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

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September 18, 2014

1.1 Constraint satisfaction problems

1.2 Organizational matters

1.3 Seminar Schedule and Topics

1.4 Next steps

1.1 Constraint satisfaction problems

Topic of the Seminar

"Search and Optimization" is a very wide field.

This year, we concentrate on
constraint satisfaction and optimization problems

Example: Seating Arrangement for Wedding Party

Task: assign every guest (variable) a seat (value from its domain)

. . . but consider that . . .

- ▶ The bridal couple must sit at a table in the center.
- ▶ Parents must sit close to the bridal couple.
- ▶ There should be a man beside every woman.
- ▶ Sworn enemies must not sit at the same table.
- ▶ Everyone should have someone with similar interests or hobbies at the same table.

Such restrictions are called constraints.

Example: Sudoku

5	3	4	6	7	8	9	1	2
6	7	2	1	9	5	3	4	8
1	9	8	3	4	2	5	6	7
8	5	9	7	6	1	4	2	3
4	2	6	8	5	3	7	9	1
7	1	3	9	2	4	8	5	6
9	6	1	5	3	7	2	8	4
2	8	7	4	1	9	6	3	5
3	4	5	2	8	6	1	7	9

Variables: cells
Domain of each variable: $\{1, 2, \ldots, 9\}$
Constraints:

- ▶ Within one block/row/column no number may be used twice.

Other examples

- ▶ Assigning time slots and classrooms to courses
- ▶ Coloring a map so that no neighbouring countries have the same color
- ▶ Resource allocation in manufacturing

Always:

- ▶ Variables that need to get assigned values from their domain
- ▶ Constraints that restrict the valid variable assignments

Main techniques

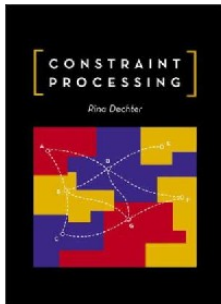### Search
Search for a solution by trying different values for each variable.

Inference
Reformulate the problem to make the search space smaller.

Book

Rina Dechter: Constraint Processing
Morgan Kaufmann, 2003

Available for free (from university network) at
`http://proquest.tech.`
`safaribooksonline.de/9781558608900`
(access limited to three readers at a time)

1.2 Organizational matters

Target audience and prerequisites

Target audience
- ▶ MSc students of computer science and related subjects
- ▶ PhD students of computer science and related subjects

Prerequisites
- ▶ lecture "Foundations of AI (CS205)" or equivalent knowledge
- ▶ programming skills (only for the software project)

. . . or willingness to acquire these on the fly

Format

Seminar format
- ▶ 3 ECTS points for the seminar
- ▶ +3 ECTS points for the optional project extension
- ▶ evaluation: graded

Requirements

Requirements to pass

- Give a seminar presentation
  - 50–70 mins
  - 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

- Give a seminar presentation (40%)
- Write a seminar paper (45%)
- Actively participate in discussions (15%)

These three aspects will be individually graded on a scale of 1.0-6.0, and the overall grade for the seminar will be determined as a weighted average of the three components.

People

Organizers

Prof. Dr. Malte Helmert
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Gabriele Röger
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People

Organizers (ctd.)

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People

Malte Helmert   Manuel Heusner   Florian Pommerening

Silvan Sievers   Salomé Simon   Martin Wehrle

Time & place

Seminar

- ▶ Time: Thursdays, 15:15-17:00
- ▶ Place: Bernoullistrasse 16, seminar room 205

Project

- ▶ free project work
- ▶ meetings by appointment

Internet

Seminar homepage

http://informatik.unibas.ch/hs2014/
seminar-search-optimization/

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

Registration:

- ▶ https://services.unibas.ch/

Plagiarism

Plagiarism

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

Learning goals

Learning goals

Seminar: dealing with scientific literature

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

Project: implementing efficient problem solvers

- ▶ practice in programming
- ▶ clean and efficient code ($\rightsquigarrow$ code reviews)
- ▶ evaluation of algorithms ($\rightsquigarrow$ scientific experiments)

Questions on organization

Questions?

1.3 Seminar Schedule and Topics

Schedule

18.09. Organization, Schedule & Seminar Topics
25.09. Mathematical Background &
       Project Organization and Topics
02.10. Introduction to Mercurial
09.10. Presentation #1
16.10. Presentation #2
23.10. Presentation #3
30.10. Presentation #4
06.11. Presentation #5
13.11. Presentation #6
20.11. Presentation #7
27.11. Presentation #8
04.12. Presentation #9
11.12. Presentation #10
18.12. Presentation of Project Results

Topic #1 (October 9)

Topic #1: Constraint Networks

- Basic concepts: constraint network, solution, . . .
- Properties of binary constraint networks
- Graph representations

Topic #2 (October 16)

Topic #2: Basic Inference Methods

- Arc consistency
- Path consistency
- More general consistency concepts

Topic #3 (October 23)

Topic #3: Look-Ahead Search

How can we find a solution for a constraint network?

Topic #4 (November 6)

Topic #4: Look-back Strategies

How can we learn from mistakes during the search?

Topic #5 (November 13)

Topic #5: Directional Consistency

Is it possible to solve CSPs without search?

Topic #6 (November 20)

Topic #6: Stochastic Search

Feeling lucky? Finding solutions quickly (or possibly never)

Topic #7 (November 27)

Topic #7: Tree Decomposition

Find all solutions for small subproblems.
Then extract overall solution quickly.

Topic #8 (December 4)

Topic #8: Exploiting special constraints

Different topics possible e. g. numeric constraints, boolean constraints, global constraints, temporal constraint networks

Topic #9/#10 (December 11 + 18)

Topic #9/#10: Constraint Optimization

Finding the best solution

1.4 Next steps

Assignment of Topics

- ▶ 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 24 (next Wednesday)

Then:

- ▶ Paper assignment and supervisors announced September 25.