CS 455 Final Project Instructions
Spring 2020

1 Overview

The final project for CS 455: Artificial Intelligence is to select one of the suggested project topics or propose one of your own that provides you with an opportunity to demonstrate and grow your knowledge and experience in artificial intelligence (AI) and machine learning (ML).

You are permitted to work in a group of up to three students, but individual work is also permitted enrolled in CS 455. Unfortunately, due to differences in deliverables, we cannot have teams of students mixed across courses.

You will be asked to:

- Complete a proposal identifying the project you will complete.
- Implement your software to address the project's challenge/problem.
- Write a report summarizing your work and lessons learned.
- Present and demonstrate your work to the class.

2 Potential Projects

You can propose a project of your own design. Or, you can choose a project from one of the options below and perform the work as suggested or adapt to create a new project.

Pac-Man Maze Challenge: For this project, refer to the UC Berkley project site (http://ai.berkeley.edu/search.html).

- You must define a project based upon the search environment provided and inspired by the questions asked on the site.
- For your proposal, you must propose, implement, and demonstrate three search strategies to locate a food pellet within a maze.
- Using the Maze environment, you must propose an experiment that demonstrates the search runtime, search depth, number of search nodes evaluated, and path cost.

Kaggle Competition: Select an active or concluded Kaggle.com Competition and implement a solution:

- These challenges provide clear success criteria and an automated scoring system for submissions.
- It is recommended that you pick a challenge that a "Featured" or "Research" challenge.
  - Link [All Competition]: https://www.kaggle.com/competitions
  - Link [Research Competitions]: https://www.kaggle.com/competitions?sortBy=grouped&group=general&page=1&pageSize=20&category=research

  - Link [Featured Competitions]: https://www.kaggle.com/competitions?sortBy=grouped&group=general&page=1&pageSize=20&category=featured
  - Link [Recruitment Competitions]: https://www.kaggle.com/competitions?sortBy=grouped&group=general&page=1&pageSize=20&category=recruitment
- Proposal should specify the challenge selected and the type of AI/ML general approach that will be taken (search, genetic algorithm, classification, regression, neural network, etc.), and your approach for evaluating performance of your model (based upon challenge rules).

Two player game: Implement a two player game using adversarial search (min-max or min-max with alpha-beta pruning)

- Potential games that are suitably scoped include, but are not limited to:
  - Connect-4
  - Pente: https://en.wikipedia.org/wiki/Pente
- Your proposal should identify the game you will be implementing and identify the algorithm selected.
- You must also summarize the characteristics of your environment and the actions permitted by your agents.

Rubik's Cube Solver: Implement a program that visually shows a rubik's cube solution given a randomized or pre-programmed initial state.

- Demonstrate performance using different search algorithm(s) and/or genetic algorithm
- In your proposal, identify the algorithms that you intend to evaluate and the metrics you intend to use to assess performance (e.g. solve time, path cost, etc.).

Propose your own problem: The problem must:

  - Have a suitable need for artificial intelligence/machine learning
  - Have resources available such that it can be solved (e.g. machine learning problems will require a data set)
  - Have some clear and measurable success criteria, performance metric(s), and/or bench marks to demonstrate the success of your solution.

The remainder of this document goes through the requirements for each of the project deliverables.

3 Deliverable #1: Proposal [10%]

The proposal should be one page in length. Its purpose is for you to identify your problem. Propose an approach to addressing the problem using artificial intelligence. Specify the success criteria for your project. Identify your team mates and their role within the project.

Proposal Rubric: The following rubric describes the sections of your proposal and the expectations for each. Additionally, professional technical writing is expected (typo free, well-formatted, grammatically correct).

