

Module Interface Specification for Software Engineering

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1 Revision History

Date	Version	Notes
11/03/2025	1.0	Draft Rev 1

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at [give url —SS]

[Also add any additional symbols, abbreviations or acronyms —SS]

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3 Introduction

The following document details the Module Interface Specifications for our project RLCatan. This project aims to create a competent reinforcement learning AI agent designed to master the board game Settlers of Catan through autonomous self-play training. The AI will use deep reinforcement learning algorithms to learn optimal decision-making strategies across several game states including resource management, territory expansion and adaptive responses to opponent actions.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at <https://github.com/SY3141/RLCatan>.

4 Notation

[You should describe your notation. You can use what is below as a starting point. —SS]

The structure of the MIS for modules comes from [Hoffman and Strooper \(1995\)](#), with the addition that template modules have been adapted from [Ghezzi et al. \(2003\)](#). The mathematical notation comes from Chapter 3 of [Hoffman and Strooper \(1995\)](#). For instance, the symbol \Rightarrow is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Software Engineering.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	\mathbb{Z}	a number without a fractional component in $(-\infty, \infty)$
natural number	\mathbb{N}	a number without a fractional component in $[1, \infty)$
real	\mathbb{R}	any number in $(-\infty, \infty)$

The specification of Software Engineering uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Software Engineering uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	Level 2
Hardware-Hiding	
	Input Parameters
	Output Format
	Output Verification
Behaviour-Hiding	Temperature ODEs
	Energy Equations
	Control Module
	Specification Parameters Module
Software Decision	Sequence Data Structure
	ODE Solver
	Plotting

Table 1: Module Hierarchy

6 MIS of [Module Name —SS]

[Use labels for cross-referencing —SS]

[You can reference SRS labels, such as R???. —SS]

[It is also possible to use L^AT_EX for hyperlinks to external documents. —SS]

6.1 Module

[Short name for the module —SS]

6.2 Uses

6.3 Syntax

6.3.1 Exported Constants

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
[accessProg —SS]	-	-	-

6.4 Semantics

6.4.1 State Variables

[Not all modules will have state variables. State variables give the module a memory. —SS]

6.4.2 Environment Variables

[This section is not necessary for all modules. Its purpose is to capture when the module has external interaction with the environment, such as for a device driver, screen interface, keyboard, file, etc. —SS]

6.4.3 Assumptions

[Try to minimize assumptions and anticipate programmer errors via exceptions, but for practical purposes assumptions are sometimes appropriate. —SS]

6.4.4 Access Routine Semantics

[accessProg —SS]():

- transition: [if appropriate —SS]
- output: [if appropriate —SS]

- exception: [if appropriate —SS]

[A module without environment variables or state variables is unlikely to have a state transition. In this case a state transition can only occur if the module is changing the state of another module. —SS]

[Modules rarely have both a transition and an output. In most cases you will have one or the other. —SS]

6.4.5 Local Functions

[As appropriate —SS] [These functions are for the purpose of specification. They are not necessarily something that is going to be implemented explicitly. Even if they are implemented, they are not exported; they only have local scope. —SS]

7 MIS of CV Model Module

7.1 Module

CV Model

7.2 Uses

Image Queue, Board Representation

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
processImage	imageData	boardState	InvalidImageError

7.4 Semantics

7.4.1 State Variables

currentFrame : Image

7.4.2 Environment Variables

None

7.4.3 Assumptions

Assumes lighting and camera position are consistent.

7.4.4 Access Routine Semantics

processImage(imageData):

- transition: updates *currentFrame*
- output: returns detected *boardState*
- exception: InvalidImageError if frame unreadable

7.4.5 Local Functions

detectPieces(image), convertToBoardState(pieces)

8 MIS of Board Representation Module

8.1 Module

Board Representation

8.2 Uses

CV Model, Game-State Manager, User Interface

8.3 Syntax

8.3.1 Exported Constants

None

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
updateBoard	boardState	-	InvalidStateError
getBoardState		boardState	-

8.4 Semantics

8.4.1 State Variables

board : internal data structure of piece positions

8.4.2 Assumptions

Board state updates atomically.

