

Hello and welcome to CS 7637: Knowledge-Based AI.

Knowledge-based AI pertains to the issues of the content, representation, organization, acquisition, storage, retrieval, and use of knowledge for designing AI agents, as well as for understanding the design of human intelligence. For this reason, the course has a subtitle: cognitive systems. Knowledge-based AI is especially relevant to the longstanding goal to develop human-level AI. It is also relevant to the more modern movement to develop human-centered AI for augmenting and amplifying human intelligence.

### About this Course

CS 7637 KBAI is a core course in artificial intelligence. It is designed to be a challenging course, involving significant independent work, readings, assignments, and projects. It covers structured knowledge representations, as well as knowledge-based methods of problem solving, planning, decision-making, and learning. For additional information on the course, we invite you to read the following article:

<https://ojs.aaai.org/aimagazine/index.php/aimagazine/article/view/2732>

and watch the following video:

<https://www.youtube.com/watch?v=N56ghCGmWWQ>

### About the Teaching Team

The course instructor is Ashok K. Goel, a professor of computer science and human-centered computing in the School for Interactive Computing, and a Fellow of the Association for the Advancement of Artificial Intelligence.

The Head TA for the course is Kai Ouyang, a graduate of the OMSCS program. Co-Head TAs are Meredith Sanders and John Hameier. The teaching team also includes several other TAs: Alex Houk, Andrew Cho, Barbara Vanaki, Boyuan Liu, Brittney Exline, Fnu Farzana, Joewie Koh, J. Thomas, Karan Taneja, Melanie Duffin, Meredith Sanders, Michael Cohen, Michelle Adea, Mike Hagedorn, Olivia Hadlaw, Oscar Alba, Rebecca Johnson, Yaroslav Litvak, and Yeeling Lam.

### Competency

This course requires substantial programming as well as significant writing. To succeed in this course, you should be able to answer 'Yes' to the following questions:

- Are you confident with computer programming in Python (or Java)?
- Are you strongly familiar with basic concepts of data structures and object-oriented programming, such as inheritance and polymorphism?

- Are you strongly familiar with basic concepts of algorithm design, such as algorithms for sorting, searching, and matching?
- Are you comfortable with writing essays, totaling almost 20,000 words throughout the semester?
- Are you willing to deeply engage with your classmates through discussions on the Piazza forum, Peer Feedback, and sharing of exemplary assignments?
- Are you willing to work independently on challenging design, programming and reflection projects all on your own?
- Are you able to read papers on your own that go beyond the video lessons?
- Are you able to meet fixed deadlines for assignments with no possibility of any extension?
- Are you willing and able to spend significant amounts of time and energy on a regular basis to this course?
- Are you ready to adhere to the Georgia Tech code of academic conduct?

If your answer is not a strong “Yes” to all of these questions, this course may not be appropriate for you. If your answer is “No” to any of these questions, this course almost surely is not appropriate for you.

### **Learning Goals**

The class is organized around three primary learning goals. First, this class teaches the concepts, methods, and prominent issues in knowledge-based AI. Second, it teaches the specific skills and abilities needed to apply those concepts to the design of knowledge-based AI agents. Third, it teaches the relationship between knowledge-based artificial intelligence and the study of human cognition.

### **Learning Strategies**

This structure of this course is driven by several pedagogical motivations:

- **Learning by example:** Each topic is taught through examples of the way in which humans and artificial intelligence agents approach certain problems, often building from human thought toward AI agents and subsequently referring back to human cognition.
- **Learning by doing:** you will participate in the reasoning within each particular lesson, and subsequently tie the topic back to a broader problem.
- **Project-Based Learning:** This class has three projects, each of which build on the previous one, and the overall goals and motivations of KBAI are presented through these projects.

