# CPSC 3720: Lecture 14: Intro to Math Modeling



Eileen T. Kraemer and Murali Sitaraman, Clemson
E-mails: etkraem@clemson.edu and murali@Clemson.edu

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# Some Mathematics is Implicit



- We view programming integers as though they are mathematical integers (subject to bounds, of course)
- We associate mathematical operators (e.g., +) with operations we can do on integers in programs (e.g., +)
- This association can be made explicit

# Mathematical Modeling



- **Type** Integer **is modeled by** Z;

  **For all** i: Integer,

  min_int <= i <= max_int;

# Alternatively



- **Type** Integer **is modeled by** Z;

  **Let** i **be an example**;

  **Constraints**

  min_int <= i <= max_int;

# Alternatively



- **Type** Integer **is modeled by** Z;
  **exemplar** i;
  **constraints**
  min_int <= i <= max_int;

# Initial Value Specification



- **Type** Integer **is modeled by** Z;
  **exemplar** i;
  **constraints**
  min_int <= i <= max_int;
  **initialization ensures** i = 0;

# Specification of Operations



- **Type** Integer **is modeled by** Z;

  ...

- Specification of operations, e.g., i++

  **Operation** Inc (**updates** i: Integer)
  **requires** i < max_int
  **ensures** i = #i +1

# More Examples



- What is a suitable way to model the state of a lightbulb?

# More Examples



**Type** Light_Bulb_State

**is modeled by** B;

**exemplar** b;

**Initialization ensures** b = **false**;

Exercises: specification of operations

Turn_on, Turn_off, and Is_On

# More Examples



- How would you model the state of a traffic light?

- Alternative models and discussion

# More Examples



- How would you model a paper weight?

# Mathematical Modeling Summary



- To write formal specifications, we need to model the state mathematically
- Some objects we use in programming, such as Integers and Reals, have implicit models
- For others, such as stacks, queues, lists, etc., we need to conceive explicit mathematical models