

**SE 2AA4, CS 2ME3 (Introduction to Software
Development)**

Winter 2017

21 Intro to Specification (Ch. 5)

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February 27, 2017



Introduction to Specification

- Administrative details
- Questions on midterm?
- Overview of A3
- Review of mathematical notation
- Outline of specification topics
- Definition of specification
- Uses of specification
- Qualities of a good specification
- Classification of specification styles
- Examples
- How to verify a specification

Administrative Details

- Some of today's slides adapted from Dr. Wassying's slides
- A2 Part 2 due today
- A3 deadlines
 - ▶ Part 1 - Specification: due 11:59 pm Mar 8
 - ▶ Part 2 - Code: due 11:59 pm Mar 20
- A4
 - ▶ Your own design and specification
 - ▶ Due April 3 at 11:59 pm
- Midterm exam
 - ▶ March 1, 7:00 pm, TSH/120
 - ▶ 90 minute duration
 - ▶ Multiple choice - 30 questions
 - ▶ Open book (any paper)

Midterm Examination

- Everything up to and including Friday, Feb 17, 2017
- Any questions?

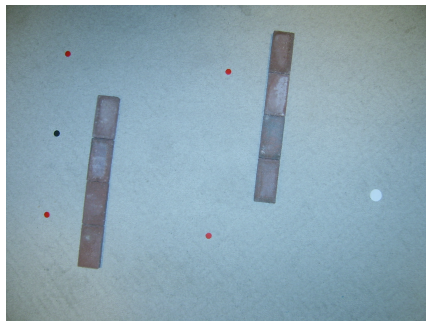
A3: Remote Image Guided Autonomous Rescue Robots (RIGARR)

- Motivated by existing technology
- In the event of a disaster, robots can be used to find and rescue the survivors
- In some cases the robots may be autonomous

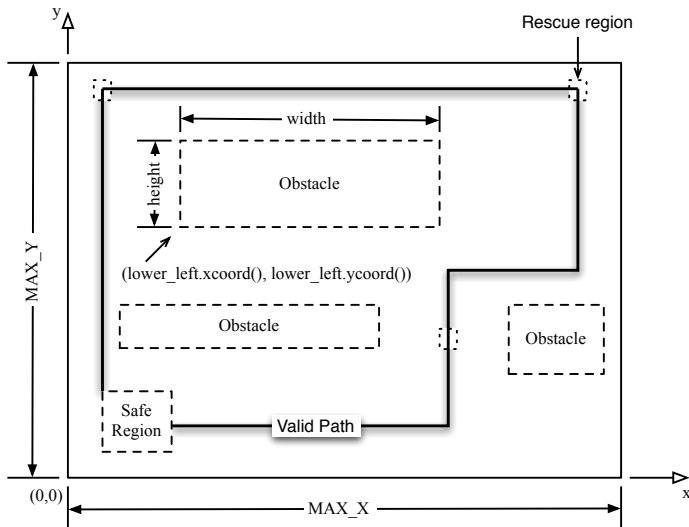
Images

A3: RIGARR Continued

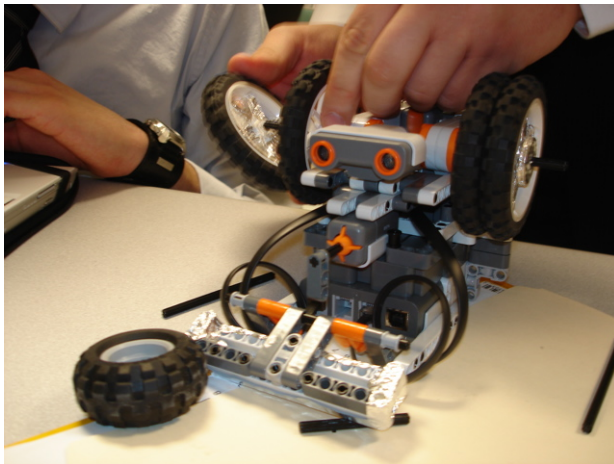
- Given an image
- Begin at the start (white circle)
- Reach destinations (black circles)
- Benchmarks (red circles)
- Teams competed for fastest time

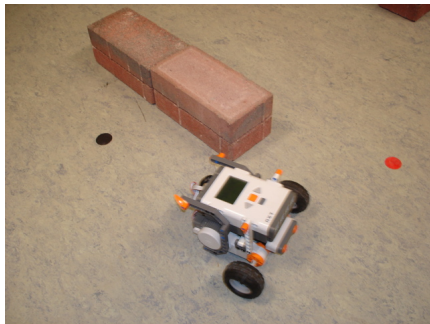
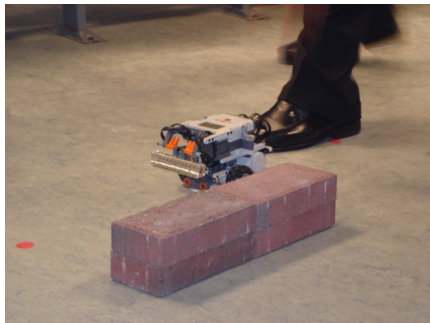


A3 Example Map and Path



A Robot





A3 Specify and Implement a Portion of RIGARR

- Focusing on the data model portion of the design
- Part 1
 - ▶ Complete incomplete specification
 - ▶ Critique design of interface
 - ▶ Use LaTeX
- Part 2
 - ▶ Given complete specification
 - ▶ Implement in Java
 - ▶ Test using JUnit
- Assignment Specification

Mathematical Notation Example 1

- $\{x : \mathbb{N} \mid x \in [0..5] : x^2\}$
- What does this notation mean?