- **Personalization:** Individualized feedback will be given on your performance on the exercises, assignments, projects, and tests. Additionally, you are welcome and encouraged to proceed at your own pace throughout the lessons, including viewing them outside of the designed order to better align with your interests.
- **Collaborative Learning:** We encourage collaboration and the development of communities of practice surrounding the course material and projects. We are excited to see you borrow one another's ideas and build on them, as well as spin off your own study groups.
- **Peer-to-Peer Learning:** During this class you will give your peers feedback on their work on the same assignments you complete. This lets you see additional approaches to the problems, provides you extra feedback, and puts you in the position of a teacher and role reversal.
- **Self-Reflection:** At the conclusion of each lesson, we ask each student to reflect on what they learned in the class. Each design project requires the writing of a project reflection that explains and critiques, and reflects on the student's work on the project.
- **Authenticity:** The project that you will explore in this class is an open research question in the AI and Cognitive Systems research communities. Two students from our lab have completed dissertations working on these questions in the past two years, and we have had papers published on these topics within the past several months.

### Learning Outcomes

At the conclusion of this class, you will be able to accomplish three primary tasks. First, you will be able to design and implement a knowledge-based artificial intelligence agent that can address a complex task using the methods discussed in the course. Second, you will be able to use this agent to reflect on the process of human cognition. Third, you will be able to use both these practices to address practical problems in multiple domains. The journal article mentioned earlier provides a more detailed account of learning goals, strategies and outcomes of this course.

## Syllabus

## Course Assessments

Your grade in this class is generally made of five components: three homework assignments, five mini-projects, one large project, two exams, and class participation. Final grades will be calculated as an average of all individual grade components, weighted according to the percentages below. Students receiving a final average of 90 or above will receive an A; of 80 to 90 will receive a B; of 70 to 80 will receive a C; of 60

to 70 will receive a D; and of below 60 will receive an F. We do not plan to have a curve. It is intentionally possible for every student in the class to receive an A.

## Homework (15%)

You will complete three homework assignments in this course, each worth 5% (now 7.5% due to dropping your lowest HW grade) of your average. Each homework assignment will have two questions, which you will answer in around three pages each. These questions will cover the course material, as well as give you a chance to investigate cutting-edge AI research. You will be expected to do some outside research for some of these questions. All assignments should be written [using JDF \(Links to an external site.\)](#).

Your final grade will take your top two grades in this section into consideration.

## Mini-Projects (30%)

You will complete five mini-projects in this course, each worth 6% (now 10% due to drop of 2 lowest grade: 2 lowest mini journals, 2 lowest mini gradescope, can mix and match) of your average. Each mini-project asks you to implement some AI logic shown in the course lectures, although you are also welcome to attempt to solve the problems using other techniques. For each of the mini-projects, you will also provide a short write-up of your approach, mainly to share with classmates and look through others' approaches. These write-ups should be written [using JDF \(Links to an external site.\)](#). You'll submit the write-ups to Canvas and the code to Gradescope.

Your final grade will take your top 3 grades in this section into consideration.

## Raven's Project Milestones (15%) and Raven's Final Project (15%)

The semester-long project is the Raven's project, where you will write an agent that can solve problems on the Raven's Progressive Matrices test. For the project, you will complete four milestones throughout the semester, and then a final submission. The four milestones together are worth 15% of your average, and the final submission is worth another 15%. The milestones are there to ensure that you get started on the project early and have an opportunity to see your classmates' approaches. Each milestone, as well as the final project submission, is graded half on performance and half on a written report. These write-ups should be written [using JDF \(Links to an external site.\)](#). You'll submit the write-ups to Canvas and the code to Gradescope.

## Exams (15%)

Please see Canvas Quizzes Link for Exam Details

## Class Participation (10%)

One of the major strengths of large online classes is the way they allow students to have significant impact on their classmates' experiences. As such, 10% of your class grade and 10% of the time you spend on this class will be improving the course experience for other students. This is participation credit, and it can be earned in various ways, including forum participation, peer review, and course survey completion. There may be other mechanisms to earn participation points announced throughout the semester; check the course forum for that! More information can be found [here](#).

## Course Policies

The following policies are binding for this course.

### Official Course Communication

You are responsible for knowing the following information:

1. Anything posted to this syllabus
2. Anything emailed directly to you by the teaching team (including announcements via the course forum or Canvas), 24 hours after receiving such an email.

