GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 2806: AI First "AI Foundations" (2-3-3)
Syllabus – Spring 2025

Instructor: Prof. Ghassan AlRegib alregib@gatech.edu
Staff:
Teaching Fellow: Kiran P. Kokilepersaud kpk6@gatech.edu
Teaching Fellow: Seulgi Kim seulgi.kim@gatech.edu
Teaching Assistants: TBD

Course Days, Times, and Locations*:
Lectures on MW 11:00 – 11:50 a.m.
Studios: Check Oscar, all in Klaus 2440

Office Hours:
TBD

Textbook: No required textbook but lecture notes will be shared in Spring 2025. The following books could serve as references for this class:

- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson (Fourth Edition) 2020. (**https://aima.cs.berkeley.edu/**) (ISBN-13 9780134610993)
- Chowdhary, K.R., Fundamentals of Artificial Intelligence, Springer, 2020. (ISBN 978-81-322-3972-7)
- **http://openbookproject.net/thinkcs/python/english3e/**

The studios materials have extensive notes and they serve as reading materials. Also, lecture slides are the key source of materials.

Prerequisite: Undergraduate Semester level MATH 1554 Minimum Grade of C **and** Undergraduate Semester level CS 1301 Minimum Grade of C OR 1xxx-level COE Course on "Programming for Engineers"

Course Objective: An introduction to AI Foundations.

1. To understand the basic concepts of Artificial Intelligence
2. To build on the basic concepts of computer programming in a high-level language
3. To understand the principles of data literacy
4. To understand the math principles for AI
5. To understand the process and skills necessary to effectively deal with problem solving in relation to constructing AI algorithms
6. To be able to test and evaluate AI models and systems
7. To understand the societal and ethical implications of AI systems
8. To become comfortable with common software packages in use today such as numpy and scikit-learn

Course Description: Establish AI literacy for all students. Students will gain experience and practice with algorithm design, data structure, logical thinking, reasoning, explanations, and AI systems. A focus is on developing skills and experience in utilizing the AI Makerspace to perform certain functionalities on real data.

Course Outcomes:

1. Formulate real-life problems using data-driven approaches
2. Compute solutions using AI principles and reasoning
3. Analyze data and build AI components that fit the data and the application
4. Assess AI systems from technical as well as ethical perspectives

Students Outcomes:

1. (P) an ability to identify, formulate, and solve complex problems by applying principles of AI
2. (P) an ability to recognize ethical responsibilities of AI systems and assess their decisions in real-world contexts
3. (M) develop and conduct appropriate experimentation, analyze and interpret data, and use AI judgment to draw conclusions
4. (M) an ability to acquire and apply new knowledge as needed, using appropriate AI strategies

Academic Honesty: All violations of the Georgia Tech Honor Code will be handled by referring the case directly to the Dean of Students for investigation and penalties. Past infractions have included cheating on tests, copying lab results, copying homework, and forging TA signatures. Additionally, you are not permitted to complete any in-class exercises or attendance checks for another student other than yourself. Doing so will be considered a violation of the Georgia Tech Honor Code and be handled accordingly. As a reminder to students, violations of the Honor Code can be met with minimum drop of one letter grade in their final course grade and potentially academic probation. The complete honor code can be found online at: http://www.policylibrary.gatech.edu/student-affairs/academic-honor-code

Grading:

Homework	25%	Quiz 1	10%	Quiz 2	10%
Studios	30%	Final Project	20%	Participation	5%

In all cases we will at least follow the basic traditional grading scale where: A=90-100; B=80-89; C=70-79; D=60-69; F=0-59. While in all cases a grade of 90-100 will be assigned an 'A', the boundaries/cutoffs for the other grades will be determined at the end of the semester based on the overall class performance. It is impossible to determine what the exact "cutoffs" will be for each grade, but you can be assured that your assigned grade will not be lower than the "traditional" grading scale described above based on your final class average.
The plan is to have 6 homework assignments and 6 studios. The grade of the lowest homework will not be counted towards the homework grade.

Exams: There will be two quizzes, amounting to **10 course points each out of 100**. Moreover, in lieu of the final exam, there will be a final portfolio project due at semester end, and it accounts for **25 course points out of 100**. There will be no make-up quizzes. If you have to miss a quiz, communicate with the instructors ahead of time with an official excuse.

