Problem Statement and Goals
ProgName

Team #, Team Name
Student 1 name
Student 2 name
Student 3 name
Student 4 name

Table 1: Revision History

Date	Developer(s)	Change
Sept. 17th	Matthew	Added preliminary problem statement for sections 1-1.4
Date2	Name(s)	Description of changes
...	...	...

1 Problem Statement

1.1 Problem

The project aims to create an AI-enabled digital twin for the board game Settlers of Catan. The core problem is that Catan's complexity, with its numerous possible moves and game states, makes it challenging for human players to calculate optimal strategies. This project seeks to leverage AI, specifically reinforcement learning (RL), to overcome this limitation. **The AI will provide real-time decision support offering in-game advice to help players learn and improve, as well as post-game analysis to review critical moments.

1.2 Inputs and Outputs

The system's high-level inputs are the game state information of a Catan match. This includes the positions of roads, settlements, and cities, the resources and development cards held by each player, and the location of the robber. This information can be fed into the system in various ways, such as a manual entry of a static snapshot or **through real-time video feeds that are processed to detect the game state. The high-level outputs recommended actions for the player and the ability to simulate gameplay against one or more AI bots, each having their own unique playstyle **(e.g., longest road, largest army). **This includes suggesting the best move to make during a turn, such as where to build a road or what to trade. It also includes providing post-game advice, such as identifying a past decision that could have been made differently to alter the game's outcome.

1.3 Stakeholders

The primary stakeholders for this project are:

- Players of Settlers of Catan: The end-users who will use the AI for in-game and post-game analysis to improve their skills, or train against various skilled AI bots.

- Dr. Istvan David: The project supervisor who provides guidance, expertise, and oversight.

- The Project Team: The developers responsible for designing, implementing, and testing the software.

- The Department of Computing and Software (CAS) at McMaster University: The organization hosting the project, which benefits from the academic and technical achievements of its students and faculty.

1.4 Environment

The project requires a hardware and software environment to support the various modules. The core of the system will run on a central processing unit (for example, a server or a high-powered laptop) capable of handling the computational demands of AI.

On the software side, the system will need:

- a game simulator to serve as a training environment for the RL agents

- a reinforcement learning framework (for example, Farama Foundation's Gymnasium) to train the AI

- a computer vision library (for example, YOLO) to process video feeds and translate them into a digital game state representation

- a user-facing application for the player, for example a website or mobile application

- a visual display (for example, a virtual board or text) to show a digital representation of the game state and the AI's actions

On the hardware side, the project requires:

- a computer with a processor and GPU to run the AI and computer vision modules

- devices (for example, laptops or smartphones) for the players to use the application and stream video of the game board

- a physical Catan board game for testing the computer vision and digital twin functionalities

2 Goals

3 Stretch Goals

4 Extras

[For CAS 741: State whether the project is a research project. This designation, with the approval (or request) of the instructor, can be modified over the course of the term. —SS]

[For SE Capstone: List your extras. Potential extras include usability testing, code walkthroughs, user documentation, formal proof, GenderMag personas, Design Thinking, etc. (The full list is on the course outline and in Lecture 02.) Normally the number of extras will be two. Approval of the extras will be part of the discussion with the instructor for approving the project. The extras, with the approval (or request) of the instructor, can be modified over the course of the term. —SS]

Appendix — Reflection

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?

2. What pain points did you experience during this deliverable, and how did you resolve them?

3. How did you and your team adjust the scope of your goals to ensure they are suitable for a Capstone project (not overly ambitious but also of appropriate complexity for a senior design project)?