesis
- Lecture slides

PART IV: SOCIAL EMOTIONS

Lecture 7a (Tue, Aug 1) Emotion and Social Interaction I

- **Homework 4: Short negotiation experiment** (Due before class Wednesday)
- How social goals shape emotion elicitation and consequences
- IN CLASS Exercise
- Review behavioral game theory as computational framework
- Consider how AI can shape social goals
- 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
 - FAST current opinions
- Lecture slides

Lecture 7b: 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
- 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 8a (Wed, Aug 2) Emotion and Social Interaction III

- Social regulation and Social-functional theories of emotion expression
- Emotional Labor
- Role of affective computing in emotional labor
- Optional Reading: [Scarantino, 2017](#): Gives nice review of theories of facial expressions and proposed model of emotion displays as “speech acts”
- Lecture slides

Lecture 8b: Emotion and Social Interaction IV: Deception and Manipulation

- Negotiation as a challenge problem for affective computing
- IN CLASS Negotiation
- Manipulative emotions
- Optional Reading:
 - [Okekalns2015](#): How emotions shape negotiation
 - [Gratch et al 2015](#): the misrepresentation game
- Lecture slides

PART V: OTHER TOPICS

Lecture 9a (Thur, Aug 3) Rapport and Social Interactivity

- Emotional feedback and attunement
- Rapport agent. Review learning approaches.
- **Homework 5: Algorithmic Bias** (Due TONIGHT!)
- Optional Reading:
 - [Gratch 2023](#): Discusses how virtual humans can help study interaction
 - [Parkinson 2014](#): reviews theories of social emotions

- [Tutorials on nonlinear methods](#)
- Lecture slides

Lecture 9b: 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
- 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 10a (Fri, Aug 4) 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 10b: 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