Generally speaking, we will post announcements via Canvas and cross-post their content to the course forum; you should thus ensure that your Canvas settings are such that you receive these announcements promptly, ideally via email (in addition to other mechanisms if you'd like). Georgia Tech generally recommends students to check their Georgia Tech email once every 24 hours. So, if an announcement or message is time sensitive, you will not be responsible for the contents of the announcement until 24 hours after it has been sent.

We generally prefer to handle communication via the course forum to help with collaboration among the teaching team, but we understand the course forum is not ideal for having information "pushed" to you. We may contact you via a private the course forum post instead of an email, but if we do so, we will choose to send email notifications immediately, bypassing your individual settings, in order to ensure you're alerted. As such, this type of communication will also spring under #2 above.

Note that this means you won't be responsible for knowing information communicated in several other methods we'll be using. You aren't responsible for knowing anything

posted to the course forum that isn't linked from an official announcement. You aren't responsible for anything said in Slack or other third-party sites we may sometimes use to communicate with students. You don't need to worry about missing critical information so long as you keep up with your email and understand the documents on this web site. This also applies in reverse: we do **not** monitor or Canvas message boxes and we may not respond to direct emails. If you need to get in touch with the course staff, please post privately to the course forum (either to all Instructors or to an instructor individually) or tag the instructor in the relevant post.

## Communicating with Instructors and TAs

Communication with the course teaching team should be handled via the discussion forum. If your question is relevant to the entire class, you should ask it publicly; if your question is specific to you, such as a question about your specific grade or submission, you should ask it privately.

Our workflow is to regularly filter the forum for Unresolved posts, which includes top-level threads with no answer accepted by the original poster, as well as mega-threads with unresolved follow-ups. If your question requires an official answer or follow-up from an instructor or teaching assistant, make sure that it is posted as either a Question or as a follow-up to a mega-thread, and that it is marked Unresolved. Once an instructor or TA has answered your question, it will automatically be marked as Resolved; if you require further assistance, you are welcome to add a follow-up, but make sure to unmark the question as Resolved in order to make sure that it is seen by a member of the teaching team.

Similarly, in order to keep the forum organized, please post as a Post or Note instead of a Question if your question does not require an official response from the teaching team. For example, if you are interested in getting multiple perspective from classmates, getting feedback on your ideas, or having a discussion that does not have a single answer, please use Post or Note instead of Question. Please reserve Question threads for questions that will likely have a single official response. TAs and instructors will regularly convert Questions to Posts or Notes that do not need a single official answer, but it will save time and allow them to focus their attention on other students if you correctly categorize your post in the first place.

## Late Work

Running such a large class involves a detailed workflow for assigning assignments to graders, grading those assignments, and returning those grades. As such, work that does not enter into that workflow presents a major delay. We have taken steps to limit as much as possible the need to ever submit work late: we have made the descriptions of all assignments available on the first day of class so that if there are expected interruptions (such as like weddings, business trips, and conferences), you can complete

the work ahead of time. If you have technical difficulties submitting the assignment to Canvas by the deadline, post privately to the course forum **immediately** and attach your submission. Then, submit it to Canvas as soon as you can thereafter.

If due to a personal emergency, health emergency, family emergency, or other unforeseeable life event you find you are unable to complete an assignment on time, please post privately to the course forum with information regarding the emergency. Depending on your unique situation, we will share guidance on how to proceed; if the emergency is projected to delay a significant quantity of the work required for the class, we may recommend withdrawing and reattempting the class at a later date. If the emergency will likely only impact a small amount of the course, we may be able to accept the work late as a one-time exception. If the emergency takes place once you have already completed a significant fraction of the coursework, we may offer an Incomplete grade to allow you to finish the class after the semester is over.

