Project 2-1

Play it!

An investigation into strategy games

Academic Year 2021-2022

Courses

Databases (KEN2110)
Linear Programming (KEN2520)
Probability and Statistics (KEN2130)
Machine Learning (KEN2240)
Graph Theory (KEN2220)
Reasoning Techniques (KEN2230)

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PROJECT 2-1

The central topic of this project consists of strategy games. The aim is to develop algorithms, which are able to play the game as good as possible.

1. Project description

The central topic of this project consists of strategy games. You are required to implement a human-human player version and a human-computer player version using object-oriented programming. For the artificial player you will need to take into account that you have to implement a game data structure and a smart evaluation function, which you can apply to your game. Additionally, your artificial player should be adaptive and present some form of learning. The three phases of this project can be described as follows:

Phase 1:

The following lists provide the games from which you as a project group should choose one. For each game, you should refer to the given link for the standard rules that you have to implement. Note that we have categorized them according to three (difficulty) criteria: 1) two-player or multi(more than two)-player; 2) perfect or imperfect information; 3) with or without chance.

The "easiest" games are perfect-information, two-player games without chance: specify these are standard rules

- Connections (https://boardgames.lovetoknow.com/Connections_Board_Game)
- Tak (https://en.wikipedia.org/wiki/Tak_(game))
- Yinsh (http://www.gipf.com/yinsh/rules/rules.html)
- ArdRi (http://www.dragonheelslair.com/en/rulesard.php)
- Cage (http://web.archive.org/web/20200701105455/http://www.marksteeregames.com/Cage_rules.html)
- Bamboo (http://www.marksteeregames.com/Bamboo_rules.pdf)

The more difficult games (with one difficulty criterion) are:
- Dice Chess (https://brainking.com/en/GameRules?tp=95) – chance
- Sneakthrough (https://ludii.games/details.php?keyword=Sneakthrough) – imperfect information
- 3-player Hex (https://ludii.games/details.php?keyword=Three-Player%20Hex) – multi-player
- 2-player Briscola (https://www.pagat.com/aceten/briscola.html) – imperfect information (you can extend it to multi-player)
- Imperial (https://www.fgbradleys.com/rules/rules4/Imperial%20-%20Rules.pdf) – multi-player
- 3 player checkers (https://boardgamegeek.com/thread/942121/rules-checkers-3) - multi-player

Finally, two "hard" games (with two difficulty criteria)
- Pandemic (https://images.zmangames.com/filer_public/53/ed/53edbee8-adfb-4715-899f-dd381e1420d7/zm7101_rules_web.pdf) – multi-player, chance

- Carcassonne (https://images.zmangames.com/filer_public/d5/20/d5208d61-8583-478b-a06d-b49fc9cd7aaa/zm7810_carcassonne_rules.pdf) – multi-player, chance

It is clear that the easier games are easier to implement, but of course also less challenging. It is strongly recommended that you clearly discuss this within your group and estimate your skills when choosing one of the games.

For the chosen game, make a UML class diagram of the system that you will develop, including data structures that you will use to implement the game. Implement – in Java – the game chosen such that two or more human players can play it "on the computer" and make sure you have a good visualization of the game.

Research different algorithms to design a computer player capable of playing against a human. Do a literature study of available AI techniques, decide which ones you will use for your game, and argue why they are suitable for it. You should look into different techniques from the fields of Machine Learning and Adversarial Search and choose at least one technique for each of the two fields.

Furthermore, by the end of this phase you have to deliver a draft introduction for the final report. The draft introduction must include the definition of the problem statement and the research questions the group wants to address, and the literature review. In the draft, it should also be clear which AI techniques you plan to implement for the computer player in the next phases. Please, check the report guidelines for more details on how to write the report.

Peer feedback: by the end of phase 1, each group will have to anonymously evaluate the games implemented by three other groups and fill out a feedback form. Groups can consider this feedback to improve their programs in the subsequent phase.

It is furthermore possible to choose a game that is not on the provided list. In that case, you have to ask the examiners for permission.

Phase 2:

Implement at least one type of game-playing agent based on at least one of the AI techniques you examined and test it against a baseline agent. The simplest baseline agent you can use is one that chooses random actions for each game step, but you can also implement a more advanced baseline. Furthermore, perform a complexity analysis for your algorithm.

Peer feedback: by the end of phase 2, each group will have to anonymously evaluate the games and computer players implemented by three other groups and fill out a feedback form. Groups can consider this feedback to improve their programs in the subsequent phase.

Phase 3:

Improve the agent you developed in phase 2. If your agent was using only one among the Adversarial Search and Machine Learning techniques you selected in phase 1, make sure that in this phase you implement a hybrid agent that combines techniques from both areas. Finally, test and evaluate all the strategies you implemented.

Project examiners: Mark Winands, Siamak Mehrkanoon, Chiara Sironi, Martijn Bousse

Appendix

Project phases

The project assignments in period 1.1 and 1.2 are preparatory for the concluding part of project 1-3 which takes place in period 1.3. At the beginning of period 1.1 the project starts with the project opening. In period 1.2 and 1.3, you will start working on the project immediately without having a separate project opening. While in period 1.1 and 1.2, you will work part-time on the project (simultaneously to your courses), in block 1.3, you will work full-time on the project. At the end of each phase, you will present your project work to the examiners and your tutor. In the last project phase, this presentation will additionally be in front of your fellow students. Furthermore, at the end of the last phase, you have to hand in a project report.

