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CS 6795: Cognitive Science
Spring 2022
Ashok Goel
Course Description and Syllabus

Description: CS 6795 is a 3-credit graduate introductory course on cognitive science. Cognitive science is an interdisciplinary study of mind and intelligence. The core question is *how does mind work? That is, how does mind produce intelligent behavior?*

Cognitive science lies at the intersection of computer science (especially artificial intelligence), psychology, biology (especially neurobiology), education, linguistics, anthropology, and philosophy, as indicated by this logo of the Cognitive Science Society (https://cognitivesciencesociety.org/):

From the Georgia Tech course catalog: "Multidisciplinary perspectives on cognitive science. Interdisciplinary approaches to issues in cognition, including memory, language, problem solving, learning, perception, and action."

Like the in-person version (CS 6795), this course is heavily project-based including both guided and self-directed projects. It will consist of series of twenty nine video lessons; thirty two reading assignments; thirteen quizzes; six small group exercises; two short guided team projects, and one self-directed team project. Unlike the on-campus class, this (OMSCS 6795) class is fully online and asynchronous, with the video lessons and the online discussion forum replacing the in-person classes. However, the TAs will hold online office hours at specific times.

Prerequisites: An open and inquisitive mind! An aptitude for reading! An aptitude for self-directed, project-based and collaborative learning. Also, some background in basic computer science and programming such as data structures and algorithms. Note again that this course requires substantial reading and writing, as well as considerable investment of time.

Learning Goals: The main learning goal of the course is an introduction to the basic concepts, hypotheses, models, methods, issues and debates in cognitive science. Specific objectives include: (1) Introduction to the main information-processing paradigms in cognitive science as well as the main critiques of the paradigms, (2) Introduction to the central questions, topics, themes and perspectives that drive the study of cognitive science, including their historical development as well as the state of the art, (3) Understanding the variety of methodologies used to explore cognitive science, including the capabilities and limitations of different research methods, and (4) Learning about the relationship between cognitive science and computing, including human-centered computing, design, and educational technology.

Learning Outcomes: By the end of the course, the typical student should know enough about cognitive science to: (1) Understand and participate in scholarly conversations on cognitive science, (2) read and understand the cognitive science literature, (3) take advanced courses in cognitive science, (4) take the cognitive science specialization in the Georgia Tech Ph.D. qualifying examination in human-centered computing, (5) analyze and address problems in human-centered computing from a cognitive science perspective, and (6) conduct research into cognitive science.

Learning Strategies: We will use a wide range of learning strategies to accomplish the above learning goals and outcomes, including learning by example, learning by doing, authentic learning, project-based learning, personalized learning, collaborative learning, peer-to-peer learning, learning by teaching, learning by reflection, and immersion in a community of interest. Much of the learning in this class will be self-directed.

Learning Assessments: We will use a wide variety of learning assessments to evaluate the learning outcomes in this class, including quizzes, small group exercises, two guided projects, and one self-directed project. The various projects will involving writing of project reports.

Instructor:
Ashok Goel:
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Teaching Assistants:

Head TA:
Irene Ng
lng6@gatech.edu

TA for the two guided projects:
Sungeun (Sung) An
Sungeun.an@gatech.edu

TA for the Self-Directed Team Research project:
Qiaosi (Chelsea) Wang
qswang@gatech.edu

Grading TA:
William Hudgins
wkhudgins@gatech.edu

The teaching team may also consist of one or more AI TAs.

Office Hours:
There will not be any formal office hours held during the semester, but students may request meetings with the (human) teaching assistants as needed. Otherwise, please direct all questions to the course discussion forum.

Textbooks: The primary textbook is:

MIND, An Introduction to Cognitive Science, Paul Thagard, MIT Press, 2nd edition, 2005.