Note that depending on the nature and significance of the request, we may require documentation from the Dean of Students office that the emergency is sufficient to justify offering an incomplete grade or accepting late work. Note also that regardless of the reason, we also cannot promise any particular turnaround time for grading work that was approved to be submitted late; it may be that grades and feedback will not be returned before the end of the term, and it may be that a temporary grade of Incomplete must be entered to leave time to grade work that was accepted late.

If you are not comfortable sharing with us the nature of an emergency, or if you need more comprehensive advocacy, we ask you to go through the Dean of Students' office regarding class absences. The Dean of Students is equipped to address emergencies that we lack the resources to address. Additionally, the Dean of Students office can coordinate with you and alert all your classes together instead of requiring you to contact each professor individually. The Dean of Students is there to be an advocate and partner for you when you're in a crisis; we wholeheartedly recommend taking advantage of this resource if you are in need. You may find information on contacting the Dean of Students with regard to personal emergencies here: [https://gatech-advocate.symplcity.com/care\\_report/](https://gatech-advocate.symplcity.com/care_report/) (Links to an external site.)

## Academic Honesty

All students in the class are expected to know and abide by the Georgia Tech [Academic Honor Code](#) (Links to an external site.). Specifically for us, the following academic honesty policies are binding for this class:

- In written essays, all sources are expected to be cited according to APA style, **both in-line with quotation marks and at the end of the document**. You should consult the [Purdue OWL Research and Citation Resources](#) (Links to an external site.) for proper citation practices, especially the following pages: [Quoting, Paraphrasing, and Summarizing](#) (Links to an external site.)



[site.](#)), [Paraphrasing \(Links to an external site.\)](#), [Avoiding Plagiarism Overview \(Links to an external site.\)](#), [Is It Plagiarism? \(Links to an external site.\)](#), and [Safe Practices \(Links to an external site.\)](#). You should also consult our dedicated pages (from another course) on [how to use citations \(Links to an external site.\)](#) and [how to avoid plagiarism \(Links to an external site.\)](#).

- Any non-original figures must similarly be cited. If you borrow an existing figure and modify it, you must still cite the original figure. It must be obvious what portion of your submission is your own creation.
- In written essays, you may not copy any content from any current or previous student in this class, regardless of whether you cite it or not.
- You may not under any circumstances copy any code from any current or former student in the class, or from any public project addressing the same content as the course projects, such as the Raven's Progressive Matrices or a Block World agent.
- The only code segments you are permitted to borrow are **isolated project-agnostic functions**, meaning functions which serve a purpose that makes sense outside the context of our projects (such as, for example, inverting colors in an image). Include a link to the original source of the code and clearly note where the copied code begins and ends (for example, with `/* BEGIN CODE FROM (source link) */` before and `/* END CODE FROM (source link) */` after the copied code). This is partially to emphasize what your unique project and deliverable is, and partially to protect against instances where you and a classmate both borrowed a function from the same external repository.
- During exams, you are prohibited from interacting directly with any other person on the topic of the exam material. This includes posting on forums, sending emails or text messages, talking in person or on the phone, or any other mechanism that would allow you to receive live input from another person.
- You may not post the work that you submit for this class publicly either during or after the semester is concluded. We understand that the work you submit for this class may be valuable for job opportunities, personal web sites, etc.; you are welcome to write *about* what you did for this class, and to provide the actual work privately when requested, but we ask that you do not make your actual submissions or code publicly available; this is to reduce the likelihood of future students plagiarizing your work. Similarly, unless you notify us otherwise, by participating in this class you authorize us to pursue the removal of your content if it is discovered on any public assignment repositories, especially if it is clearly contributed there by someone else.

There is one exception to these policies: unless you are quoting the course videos directly, you are not required to cite content borrowed from the course itself (such as figures in videos, topics in the video, etc.). The assumption is that the reader knows what you write is based on your participation in this class, thus references to course material are not inferred to be claiming credit for the course content itself.

These policies, including the rules on all pages linked in this section, are binding for the class. Any violations of this policy will be subject to the institute's Academic Integrity



procedures, which may include a 0 grade on assignments found to contain violations; additional grade penalties; and academic probation or dismissal.