8.4.3 Access Routine Semantics

updateBoard(boardState):

- transition: replaces internal *board*
- exception: InvalidStateError if inconsistent data

getBoardState():

- output: returns current *board*

8.4.4 Local Functions

None

9 MIS of User Interface Module

9.1 Module

User Interface

9.2 Uses

Board Representation, Game-State Manager

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
displayBoard	boardState	-	-
getPlayerMove		playerAction	InputError

9.4 Semantics

9.4.1 Environment Variables

Screen, Keyboard/Mouse

9.4.2 Assumptions

User provides input via interface devices; boardState is valid.

9.4.3 Access Routine Semantics

displayBoard(boardState):

- output: renders updated board

getPlayerMove():

- output: returns player's chosen move
- exception: InputError if invalid

9.4.4 Local Functions

None

10 MIS of Game Database Module

10.1 Module

Game Database

10.2 Uses

Game-State Manager

10.3 Syntax

10.3.1 Exported Constants

None

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
recordGame	gameData	-	DatabaseError
fetchRecord	query	gameData	NotFoundError

10.4 Semantics

10.4.1 State Variables

database : collection of previous games

10.4.2 Assumptions

Database integrity maintained; queries valid.

10.4.3 Access Routine Semantics

recordGame(gameData):

- transition: adds gameData to *database*
- exception: DatabaseError if write fails

fetchRecord(query):

- output: returns gameData matching query
- exception: NotFoundError if no record found

10.4.4 Local Functions

None

11 MIS of Game-State Manager Module

11.1 Module

Game-State Manager

11.2 Uses

Game Database, AI Model, Board Representation

11.3 Syntax

11.3.1 Exported Constants

None

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
updateState	playerAction	-	InvalidMoveError
getNextAction		aiAction	-

11.4 Semantics

11.4.1 State Variables

currentState : boardState

11.4.2 Access Routine Semantics

updateState(playerAction):

- transition: updates *currentState*
- exception: InvalidMoveError if illegal move

getNextAction():

- output: returns action from AI Model

11.4.3 Local Functions

None

12 MIS of AI Model Module

12.1 Module

AI Model

12.2 Uses

Game-State Manager, Reinforcement Learning Environment

12.3 Syntax

12.3.1 Exported Constants

None

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
inferMove	boardState	aiAction	ModelError
trainModel	reward, loss	-	TrainingError

12.4 Semantics

12.4.1 State Variables

weights : numeric matrix

12.4.2 Access Routine Semantics

inferMove(boardState):

- output: returns *aiAction*
- exception: ModelError if inference fails

trainModel(reward, loss):

- transition: updates *weights*
- exception: TrainingError if training fails

12.4.3 Local Functions

predictNextState(boardState), updateWeights(loss)

13 MIS of Reinforcement Learning Environment Module

13.1 Module

Reinforcement Learning Environment

13.2 Uses

AI Model

13.3 Syntax

13.3.1 Exported Constants

None

13.3.2 Exported Access Programs

Name	In	Out	Exceptions
generateReward	aiAction	reward	-
computeLoss	reward, aiAction	loss	-

13.4 Semantics

13.4.1 Access Routine Semantics

generateReward(aiAction):

- output: returns numeric *reward*

computeLoss(reward, aiAction):

- output: computes *loss* for model update

13.4.2 Local Functions

None

References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL <http://citeseer.ist.psu.edu/428727.html>.

14 Appendix

[Extra information if required —SS]

Appendix — Reflection

[Not required for CAS 741 projects —SS]

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design.

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. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from?
4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), if any, needed to be changed, and why?
5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions)
6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design? (LO_Explores)