Seminar: Search and Optimization
1. Organization, Seminar Schedule & Topics

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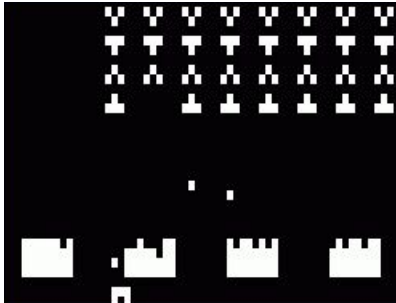# Introduction

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Seminar Topic

Search and optimization is a wide research field.

This year's seminar topic

Search and optimization techniques in video games.

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Video Games: Examples

Space Invaders

- first release in 1978
- no "real" AI
- player must destroy attacking aliens ("non-player characters")

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Video Games: Examples

Command and Conquer

- first release in 1995, sequels until 2013
- real-time strategy game
- player's units must destroy enemy's units and structures

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Video Games: Examples

StarCraft

- first release in 1998, still developed further
- real-time strategy game
- player's units must destroy enemy's units and structures

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Search and Optimization in Video Games

What is a "good" AI for a video game?

Improve user experience

- create adaptive, believable game AI
- create realistic character movement
- deliver accurate entertainment value

⤳ Tutorial on "Video Games and Artificial Intelligence"
(Botea et al., IJCAI 2009)

Search and Optimization in Video Games

Video games are challenging

- multiple agents choose actions
- high branching factor (for example, in StarCraft, the branching factor can reach numbers between 30^{50} and 30^{200})
- strict resource limitations (both time and memory)

Like life: complex, adversarial, uncertain! In it for the long run!

Why Search and Optimization in Video Games?

High-level topics of the seminar

- pathfinding: find a path between two given locations on a (large) map with obstacles
- real-time strategy games: what is the "best" next action?
- content generation and experience management

⤳ more detailed descriptions will follow

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Target Audience and Prerequisites

Target audience

- MSc students of computer science and related subjects
- PhD students of computer science and related subjects

Prerequisites

- course "Foundations of AI" or equivalent knowledge
- programming skills (only for the software project)

. . . or willingness to acquire these on the fly

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Format

Seminar format

- 3 ECTS points for the seminar
- +3 ECTS points for the optional project extension
- evaluation: graded (1.0–6.0)

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Project Extension

Optional project

- free project work
- meetings by appointment
- milestone presentations (during seminar time slot)

⤳ content, grading, schedule etc. discussed next week

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Requirements

Requirements to pass seminar

- give a seminar presentation
  - 30–35 minutes
  - submit slides to advisor three days in advance
- write a seminar paper
  - 10–12 pages, LaTeX
  - due one week before presentation
- read all presented material
  - prepare summary and questions
  - submit to advisor one day in advance
- actively participate in discussions
- participate regularly
  - be absent at most twice
  - notify us in advance if absent

Grading

Grading

- seminar presentation
- seminar paper
- participation in other presentations
  (summaries, submitted questions, discussions)

These three aspects will be individually graded (1.0–6.0).
The overall grade is the average of the three components.

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People

Organizers

Malte Helmert

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Martin Wehrle

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People

Organizers (ctd.)

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People

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Time & Place

Seminar meetings

- time: Thursday, 15:15-17:00
- place: Seminarraum 00.003, Spiegelgasse 1

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Internet

Seminar homepage

`http://informatik.unibas.ch/hs2015/`
`seminar-search-optimization/`

- description of seminar
- slides (to appear)
- additional materials (to appear)

Registration:

- `https://services.unibas.ch/`

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Plagiarism

Plagiarism

- plagiarism: passing off someone else's work as your own
- consequence: failing the seminar/project
- if in doubt, ask us!

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Learning Goals

Learning goals

Dealing with scientific literature:

- reading and understanding
- explaining and presenting
- comparing and discussing

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Questions on Organization

Questions?

