Artificial Intelligence: Modeling Human Intelligence with Networks
Summer 2019

General Information and Course Syllabus

Instructor: Anna Grim
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Office: 170 Hope, Room 216
Class Location: List Art Center, Room 220
Class Time: 12:15-3:05PM
Class Dates: MTWRF - 7/15-8/2
Office Hours: MTWRF - 4-5:30pm

Objective. The goal of this course is to take an interdisciplinary approach to introduce students to artificial intelligence. The structure of this course is to look at how neuroscience has inspired artificial intelligence models and then translate these ideas into mathematical models that can be programmed into a computer. By the end of this course, students will program a neural network that can identify handwritten digits. In addition, students will be introduced to basic linear algebra and differential calculus.

Prerequisites. Algebra and basic probability

Topics. This three week course covers the following topics:

- Basics of linear algebra
- Perceptron algorithm
- Differential Calculus
- Gradient Descent
- MNIST Classification
- Multilayer neural net
- Basic probability
- Random walks
- Markov chains
- Random sentence generation

Course Materials. There is no textbook for this course. Any reading materials are provided.

Attendance and Course Etiquette.

- Regular attendance and completion of homework is expected of all students and is the key to success in this course.

- Cell phones should be turned off during class; no e-mails or communication on social media should take place during class.

- Students are encouraged to ask questions during class, contact the instruct by email with any concerns, and attend office hours.

Homework and Assignments. There will be a homework assigned after each class that is due the next day at the beginning of class, which includes quantitative, conceptual, and small programming problems. Each week there will be one larger programming project that will be assigned at the beginning of the week and due on Friday. In addition, the students will be divided into pairs and each group will give a presentation about some aspect or application of artificial intelligence on Fridays.

Grading Policy.

- Programming Projects — 40 %
- Group Presentations. — 30 %
- Homework — 20 %
- Quizzes — 10 %

Honor Code. Students are encouraged to work together on homework assignments, but each student must write up their solutions individually.

Course Schedule.

Week 1	Theoretical Topic	Programming Topic
Monday	- Introduction to AI - Classification task - Neuron model - Vectors, dot product, geometry	- Intro to programming - For loops, while loops, if statements - Data structures
Tuesday	- Linear separators - Loss functions - What is learning? - Sequences - Convergence	- Uploading data - Data visualization - Plotting functions
Wednesday	- Perceptron algorithm - Geometry of algorithm - Convergence results	- Implement perceptron algorithm
Thursday	- Multi-class classification - MNIST challenge - Matrices - Network architecture	- Matrix data structure - Matrix operations - Programming MNIST forward pass
Friday	- Group presentations	- Programming project due

Week 2	Theoretical Topic	Programming Topic
Monday	- Limits - Definition of derivative - Extrema of a differentiable function	- Plotting single variable function - Numerical limits - Numerical derivatives - Plotting tangent lines
Tuesday	- Loss function - Gradient descent - Convexity	- Gradient descent
Wednesday	- Algorithm for MNIST - Multilayer neural network	- MNIST algorithm
Thursday	- Convolutions - Relu, Sigmoids - Cross correlation - Dropout - AlexNet, RCNN	- TensorFlow
Friday	- Group presentations	- Programming project due

Week 3	Theoretical Topic	Programming Topic
Monday	- Sample space - Probability distribution - Random variables - Expectation - Independence	- Generating random numbers - Plot distributions and histograms - Random process - Law of large numbers simulation
Tuesday	- Conditional probability - Markov chains - Graphs - Random walk	- Construct and visualize network - Simulate random walk - Implement random walk on map
Wednesday	- Markov model for random sentence generation	- Implementation
Thursday	- PageRank - QMR-DT Network - Belief propagation - Social mobility	- Games
Friday	- Group presentations	- Programming project due