

What to do with your problems?

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1

Unit A1: Overview

- Discuss your own **problems**
- Analyze the process of going from **problems** to solutions
- Identify different types of **problems**
- Discuss how to represent **problems**
- Practice transforming **problems**
- Preview Exercise A1 “Using a Theory”

Questions about the course? (Ex00 Part 2)

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2

Exercise 00 Part 1

- Your own problems
- Analysis of computational aspects (optional)
 - Can obtain an answer?
 - Can do it with available resources?
 - Can do it within a reasonable time?
 - Can handle different cases of the problem?

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Why problems? 3

Problems

- Problem transformation
 - From more realistic to more manageable
- Problem types e.g., use of computers
 - **Practical** problems: Calls for an *action* (in reality)
 - **Research** problems: Calls for *information*
 - **Computational** problems: Calls for *computation*

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4

Research Problems

- As **questions**
 - *Yes-no* question: “Is Furby male?”
 - *Wh*-question: “What is the sex of Furby?”
- **Cost or significance**
 - Suffering of not being able to answer *or* benefit of answering [opposite sides]
 - Often, in connection to a practical problem
- Example: “How do ants find food?”

“The Craft of Research” (see the topic list)

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5

Digression: Analogy

- Problem (question) and significance
- Course (materials) and significance
- Organization and role
- Anatomy and physiology

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Feeding problems to a computer 6

Computational Problems

- Research problem 1: “Is Furby male?”
 - Computational problem (à la Prolog)
 - Input: `furbySex(male)`. Suppose the computer knows the answer
 - Output: e.g., `no`.
- Research problem 2: “What is the sex of Furby?”
 - Computational problem (à la Prolog)
 - Input: `furbySex(x)`.
 - Output: e.g., `x = female`.

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7

Imagine a Lazy Machine

- Only responds with “uh” or “nah”
- Question: Can we phrase various problems in a way even the lazy machine can still be useful? If so, how?

Possibility of dealing with problems in a more uniform manner

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8

Converting Questions

- Any question (including *wh*-questions) can be converted into a series of *yes-no* questions.
 - *Wh*-question: “What is the sex of Furby?”
 - *Yes-no* questions: “Is Furby male?” “Is Furby female?”
- This technique allows us to deal with complex problems with “lazy” machines.

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9

Group Exercise 1

- Convert the following *wh*-questions into a series of *yes-no* questions
 1. What are the planets (of the Sun)?
 2. Where did you eat?
 3. When will the last human be born?

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Representing formally? 10

Formal Representation

- *wh*: “What is the square of x ?” Function
 - $f = \{(1, 1), (2, 4), (3, 9), \dots\}$
 - I.e., $f(1) = 1, f(2) = 4, f(3) = 9, \dots$
 - Pairs of an **input** and the **output**
- *yes-no*: “Is y the square of x ?” Relation
 - $R = \{(1, 1), (2, 4), (3, 9), \dots\}$
 - I.e., $(1, 1) \in R, (2, 4) \in R, (3, 9) \in R, \dots$
 - Pairs of two **inputs**

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Discrete math: review if necessary

11

Number of Arguments

- 2 arguments
 - E.g., “Is 1 the square of 1?” “Is 4 the square of 2?” etc.
 - Cf. “What is the square of what?”
 - $\{(1, 1), (2, 4), (3, 9), \dots\} = \{(x, y) \mid y = x^2\}$
- 1 argument
 - E.g., “Is 1 a square?” “Is 4 a square?” etc.
 - Cf. “What are squares?”
 - $\{1, 4, 9, \dots\} = \{x \mid x \text{ is a square of some number}\}$

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12

Computational Problem

- Checking the membership of a set (could be a relation)
- Then, we may just identify a computational problem with the **set. ~ language** **Recall this?**
- Examples (cf. Group Exercise 1)
 - {Mercury, Venus, Earth, Mars, Jupiter, ... }
 - {(Nobo, Penang), (Furby, home), ... }
 - {2005, 2006, 2007, 2008, 2009, 2010, ... }

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Potential problems with this description?

13

Interim Summary: Problem Transformation

- Practical problem ~ action
 - Significance: Real-life situation
- Research problem ~ question
 - Significance: possibility of solving the associated practical problem (if acted)
- Computational problem ~ set
 - Significance: Abstract/computational treatment ⇒ Only yes-no response needed

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14

Practice: "Dating"

- Practical problem: Date an ideal partner.
- Research problem:
 - Cost/significance
- Computational problem (set):

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15

Group Exercise 2

- Transform the following **research problems** into the corresponding **computational problems**, and represent them as **sets**
 1. Is it going to rain this evening?
 2. Why do people (still) smoke cigarette?
 3. How can one cook pasta?

If you need clarification, ask questions.

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16

Group Exercise 3

- Identify each of your own problem (Ex 00) with respect to the following stages:
 - Practical
 - Research **Work on your problems jointly within your group**
 - Computational
 - Set
- Transform your problems so that you eventually convert them into sets (may need to make adjustments)

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17

Unit Summary

- **Types of problems:** practical, research, computational
 - Why categorize?
- Computational **problem ~ set**
 - Why set?
- **Problem transformation**
 - How to do it?

Cf. Content Goal 1

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18

Exercise A1: Using a Theory

- Part 1: Using a Theory
 - Task 1: Identify theories (in/out CS)
 - Task 2: Define “theory” (your own)
 - Task 3: Personal feelings about theory
- Part 2: Review “Problems”
 - Group Exercise 3 (previous slide)
- Unit A1 Summary question
 - Were you sufficiently motivated to discuss “problems” as the starting point of this course? Explain.