Homework: Written homework will be assigned (approximately) every other week and will be due on Thursdays (unless otherwise specified). For help, check the course website for office hours with instructors. Solutions will be posted for all HW assignments. Late homework will not be accepted. There will be approximately 7 written homework assignments. Check Canvas Assignments for submission instructions. The homework with the lowest grade, per student, will be dropped and the final homework grade will be calculated according to the remaining homework assignments grades.

Programming Language: We will utilize Python on the AI Makerspace.

Studios (times vary, check your registered schedule): The studio sections will meet once per week unless otherwise announced. See the lab schedule on the lab page of the class website. The studio has two parts. In the first part, the purpose is to answer questions and facilitate a deeper and more personal interaction with an instructor on the course content. Ideally, this part is student led in that the instructor functions to assist students in the areas they feel most challenging. The second part is to explore hands-on applications of the course concepts using Python and the AI Makerspace. It is a critical component of the course. There will be approximately seven written lab reports, including corresponding codes and plots, compiled into a single pdf file. Check Canvas Assignments for submission instructions. Attendance is expected at each studio. If you must miss a studio session for any reason, you MUST contact your instructor before the session with a valid excuse, or you will get an absence mark for the missed session. You can also schedule and attend another session in the same week. The instructors will be responsible for 5% of your grade. Do discuss grading expectations with your studio instructor. The studio with the lowest grade, per student, will be dropped and the final studios grade will be calculated according to the remaining studios grades.

Canvas: Course website on Canvas: when clicking the course, students will see an overall view of all the course components, including Syllabus, Lecture, Homework, Exam, Piazza, Supplements, etc. Go to https://canvas.gatech.edu/ and if you do not see the class page, make sure you are registered for the course.

Piazza: Students are expected to utilize PIAZZA platform to post questions and engage into online discussions. Make sure you enroll into the course site on Piazza. Check for sign-up link at LINK HERE . If you have any problems or feedback for the developers, email team@piazza.com. Find our class page by clicking the Piazza link on the left navigation menu on Canvas. If Georgia Tech ends Piazza and moves to another platform, we will be utilizing the new platform.

Attendance: Your attendance and participation are strongly encouraged. Check the Institute Absence Policy at: https://studentlife.gatech.edu/resources/class-attendance. Typically, in the first two weeks, we must submit a report on Verification of Participation. If this applies this year, we will

use lecture attendance and/or other metrics (e.g., TurningPoint survey responses, Canvas activities, or Piazza activities) to decide your participation.

Communications: All communication is expected to be conducted on Piazza. One can utilize the private message option. Direct Emails to instructor and staff are strongly discouraged.

Announcements: Official announcements will be posted on Canvas and/or Piazza or announced during lectures or studios.

Available Resources:

- The Center for Academic Success has programs to help students improve their study habits and time management: https://www.success.gatech.edu/.
- The Dean of Students Office helps students who have personal or medical issues that impact their academic performance: http://www.deanofstudents.gatech.edu/

Office of Disability Services: If you are a student registered with the Office of Disability Services (ODS), please make sure the appropriate forms and paperwork are completed with the instructor within the first week of classes. The instructor will abide by all accommodations required by ODS. The schedule for exams is posted in the syllabus and any potential modifications or changes will be made with at least one week's notice. It is the responsibility of the student to properly arrange test accommodations for each exam with ODS in sufficient time to guarantee space for exam administration. ALL exam accommodations must be handled through ODS. If the student does not register accommodations with ODS for the taking of an exam, then they will have to take the exam at the normally scheduled times without any additional accommodation unless the instructor is given specific directive from ODS on the student's behalf due to a mitigating circumstance. (https://disabilityservices.gatech.edu/)

Student Collaboration: Students are encouraged to study together for homework, studio problems and exams to openly discuss course topics. However, each assignment that is turned in must reflect the work of each individual student. No copying of work from other students in (or out) of this class is allowed and such activity would represent a violation of the Academic Honor Code. If you are not certain of the nature of a student collaboration you are involved in, please feel free to contact Prof. AlRegib, or your recitation instructor for their expectations.

Teacher Commitment: All of the instructors and graduate teaching assistants commit to dedicating our time and energy to ensure that you have a productive learning environment for this course.