Assessment Moments

10-15 minutes presentation + 5 minutes questions

Presentation First Phase (PFP): The presentation first phase concludes the first phase of the project. The group will present in front of the examiners and the tutor. The group should bring an additional laptop with code ready to be checked and run (if the presentation takes place in person). The group needs to wait in a zoom/collaborate ultra session until the examiners join that session (if the presentation takes place online). When entering the session, the examiners should find the group sharing a screen with the presentation and ready to start. After the presentation, one computer/laptop should be ready to run the code and share the screen.

Presentation Second Phase (PSP): The presentation first phase concludes the first phase of the project. The group will present in front of the examiners and the tutor. The group should bring an additional laptop with code ready to be checked and run (if the presentation takes place in person). The group needs to wait in a zoom/collaborate ultra session until the examiners join that session (if the presentation takes place online). When entering the session, the examiners should find the group sharing a screen with the presentation and ready to start. After the presentation, one computer/laptop should be ready to run the code and share the screen.

Pre-Examination: This is the last opportunity for the group to receive feedback from the examiners. The students can receive feedback on their report draft, presentation and/or progress of their project. The students are expected to be prepared with a list of open questions they want to discuss. The pre-examination is not graded.

Final Presentations (FP): The final presentations will be attended by the examiners, tutor and the fellow students. Thus, the presentations will not contain that many technical details. They will be discussed in the product and report examination.

Product and Report Examination: The examiners can give feedback on the submissions and test the understanding, contribution and knowledge of the group (members).

The phases are assessed according to the assessment forms that can be found on Canvas.
As stated in the rules and regulations (see Canvas), "the first grade is issued after the presentation first phase and accounts for 15% of the final grade. The second grade is issued after the presentation second phase and accounts for 15% of the final grade. The third grade is issued after the final assessment at the end of the third period and accounts for 70% of the grade". More detailed information on the assessment (including the grade for skill classes and attendance requirements) can be found in the rules and regulations uploaded to Canvas. It is highly recommended to read them carefully.
To pass the project, you need a weighted average of the three grades higher or equal to 6. It is not required to obtain at least a six in each of the phases. A weak performance in one of the phases can potentially be compensated in another phase.

Project coordination

The examiners of project 2-1 are: Chiara Sironi, Mark Winands, Siamak Mehrkanoon, and Martijn Bousse. Katharina Schneider (Schüller) is coordinating the project. Marieke Musegaas and Katharina Schneider are tutoring the groups. For questions regarding the organisation, please email to k.schuller@maastrichtuniversity.nl. For other questions, contact your tutor. They will eventually forward your question to the examiners or the project coordinator.

General information, information on the courses and schedules is to be found on the Canvas:

Project meetings

The aim of a project meeting with the tutor is to continuously track the status of the project by looking backward and forward. Appointments made are checked, new appointments/agreements are made. Moreover, the planning will be checked. In case of deviations, an analysis of the situation will be made in order to trace the causes. Project meetings are scheduled on a fixed date and time. An agenda is set up by the group **in advance** to each meeting. Minutes will be taken in each of the project meetings. The project meetings are mandatory (attendance will be tracked) and participation will be assessed. The tutor can plan an additional meeting if needed.

Agenda and Chairperson

The agenda template is uploaded to Canvas. This agenda may be changed, influenced by the project or specific situation. Still all main points need to be discussed during the meeting.

The chairperson changes every project meeting. For each meeting, the group decides in advance to the project meeting on who is going to take this role and prepares an agenda (see example above). Preparation of the agenda includes **filling out the sections** 1. – 6. and **uploading** the agenda to Canvas in advance to each project meeting. During the meeting, the chairperson takes care that everybody can participate (e.g., invites other team members to talk about the tasks they have done), that the atmosphere in the meeting is safe and open, that decisions are made and that time constraints are not exceeded. The chairperson guides through the meeting based on the agenda.

Minutes and Secretary

The secretary takes care of the minutes. He/she summarizes the discussion and decisions of the meeting such that someone not attending the meeting can understand the findings of the meeting. The points listed in the minutes need to correspond to the points on the agenda, i.e., the headings in the minutes are the same as in the agenda. The minutes have to be provided with date, group number and the (full) names of those present and absent. A template for minutes is uploaded to Canvas as well as a document summarizing, what we expect from minutes. Furthermore, the secretary is responsible for uploading the minutes on time (see due date of assignment on Canvas).

Overview of tasks

Every group is expected to create an overview per phase of what every group member did during the project. It is highly recommended to start keeping track of this at the beginning of the project. It is uploaded at the end of each phase to Canvas. If you do not agree on an overview, please let your tutor know in advance. Complaints at the end of the phase about previous phases cannot be handled anymore.

Planning

Every group is expected to make a planning at the beginning of each phase for the complete phase. The planning should give an overview on when the groups expects to achieve which milestones and who is going to work on which tasks. It is uploaded to Canvas in the corresponding phase (see Canvas for concrete deadlines). An example for a planning is uploaded to Canvas.

Schedules

The concrete schedules for the project meetings and the presentations will be uploaded to Canvas.

Rules and Regulations

The rules and regulations can be found on Canvas. They include, e.g., the consequences for missing mandatory events (project meetings, skill classes, assessment moments). Please read them carefully.