Section	**Expectations**	**Points**
Problem Statement (200 words max)	• Clearly describes the problem being addressed • References any external resources that support this problem (e.g. data sets, simulation/game environment, etc.)	20
Proposed Approach (300 words max)	• Identifies the type of AI/ML approach to be used to address the problem, e.g. o Search o Classification o Prediction/regression o Reinforcement Learning • Describe how your problem relates to the proposed approach (i.e. how do you map the problem to the approach?) • Identify any planned libraries, resources, etc. you intend to utilize to facilitate your approach	45
Team Structure	• Identifies team members • Identifies any relevant background of team member(s) to the problem, if applicable • Identifies roles and responsibilities of team members	25
References	• Document includes references to any frameworks, simulation environments, data sets, problem descriptions, etc. used in this write-up • Citations and inline references are in IEEE format	10

4 Deliverable #2: Presentation and Demonstration [25%]

Each project will be presented during the final week of class (Monday or Wednesday). A presentation time slot will be assigned at least one week prior. The presentation and demonstration can be presented live, or it can be a recorded video presented to the class. The amount of time per presentation will be dependent upon how many projects are proposed.

For now, anticipate 5-8 minutes per project max.

Your presentation and demonstration must include:

- Overview of problem/challenge
- Summary of approach taken
- Demonstration (one of the following, as appropriate to your project)
  - Live demo,
  - Video of software in action (a “highlight reel”), or
  - Presentation of Jupyter notebook with data analysis and ML results
- Conclusion including key lessons learned
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The rubric for your presentation is as follows:

Section	**Expectations**	**Points**
Overview of problem/challenge	• Presentation clearly summarizes the problem that the project addresses. • Identifies the problem’s scope including any limitations and delineations	10
Summary of Approach	• Identifies algorithm(s) used • Identifies key resource used • Summaries how the algorithms and resources were combined to produce a solution to the problem.	10
Demonstration	• Demonstrates major achievement of the project toward the problem • Demonstration should be easy to follow for the audience • Demonstration should be planned and rehearsed.	10
Visual Quality	• Suitable visuals are used for the presentation and demonstration • If slides or a Jupyter notebook is used to guide the presentation, all text and graphics should be readable by the audience from anywhere in the classroom • Visuals are well organized and serve a purpose within the presentation and demonstration.	10
Verbal quality	• Presentation appears suitably practiced (student(s) know what to say and levels of umms are kept to a minimum) • Speaking is clear and professional	10

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5 Deliverable #3: Source Code [40%]

Your team is responsible for submitting your source code through a public Github.com repository.

NOTE: if you are using a framework/tool that is not compatible with Github / git version control, please talk to Dr. Stansbury for prior approval to use an alternative means for submission.

As students, you own the software that you develop and are free to include a license file stating whatever license you wish to place on your software. If your repository contains open source software appropriately used as per its license, you must include any requisite licensing documentation as applicable by the sources license. If you are unsure, please ask Dr. Stansbury

You are not obligated to submit a project in Python. While Python is the language used for course instruction, Dr. Stansbury is fully aware that there exist non-Python frameworks, simulation/game environments. You are free to use the resources that best meet the needs of your project.

Your repository should provide a read me with clear instructions on how to compile and execute your work. Build files such as makefiles, gradle files, script, etc.. are appreciated when applicable. It must also provide clear instructions on any required resources and instructions (or links to instructions) to install those resources.

You are free to use 3rd party libraries (SKLearn, Pandas, Tensorflow, Keras, etc.), simulation/game environments, cloud-services, etc. as necessary to complete your project so long as the final solution (i.e. connecting these resources to solve the AI problem) is your own.