Student Commitment: As the student, you agree to commit your time and energy to learn the material by completing all assignments in a timely manner, attending all class sessions, and seeking help when you require it.

Topical Outline:

- What is AI?
    - AI Problem Solving
    - Real-world AI Systems and Applications
    - Hardware and GPUs
- Data:
    - Sensing and acquisition; Data structures; Data Exploration with basic statistics ; Representations; Data Modalities
- Knowledge, Logic, and Reasoning
    - Logical operations, Rules of Inference, Logical Consequences, Semantics of Expression, Reasoning Patterns, Interpretations and Inferences, Rule-based reasoning, Forward and Backward Chains, Recursive functions, problem reduction, AND-OR tree, Logic foundation, Biconditional and Boolean operations
- Learning
    - Decision boundary, Markov Decision Process; Inductive, Abductive and Deductive Learning; Learning by Analogy, Explanations-based learning, supervised learning, regression, NNs, Transformers
- Search, Decision and Planning
    - mini-max, Adversarial search, mathematical programming, resource allocation using LP, risk/reward optimization using QP, sequential decision making, path planning, dynamic programming
- Ethics and AI:
    - Case studies, Issues and Challenges, Policy making and governance, bias, fairness and trust in AI, uncertainty, adversarial challenges, transparency and explainability, implications on society and individuals

Samples of Students' feedback during a mid-term survey (October 31, 2024):

"that ai is not a "magical blackbox", but is in reality a series of educated probabilities arrived at via a series of computationally complex, yet intuitively beautiful set of transformations. it is mathematical poetry"

"stuff like algorithmic thinking has been very interesting (the ideas of boiling down human concepts like pictures, pixels, etc. into numerically understandable concepts which can then be worked on by an ml model), as well as the studios which make for great projects."

"i think that learning about how to make ai models more robust/ increasing trust in ai models is the most valuable concept so far."

"the most valuable thing that i've learned is probably where to start learning for machine learning. it's not what machine learning is, or what the different types of algorithms are but the math behind all of these algorithms, which explains so much of why certain things happen the way they do."

"i think everything was very valuable. i don't have a grand ai background stepping in, so understanding and being exposed to the different types of ai and how they work at a deeper level interests me quite a bit."

"studios have been very helpful in understanding practical ideas taught in class. additionally, learning about the various mathematical techniques behind ai concepts has been great."

"yes, this course shows me how i can implement ai for various tasks (catching fraud, creating maps from databases, and classifying ratings on a website)."

"absolutely, very much. i have been interested in the field and want to work in high tech companies, and this course has demonstrated how achievable a very deep fundamental understanding of ai/ml is which i appreciate for my interest field of high performance computer arch and ai acceleration"

"yes, this course motivates me to study ai further. this course is an introduction to ai, so we are starting at the basics and working our way up, but in each class, i am getting more and more interested in ai. there are many issues in ai and areas of research in solving these issues, such as improving the robustness of models, which i would like to work on."

"yes, i feel like there is certainly a lot more to learn than what we have covered. already having this good foundation makes me want to explore the topic further and get a more clear picture of how ai works"

"yes. this course has taught me about principles in coding with ai, such as using different libraries (numpy, pandas), making conda environments, as well as writing code to train models, build neural networks, and more. i am now confident to use the ai makerspace for my own projects."

"yes. i now have the foundations to write codes to train and build models, using advanced libraries, such as jax, numpy, and pandas. because i have run and written codes using the ai makerspace in class, i am confident i can write these codes entirely on my own."

"the studios. although rigorous, they are where most of the effective learning happens, since we see the effect of the implementation of the theory taught during lectures."

"i like the studio practicums because they are helpful to slow down to understand a specific concept."

"i used to look at ai as a blackbox genie type of machine. now i understand the concepts that make it, therefore realizing it's capabilities and limitations much more"

"i appreciate this course because it helped me learn a lot about ai. i feel like i can go to a conference and listen to presentations and understand what's happening now."

"the course has made me realise that ai is honestly more blackmagic than i thought going into the class. the fact that just some math equations can train something to have a resemblance of intelligence is just mind-blowing. it makes me more excited about what is possible with it."
"i am really enjoying this course, and i am so happy that i was able to take it! i can't wait to take more ai courses!"