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Seminar Schedule and Topics

Tentative Schedule

17.09. Organization, schedule & seminar topics
24.09. Basic search algorithms + project organization
01.10. Introduction to Monte Carlo tree search and UCT
08.10. no meeting
15.10. Topic #1 + topic #2
22.10. Topic #3 + project milestone 1
29.10. Topic #4 + topic #5
05.11. Topic #6 + topic #7
12.11. no meeting
19.11. Topic #8 + project milestone 2
26.11. Topic #9 + topic #10
03.12. Topic #11 + topic #12
10.12. Topic #13 + topic #14
17.12. Wrap-up and final project presentation

(slight changes possible depending on number of participants)

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Topic #1

Topic #1: Pathfinding

- "Near Optimal Hierarchical Path-Finding" (Botea, Müller, and Schaeffer; Journal of Game Development, 2004)
- Search performed on abstract map with linked local clusters

Topic #2

Topic #2: Pathfinding

- "Memory efficient abstractions for pathfinding" (Sturtevant; AIIDE 2007)
- Optimizes abstraction techniques for games with tight memory constraints
- Underlying pathfinding technique in Dragon Age

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Topic #3

Topic #3: Pathfinding

- "Jump Point Search"
  (Rabin and Silva; Game AI Pro 2, Chapter 14)
- Combination of A* with symmetry pruning on grids

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Topic #4

Topic #4: Pathfinding

- "Subgoal Graphs for Fast Optimal Pathfinding"
  (Uras and Koenig; Game AI Pro 2, Chapter 15)
- Perform faster pathfinding on smaller "subgoal" graphs

Topic #5

Topic #5: Pathfinding

- "Euclidean Heuristic Optimization" (Rayner, Bowling, and Sturtevant; AAAI 2011)
- Use mathematical optimization techniques to design a good heuristic for pathfinding

Topic #6

Topic #6: Pathfinding

- "Theta* for Any-Angle Pathfinding"
  (Nash and Koenig; Game AI Pro 2, Chapter 16)
- Agents can move on grids in any angle

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Topic #7

Topic #7: Real-time strategy games

- "UCT for tactical assault planning in Real-Time Strategy Games" (Balla and Fern; IJCAI 2009)
- Application of Monte Carlo tree search/UCT

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Topic #8

Topic #8: Real-time strategy games

- "Fast Heuristic Search for RTS Game Combat Scenarios" (Churchill, Saffidine, and Buro; AIIDE 2012)
- Extension of alpha-beta search to durative moves

Topic #9

Topic #9: Real-time strategy games

- "Game-Tree Search over High-Level Game States in RTS Games" (Uriarte and Ontanon; AIIDE 2014)
- Abstract representation of game state to reduce branching

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Topic #10

Topic #10: Real-time strategy games

- "Build order optimization in StarCraft"
  (Churchill and Buro; AIIDE 2011)
- Optimize order in which units and structures are produced

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Topic #11

Topic #11: Content generation

- "Procedural Content Generation"
  (Smith; Game AI Pro 2, Chapter 40)
- Optimize level design
- Case study: Cut the Rope

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Topic #12

Topic #12: Experience management

- "Techniques for AI-Driven Experience Management in Interactive Narratives" (Bulitko, Lee, Poo Hernandez, Ramirez, and Thue; Game AI Pro 2, Chapter 42)
- Classification of player type
- Game story generation depending on player type

Topic #13

Topic #13: Playing video games

- "The Arcade Learning Environment: An Evaluation Platform for General Agents" (Bellemare, Naddaf, Veness, and Bowling; Journal of Artificial Intelligence Research, 2013)
- General game-playing algorithms for vintage video games (like "Space Invaders", "Ms. Pacman", . . .)

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Topic #14

Topic #14: Application in commercial games

- "F.E.A.R.: Three States of a Plan: The AI of FEAR"
  (Orkin; Game Developers Conference 2006)
- Example application of S&O for a commercial game

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Topic Assignment

- we will send you the link to a Doodle poll
- number of the option = number of the topic in these slides
- mark at least 2 topics with Yes
- mark at least 3 topics positively: Yes or (Yes)
- until September 23 (next Wednesday) at noon

Then:

- paper assignment and supervisors announced September 24