This is an easy to read book that offers a light but very useful introduction. It will provide a shared basis for our more advanced readings on selected topics. This book is available for free online:
http://users.metu.edu.tr/baykan/arch586/Readings/Cognition/Background/Thagard.pdf

Here are a few other general resources for cognitive science:
http://plato.stanford.edu/entries/cognitive-science/

http://en.wikibooks.org/wiki/Cognitive_Psychology_and_Cognitive_Neuroscience

Cognitive Science, Jay Freidenberg and Gordon Silverman, SAGE, 2016.
An earlier edition of this book is available online

http://www2.fiit.stuba.sk/~kvasnicka/CognitiveScience/Friedenberg_Cognitive%20science.pdf

The MIT Encyclopedia of the Cognitive Sciences
Robert Wilson and Frank Keil (editors)
MIT Press, 1999
http://www.aiai.ed.ac.uk/project/oplan/documents/1999/1999-MITECS.pdf

Readings: The accompanying class schedule specifies a series of reading assignments. We will provide digital copies of all readings. We expect that each student will have read at least the primary readings in the week they are assigned.

Reading a research paper is not easy and can take several hours. To make the process easier and more efficient, you want to read a paper in multiple passes. In the first pass, read only the title, abstract, the introduction, and the conclusions. This should be easy and fast, and will give you a gist of the paper. In the second pass, also read the section and subsection headings, the illustrations (figures, tables, and their captions), the discussion section, and browse through the list of references. This should give you a better understanding of the paper. In a third pass, if needed and/or if you want to, you can read the full paper. Here are some more tips on how to read a research paper:

https://web.stanford.edu/class/ee384m/Handouts/HowtoReadPaper.pdf

https://www.elsevier.com/connect/infographic-how-to-read-a-scientific-paper

Writing: Each student in the class will engage in six group exercises, two guided projects, and a semester-long self-directed project. All projects will entail the writing of a paper: the length of the paper will vary depending on the project. Here are two tutorials on how to write a term paper:
http://www.wikihow.com/Write-a-Term-Paper
http://www.collegeonline.org/library/online-assignments/termpaper-writing.html

We encourage all students to think of the semester-long self-directed team project as potentially leading to a paper worthy of publication. Here is the IEEE template for writing papers:
https://www.ieee.org/conferences/publishing/templates.html

Canvas site: The Head TA will maintain a Canvas site for the class that will provide information about the course, assessments, and grades. The Head TA will also maintain the discussion forum.

Class Participation: This class requires strong participation in the class through the online discussion forum and completion of class surveys.

Quizzes: We will have a quiz almost every week for a total of thirteen quizzes. Each quiz will consist of one short question. The expected answer likely will be in the form of a short paragraph. The quizzes will be directly from the primary readings and are intended to make sure that all students are doing the readings.

Group Exercises: We will have six small group exercises. Each of the six group exercises will also pertain to the readings in the class. The TAs will help form groups of ~4 students each. Each of the groups will produce a short (2-3 page) report on the exercise. The membership of a group may vary from one exercise to another.

VERA Team Projects: Small teams of students will do two related guided team projects on scientific cognition. The TAs will help form groups of ~4 students The learning goals in these projects include (a) learning about cognitive science theories of a cognitive phenomenon with which all of us are familiar (scientific cognition), (b) understanding how the cognitive science theory results in the design, development and deployment of an interactive AI-based learning environment (called VERA) for augmenting human cognition, (c) design of cognitive science experiments for studying the cognitive phenomena of guided learning, self-directed learning, and transfer learning, (d) using mixed methods (qualitative as well as quantitative) for analyzing the results of a cognitive science experiment, and (e) reflection on and critique of the above. The first project will result in a brief report of 5-6 pages long; the second in a report 10-12 pages long. We will provide details with the release of the project. TA Sung An will work with the students in helping them with the guided projects.