Mathematical Notation Example 1

- $\{x : \mathbb{N} \mid x \in [0..5] : x^2\}$
- What does this notation mean?
- $\{0, 1, 4, 9, 16, 25\}$

Mathematical Notation Example 1

- $\{x : \mathbb{N} \mid x \in [0..5] : x^2\}$
- What does this notation mean?
- $\{0, 1, 4, 9, 16, 25\}$
- How would we say this in Python?

Mathematical Notation Example 1

- $\{x : \mathbb{N} \mid x \in [0..5] : x^2\}$
- What does this notation mean?
- $\{0, 1, 4, 9, 16, 25\}$
- How would we say this in Python?
- `[x**2 for x in range(6)]`

Mathematical Notation Example 2

- $+(x : \mathbb{N} \mid x \in [0..5] \wedge x \% 2 == 0 : 1)$
- What does this notation mean?

Mathematical Notation Example 2

- $+(x : \mathbb{N} \mid x \in [0..5] \wedge x \% 2 == 0 : 1)$
- What does this notation mean?
- $1 + 1 + 1 = 3$

Mathematical Notation Example 2

- $+(x : \mathbb{N} \mid x \in [0..5] \wedge x \% 2 == 0 : 1)$
- What does this notation mean?
- $1 + 1 + 1 = 3$
- How would we say this in Python?

Mathematical Notation Example 2

- $+(x : \mathbb{N} \mid x \in [0..5] \wedge x \% 2 == 0 : 1)$
- What does this notation mean?
- $1 + 1 + 1 = 3$
- How would we say this in Python?
- `reduce(lambda x, y: x+y, [1 for x in range(6) if x%2==0], 0)`

Mathematical Notation Example 3

- $\{p : \text{pointT} \mid p.\text{dist}(c.\text{cen}()) > c.\text{rad}() : p\}$
- What does this notation mean?

Mathematical Notation Example 3

- $\{p : \text{pointT} \mid p.\text{dist}(c.\text{cen}()) > c.\text{rad}() : p\}$
- What does this notation mean?
- Every point outside the circle
- Because p is of type pointT , we know that the domain of discourse is all possible points in 2D space

Mathematical Notation Example 4

- $\{p : \text{pointT} \mid x_{\text{left}} \leq p.\text{xcrd}() \leq x_{\text{left}} + \text{width} \wedge y_{\text{bot}} \leq p.\text{ycrd}() \leq y_{\text{bot}} + \text{height} : p\}$
- What does this notation mean?

Mathematical Notation Example 4

- $\{p : \text{pointT} \mid x_{\text{left}} \leq p.\text{xcrd}() \leq x_{\text{left}} + \text{width} \wedge y_{\text{bot}} \leq p.\text{ycrd}() \leq y_{\text{bot}} + \text{height} : p\}$
- What does this notation mean?
- Set of all points inside a box, including the boundaries

Mathematical Notation Example 4

- $\exists(t : \mathbb{R} \mid 0 \leq t \leq 1 : c.\text{cen}().\text{dist}(tp_1 + (1-t)p_2) \leq c.\text{rad}())$
- What does this notation mean?

Mathematical Notation Example 4

- $\exists(t : \mathbb{R} \mid 0 \leq t \leq 1 : c.\text{cen}().\text{dist}(tp_1 + (1-t)p_2) \leq c.\text{rad}())$
- What does this notation mean?
- True if the line and the circle overlap at least one point

Outline of Specification Topics

- Discussion of the term **specification**
- Types of specification
 - ▶ Operational
 - ▶ Data flow diagrams
 - ▶ UML diagrams
 - ▶ Mill's black-box
 - ▶ Finite state machines
 - ▶ Descriptive
 - ▶ Entity relationship diagrams
 - ▶ Logic-based notation
 - ▶ Algebraic specification
- Languages for modular specification
 - ▶ Statecharts
 - ▶ Tabular expressions

When do we use Specification?

- When do engineers use specifications?
- What documents require specifications?
- What are some examples of specifications?

Specification

- A broad term that means **definition**
- Used at different stages of software development for different purposes
- Generally, a statement or agreement (contract) between
 - ▶ Producer and consumer of a service
 - ▶ Implementer and user
- All desirable qualities must be specified

Uses of Specification

- Statement of user requirements
 - ▶ Major failures occur because of misunderstandings between the producer and the user
 - ▶ “The hardest single part of building a software system is deciding precisely what to build” (F. Brooks)
 - ▶ Precise description of the borderline bw the machine and the **environment** (end user and other systems)
- Statement of interface between the machine and the controlled environment
 - ▶ Serious undesirable effects can result due to misunderstandings between software engineers and domain experts about the phenomena affecting the control function to be implemented by software
 - ▶ Precise description of the borderline between the machine and the **environment** (devices controlled by machines)