Note that if you are accused of academic misconduct, you are **not** permitted to withdraw from the class until the accusation is resolved; if you are found to have participated in misconduct, you will not be allowed to withdraw for the duration of the semester. If you do so anyway, you will be forcibly re-enrolled without any opportunity to make up work you may have missed while illegally withdrawn.

## Feedback

Every semester, we make changes and tweaks to the course formula. As a result, every semester we try some new things, and some of these things may not work. We ask your patience and support as we figure things out, and in return, we promise that we, too, will be fair and understanding, especially with anything that might impact your grade or performance in the class. Second, we want to consistently get feedback on how we can improve and expand the course for future iterations. You can take advantage of the feedback box on the course forum (especially if you want to gather input from others in the class), give us feedback on the surveys, or contact us directly via private the course forum messages.

## AI-Based Assistance

We treat AI-based assistance, such as ChatGPT and Github Copilot, the same way we treat collaboration with other people: you are welcome to talk about your ideas and work with other people, both inside and outside the class, as well as with AI-based assistants. However, all work you *submit* must be your own. You should never include in your assignment anything that was not written directly by you without proper citation (including quotation marks and in-line citation for direct quotes). Including anything you did not write in your assignment without proper citation will be treated as an academic misconduct case.

If you are unsure where the line is between collaborating with AI and copying from AI, we recommend the following heuristics:

- Never hit “Copy” within your conversation with an AI assistant. You can copy your own work *into* your conversation, but do not copy anything from the conversation back into *your assignment*. Instead, use your interaction with the AI assistant as a learning experience, then let your assignment reflect your improved understanding.
- Do not have your assignment and the AI agent itself open on your device at the same time. Similar to above, use your conversation with the AI as a learning experience, then close the interaction down, open your assignment, and let your assignment reflect your revised knowledge. This heuristic includes avoiding using AI assistants that are directly integrated into your composition environment: just as

you should not let a classmate write content or code directly into your submission, so also you should avoid using tools that directly add content to your submission.

Deviating from these heuristics does not automatically qualify as academic misconduct; however, following these heuristics essentially guarantees your collaboration will not cross the line into misconduct.

## Course Summary:

Date	Details	Due
Mon Aug 28, 2023	Quiz <a href="#">Start-of-Course Survey</a>	due by 9am
Mon Sep 4, 2023	Assignment <a href="#">RPM Milestone 1</a>	due by 9am
Mon Sep 11, 2023	Assignment <a href="#">Mini-Project 1</a>	due by 9am
Mon Sep 18, 2023	Assignment <a href="#">Homework 1</a>	due by 9am
Mon Sep 25, 2023	Assignment <a href="#">Mini-Project 2</a>	due by 9am
	Quiz <a href="#">Quarter-Course Survey</a>	due by 9am
Mon Oct 2, 2023	Assignment <a href="#">RPM Milestone 2</a>	due by 9am
Mon Oct 9, 2023	Quiz <a href="#">Exam 1</a>	due by 9am
Mon Oct 16, 2023	Assignment <a href="#">Homework 2</a>	due by 9am
Mon Oct 23, 2023	Quiz <a href="#">Mid-Course Survey</a>	due by 9am
	Assignment <a href="#">Mini-Project 3</a>	due by 9am
Mon Oct 30, 2023	Assignment <a href="#">RPM Milestone 3</a>	due by 9am
Mon Nov 6, 2023	Assignment <a href="#">Mini-Project 4</a>	due by 9am
Mon Nov 13, 2023	Assignment <a href="#">Homework 3</a>	due by 9am
Mon Nov 20, 2023	Assignment <a href="#">Mini-Project 5</a>	due by 9am
Mon Nov 27, 2023	Assignment <a href="#">RPM Milestone 4</a>	due by 9am
Mon Dec 4, 2023	Assignment <a href="#">Final RPM Project</a>	due by 9am
Mon Dec 11, 2023	Quiz <a href="#">Exam 2</a>	due by 9am
Mon Dec 18, 2023	Quiz <a href="#">End-of-Course Survey</a>	due by 9am