Self-Directed Team Project: The semester-long self-directed team project will actually unfold over 12 weeks. Students will form teams of 3 to 5 students each (the TAs will help). Each team will investigate a topic of its choice. We expect a team of 3 students to spend at least 180 person hours on the project including at least a detailed analysis of a problem from the perspective of cognitive science and survey of the related literature. We expect a team of 4 students to spend at least 240 person hours on the project including conducting a cognitive science experiment. We expect a team of 5 students

to spend at least 300 hours on the project including the building of a small computational "proof-of-concept" system for the task. TA Chelsea Wang will work with the students in helping them with their self-directed team projects. To keep track of students' progress, we will have 4 milestones 3 weeks apart; we will provide details as part of the project release. We expect some of the term project reports to be of a quality that can be submitted to professional workshops for potential publication.

Peer assessments: A common complaint in some team projects is that one or more teammates did not do enough work. We will hold confidential peer assessments for evaluating the contributions of teammates on the group exercises and the self-directed team project. We will have a total of 12 peer assessments (6 group exercises, 2 guided team projects, and 4 milestones for the team project). The peer assessments will impact students' grades.

Examinations: There are no examinations in this class.

Assignment Due Dates: All assignments are due at 11:59:00pm EST, unless otherwise noted. All assignments are due relative to the Eastern Standard Time Zone (EST). Eastern Standard Time is UTC -5. Eastern Daylight time is UTC -4. We will not accept assignments submitted late due to time zone issues. You should update your canvas to account for EST if you are in a different time zone. There are no exceptions; sorry.

Late and Make-up Work Policy: There will be no make-up work provided for missed assignments. Of course, emergencies (illness, family emergencies) will happen. In those instances, please contact the Dean of Students office. The Dean of Students is equipped to verify emergencies and pass confirmation on to all your classes. For consistency, we ask all students to do this in the event of an emergency.

Grades: Here is a distribution of weights for different activities for calculating the final grade.
Participation in the discussion forum: 5%
Participation in the class surveys: 5%
Quizzes: 10%
Group exercises: 15%
VERA projects: 30% (P1 is 10%, P2 is 20%)
Self-directed project: 35%

We will assign extra credit to exemplary group exercises, guided projects, and self-directed projects, and post them on Canvas. Thus, it is possible to get a score higher than 100% in this class.

The final grades will be normalized (or curved).

Honor Code: Learning is a social process. This is why encourage class participation. Thus, on one hand, we strongly encourage collaboration in this class. On the other, we will abide by the Georgia Tech's honor code of academic conduct. This means that any work submitted by a student must be his or her own. With the advent of the internet, it has become easy to take materials from various resources available on the web. But please remember that it has also become easy to check for it: the TA can and will enter an arbitrary sentence from a paper into a search engine and find out if the sentence has been taken from elsewhere. Students are encouraged to consult resources available on the web and elsewhere. However, any material taken from any resource must be properly attributed. The paper must reflect the student's own design and analysis, work and writing.

Georgia Tech Counseling: The COVID-19 global pandemic has caused many problems related to health, including mental health. Georgia Tech offers counseling services to all students, staff and faculty (https://counseling.gatech.edu/content/services). It also offers emergency counseling services (https://counseling.gatech.edu/content/students-crisis). It is for all of us to take care of one another as well as ourselves.

Ashok Goel
December 24, 2021

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Class Schedule

This is a day-by-day schedule for our class. The schedule specifies a series of video lessons and corresponding reading assignments. All readings are listed by the last names of the first author. All readings are available on Canvas in a digital form. We expect that each student will have watched the video lessons and read at least the primary readings on each topic in the assigned week.

The schedule also specifies the activities and assessments for each week: surveys, quizzes, group exercises, guided projects, self-directed projects, ~~and peer reviews~~ and peer assessments. Note also that all assessments are due on Sunday midnight AOE, which translates to Monday 8 am in Atlanta.

There will be five class surveys in all, including the final CIOS survey administered by Georgia Tech.

The quizzes are short questions (requiring only a short paragraph as an answer) based on the reading assignments. All thirteen quizzes will be based on the primary readings.