Be sure to cite within your comments any use of external code regardless of the source's license. The following rubric will be used to assess the source code:

Criteria	**Expectations**	**Points**
Completeness	• The software implements a solution that applies artificial intelligence/machine learning to solving the problem. • The repository contains a complete solution based upon the work described within your report. • Upon following all set-up instructions, the solution compiles and executes. • A README file is included meeting the requirements specified above. • If a complex system set-up is required, scripts are provided to guide the set-up.	50
Correctness	• The software executes as described within the report. • The software correctly makes use of any external resources (libraries, APIs, etc.)	50

	• The software appears to be free of any obvious defects. • The software correctly utilizes the artificial intelligence algorithm's in tools in the implemented approach.	
Style	• Each source file includes a comment block identifying the author(s), the project title, and a description of the file • Each class and method should have a comment block describing its function, parameters, and outputs (as applicable) • Proper variable naming is used such that non-iterator variables have names that convey the meaning/intent/purpose of the variable • Code makes use of whitespace to enhance the readability and interpretability of the software.	60
References	• Any external resources are documented in the README file. • Use of 3rd party developed source code (including code snippets borrowed from Stackoverflow) are properly cited in the code with a comment and/or other appropriate documentation as per the source's license.	40

6 Deliverable #4: Project Report [25%]

A report must be submitted with each project. The report should be technical in nature and showcase the work done. The report should be well organized and professionally written. It shall include:

- Introduction (0.75 – 1 page in length)
    - Introduces the problem addressed by the project.
    - Summarizes the approach taken.
- Approach
    - Data/problem analysis (if applicable):
        - Discuss any work done to analyze the problem further to guide your implementation.
            - For example, data set visualization and preliminary analysis
        - Survey of tools/resources available
    - Resources used:
        - Briefly describe any external resources used to support your solution
    - Software design

        - Show through both figures and accompanying text the design of your software solution
            - e.g. flow chart, software system block diagram, etc.
        - Tell the story of how you solved through implementing your own software, connecting various resources together, etc.
    - Source Code Description:
        - In a table, provide an overview of the files within your repository including filename and description.
- Results
    - Summarize whether the project was successful
    - Discuss why it was or was not successful based upon your success criteria, performance metrics, and/or benchmarks used.
        - Describe the criteria used
        - Summarize the results of the project for each criterion
    - Discuss any known issues with the final product
- Conclusion
    - Briefly summarize your conclusions from the project including, but not limited to:
        - Summary of results
        - Technical Lessons Learned
    - Describe next steps to be considered if someone were to extend your work
- References
    - You must use IEEE style inline citations, and IEEE style references for this document.
    - Your references section should reference:
        - All papers cited
        - All external resources discussed as part of your solution
- Appendix: Personal Contribution and Lessons Learned Statements
    - For group projects, each team member must submit a one page summary of their personal contribution to the project, and any lessons learned/insights gained about artificial intelligence/machine learning gained from the project.
    - For individual projects, summarize your lessons learned.
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The following rubric will be used to assess the final report:

Criteria	**Expectations**	**Points**
Introduction	• The introduction clearly describes the problem, the approach taken, and any external resources that were vital to the success of the project. • The introduction should also state if the approach taken was successful in addressing the problem, or not.	10
Approach	• The author’s describe how they analyzed the problem and/or data set prior to implementing a solution. (if applicable)	40

	- Section adequately conveys the solution to the problem as performed for the project. - Resources used are clearly described and justified. - A table is included that summarizes each submitted source code file. - Software design aides the reader in understanding the source code submitted, the software system's assembly, and how the software flows.	
Results	- Clearly specifies whether the project was a success - Identifies any metrics, benchmarks, or success criteria used to make determination of success/failure - Identifies any lessons learned from the results including opportunities for improvement.	20
Conclusion	- Key lessons learned about the problem and solution are presented. - Future work / next steps are described	10
References	- References are complete - References are cited inline in IEEE style - Reference section is an IEEE style list of cited sources	10
Appendix: Personal Contribution and Lessons Learned (one per person working on project)	- Each team member must provide a 1-page summary of their key contributions to the project and their personal lessons learned from the experience. - For solo projects, simply discuss the lessons learned from the experience.	-10 point penalty if missing (for that person)
Writing Quality	- Professionally formatted - Professionally organized - Typo and grammatical error free	10