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

Winter 2018

21 Intro to Specification (Ch. 5)

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21 Intro to Specification (Ch. 5)

- 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

- A2: Part 2: March 3, 2018 (note date change)
- A3
  - Part 1 - Specification: due 11:59 pm Mar 12
  - Part 2 - Code: due 11:59 pm Mar 26
- A4
  - Your own design and specification
  - Due April 9 at 11:59 pm
- Tutorial this week: Introduction to C++

Midterm Details

- February 28 (today!), 7:00 pm
  - Aani to Laurant: UH/213
  - Le to Zhou: T13/123-124
- 90 minute duration
- Multiple choice - 30 questions
- Bring
  - HB Pencil
  - Student Card
- No calculators
- Coats, backpacks and electronic devices to be left against the wall
- Come to the correct room
- Remember to fill in your version and student number

Midterm Examination

- Everything up to an including Friday, Feb 16, 2018
- Any questions?

Sample Question

s: sequence of integer

mystery(j):

- output: out := $+(i : \mathbb{N} | i \in s \wedge i \geq j : 1)$

What does the mystery access program return?

A. The sum of the entries in s that are greater or equal to j
B. The sum of the entries in s that are greater than j
C. A count of the number of entries in s that are greater or equal to j
D. A count of the number of entries in s that are greater than j
E. True if there exists an entry in s that is greater than j, False otherwise

Sample Question

s: sequence of integer

mystery(j):

- output: out := $+(i : \mathbb{N} | i \in [0..|s| - 1] \wedge s[i] \geq j : 1)$

Which of the following implements mystery(j) in Python?

A.
```
reduce(lambda a, b:  a+b, [1 for i in
range(len(s)) if s[i] >= j], 0)
```

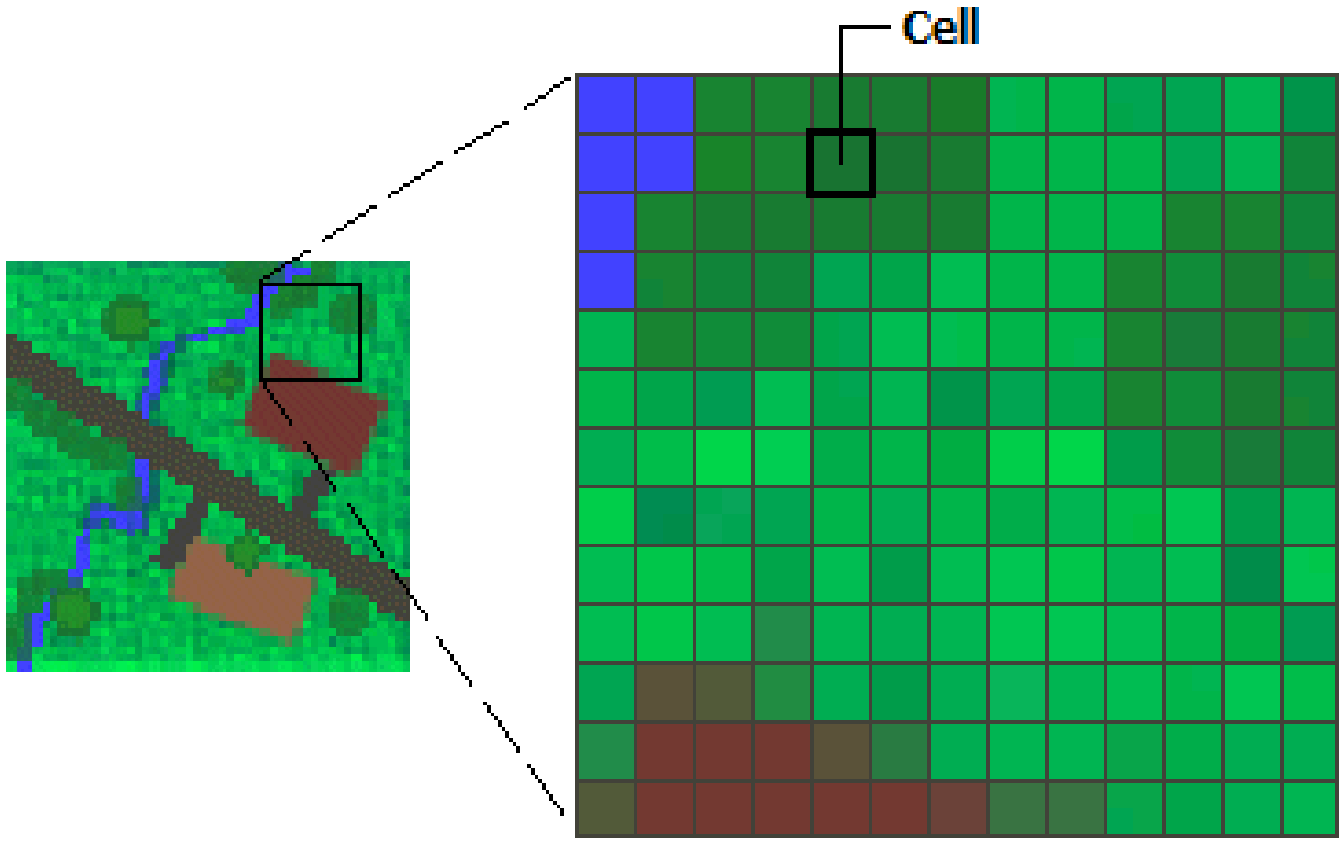
B.
```
reduce(lambda a, b:  a+b, [s[i] for i in
range(len(s)) if s[i] >= j], 0)
```

C.
```
reduce(lambda a, b:  a or b, [(i >= j) for i in
s], False)
```

D.
```
reduce(lambda a, b:  a or b, [(i >= j) for i in
s], True)
```

A3: Raster Based GIS Modules

- Motivated by existing technology
- Cells for data on
  - Landuse
  - Elevation



A3: Specify and Implement a Portion of GIS

- Focusing on the data model portion of the design
  - PointT (quick look)
  - LineT (quick look)
  - PathT
  - Seq2D(T)
- Part 1
  - Complete incomplete specification
  - Critique design of interface
  - Use LaTeX
- Part 2
  - Given complete specification
  - Implement and test in C++

Mathematical Notation Example 1

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

Mathematical Notation Example 1

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- What does this notation mean?
- $\{0, 1, 4, 9, 16, 25\}$

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

Mathematical Notation Example 1

- $\{x : \mathbb{N} | x \in [0..5] : x^2\}$
- 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

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

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- `sum(x % 2 == 0 for x in range(6))`, or

Mathematical Notation Example 2

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

Mathematical Notation Example 3

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

Mathematical Notation Example 3

- $\{p : \text{pointT} | p.\text{dist}(c.\text{cen}()) > c.\text{rad}() : p\}$
- 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

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

Mathematical Notation Example 4

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

Mathematical Notation Example 4

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

Mathematical Notation Example 4

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

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" (Brooks1987)
  - Precise description of the borderline b/w 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 b/w the machine and the environment (devices controlled by machines)