The group exercises too will be based on the primary readings. In group exercises, students will work in small groups of three to five students to address a problem or investigate a topic. There will be six group exercises in total.

The two guided projects will be based an interactive learning environment called VERA. The goal is to learn about the some of the cognitive science research methods.

In the self-directed team project, students will work in teams of three to five students on a theme/problem on their choice. The team project will unfold over 12 weeks, with 4 milestones 3 weeks apart.

Peer assessments refer to student assessing the contributions of their teammates on the group exercises and the self-directed team project. We will have a total of 10 peer assessments (6 group exercises, 2 guided projects, and 4 milestones for the team project). The peer assessments will impact students' grades.

Date	Topic	Primary Reading	Additional Readings

Part A of the course: Basics of Cognitive Science

Week of 1/10

Videos	Lesson 1	
	Lesson 2	
Readings	Representation -1	Thagard Ch. 1
	Logic, probability	Thagard Ch. 2
Activities	First class survey assigned 1/10, due 1/17	

Week of 1/17

Videos	Lesson 3	
	Lesson 4	
	https://www.youtube.com/watch?v=Rn5e9fWmPqI&list=PLwXogtSxXaLCP4AXU_VFUP92TVmotGLMv	
Readings	Rules -1	Thagard Ch. 3
	Concepts -1	Thagard Ch. 4
Activities	Quiz 1 assigned 1/17, due 1/24	
	Group exercise 1 assigned 1/17 (due 1/31)	

Week of 1/24

Videos	Lesson 5	
	Lesson 6	
Readings	Analogies -1	Thagard Ch. 5
	Images -1	Thagard Ch. 6
	Connections -1	Thagard Ch. 7
Activities	Quiz 1 due 1/24	
	Quiz 2 assigned 1/24, due 1/31	
	VERA project 1 assigned 1/24, due 2/7	

Week of 1/31

Videos	Lesson 7	
	Lesson 8	
Readings	Review of CogSci	Thagard Ch. 8
	Brains	Thagard Ch. 9

	Emotions	Thagard Ch. 10

Activities
Quiz 2 due 1/31
Quiz 3 assigned 1/31, due 2/7
Group exercise 1 due 1/31
Peer assessment for Group exercise 1 assigned 1/31, due 2/7
Group exercise 2 assigned 1/31, due 2/14
Self-directed team project assigned 1/31, Milestone 1 due 2/21

Week of 2/7

Videos
Lesson 9
Lesson 10

Readings	Consciousness	Thagard Ch. 11
	Body	Thagard Ch. 12
	Culture	Thagard Ch. 13
	Review	Thagard Ch. 14

Activities
Second class survey assigned 2/7, due 2/14
Quiz 3 due 2/7
Quiz 4 assigned 2/7, due 2/14
Peer assessment for Group exercise 1 due 2/7
VERA project 1 due 2/7
Peer assessment for VERA project 1 assigned 2/7, due 2/14

Part B of the course: Computational Cognitive Science

Week of 2/14

Videos
Lesson 11
Lesson 12

Readings	Explanations	Simon – Ch.1	Simon Ch. 5
	Information-processing levels	Marr	Newell

Activities
Second class survey due 2/14
Quiz 4 due 2/14
Quiz 5 assigned 2/14, due 2/21
Group exercise 2 due 2/14
Peer assessment for Group exercise 2 assigned 2/14, due 2/21
Group exercise 3 assigned 2/14 (due 2/28)
Peer assessment for VERA project 1 due 2/14

Week of 2/21

Videos	Lesson 13 Lesson 14		
Readings	Representation – 2 Concepts - 2	Markman Schank	Bechtel Nersessian
Activities	Quiz 5 due 2/21 Quiz 6 assigned 2/21, due 2/28 Peer assessment for Group exercise 2 due 2/21 Self-directed team project Milestone 1 due 2/21 Peer assessment for Self-directed team project Milestone 1 assigned 2/21, due 2/28		

Week of 2/28

Videos	Lesson 15 Lesson 16		
Readings	Analogies -2 Images - 2	Kolodner Larkin	Gentner Dehaene
Activities	Quiz 6 due 2/28 Quiz 7 assigned 2/28, due 3/7 Group exercise 3 due 2/28 Peer assessment for Group exercise 3 assigned 2/28, due 3/7 Group exercise 4 assigned 2/28 (due 3/14) Peer assessment for Self-directed team project Milestone 1 due 2/28		

Week of 3/7

Videos	Lesson 17 Lesson 18		
Readings	Cognitive Architectures Neural Networks	Laird, Libere, Rosenbloom Rogers	Langley Bengio
Activities	Quiz 7 due 3/7 Quiz 8 assigned 3/7, due 3/14 Peer assessment for Group exercise 3 due 3/7 VERA project 2 assigned 3/7 (due 3/21) Self-directed team project Milestone 2 due 3/14		

Peer assessment for Self-directed team project Milestone 2 assigned 3/14, due 3/21

Week of 3/14

Videos	Lesson 19 Lesson 20		
Readings	Embodied Cognition Distributed Cognition	Brooks Hutchins	 Grosz
Activities	Quiz 8 due 3/14 Quiz 9 assigned 3/14, due 3/21 Group exercise 4 due 3/14 Peer assessment for Group exercise 4 assigned 3/14 due 3/21 Group exercise 5 assigned 3/14 (due 3/28) Peer assessment for Self-directed team project Milestone 2 due 3/21		

Part C of the course: Cognitive Science and Human-Centered Computing

Week of 3/21

Videos	Lesson 21 Lesson 22		
Readings	Culture Relationship to AI	Tomasello Langley	Shore Goel
Activities	Third class survey assigned 3/21, due 3/28 Quiz 9 due 3/21 Quiz 10 assigned 3/21, due 3/28 Peer assessment for Group exercise 4 due 3/21 Guided project 2 due 3/21 Peer assessment for VERA project 2 assigned 3/21, due 3/28		

Week of 3/28

Videos	Lesson 23 Lesson 24		
Readings	Relationship to Learning Relationship to Design	Bransford Norman	Lave Simon

Activities Third class survey due 3/28
Quiz 10 due 3/28
Quiz 11 assigned 3/28, due 4/4
Group exercise 5 due 3/28
Peer assessment for Group exercise 4 assigned 3/28, due 4/4
Group exercise 6 assigned 3/28, due 4/11
Peer assessment for VERA project 2 due 3/28
Self-directed team project Milestone 3 assigned, due 4/4
Peer assessment for Self-directed team project Milestone 3 assigned 4/4, due 4/11

Week of 4/4

Videos Lesson 25
Lesson 26

Readings Relationship to Human-Computer Interaction Baron-Cohen
Relationship to Robotics Cakmak Fitzgerald

Activities Quiz 11 due 4/4
Quiz 12 assigned 4/4, due 4/11
Self-directed team project Milestone 3 due 4/4
Peer assessment for Group exercise 5, due 4/4

Week of 4/11

Videos Lesson 27
Lesson 28

Readings Relationship to Creativity Boden

Activities Quiz 12 due 4/11
Quiz 13 assigned 4/11, due 4/18
Group exercise 6 due 4/11
Peer assessment for Group exercise 6 assigned 4/11, due 4/18

Week of 4/18

Activities Quiz 13 due 4/18
Peer assessment for Group exercise 6, due 4/18

Week of April 25

Activities Fourth class survey due 4/25
Final Self-directed team project (Milestone 4) due 4/25
Peer assessment for Self-directed team Project Milestone 4 assigned 4/25, due 5/2
CIOS survey assigned 4/25, due 5/2

Week of May 2

Activities Peer assessment for Self-directed Team Project Milestone 4 due 5/2
CIOS survey due 5/2

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December 24, 2021

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