

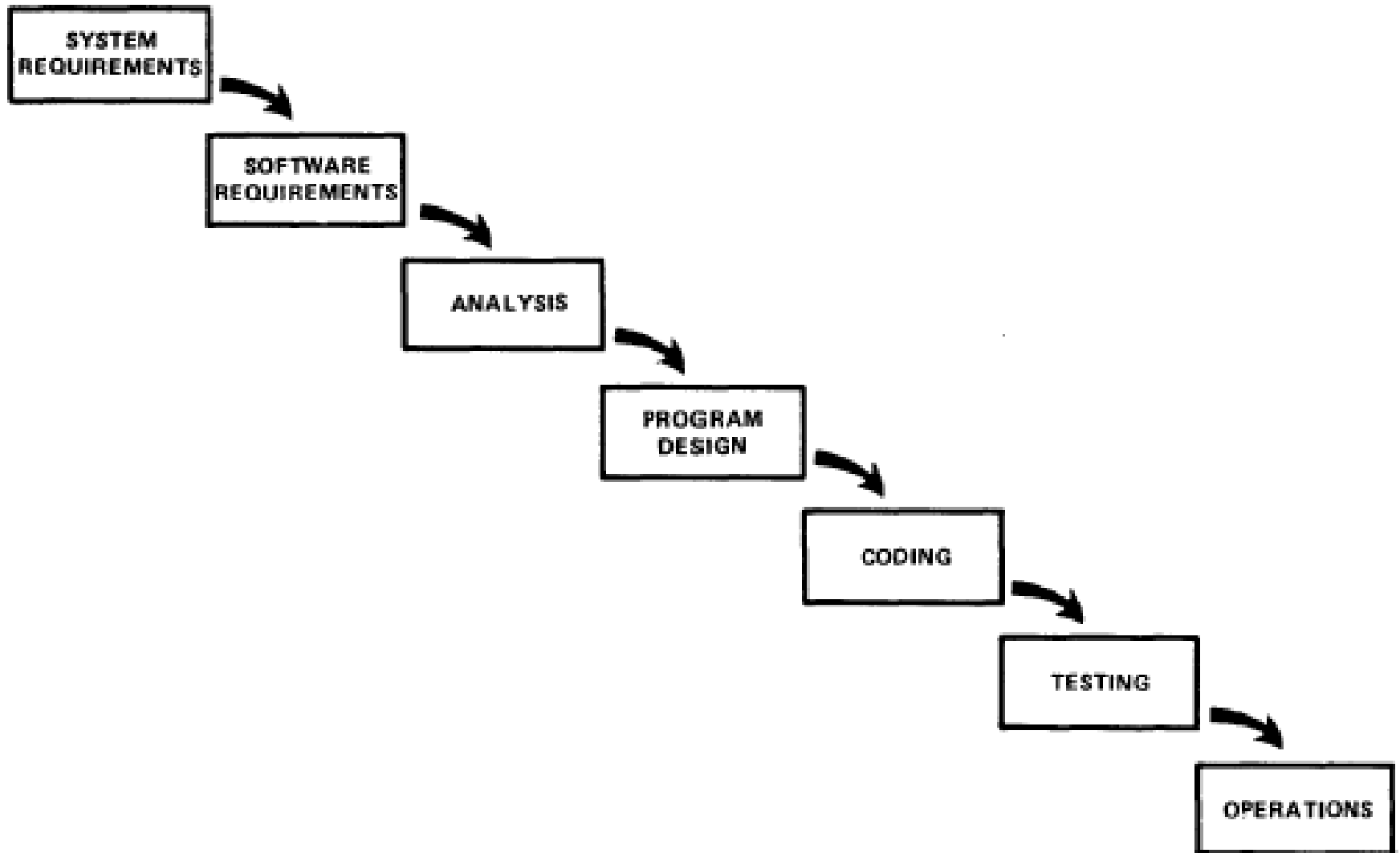
Announcements

- P3 due today
- P5 posted today
- No discussion/quiz next Thursday (July 4)
- Review session next Friday (July 5)

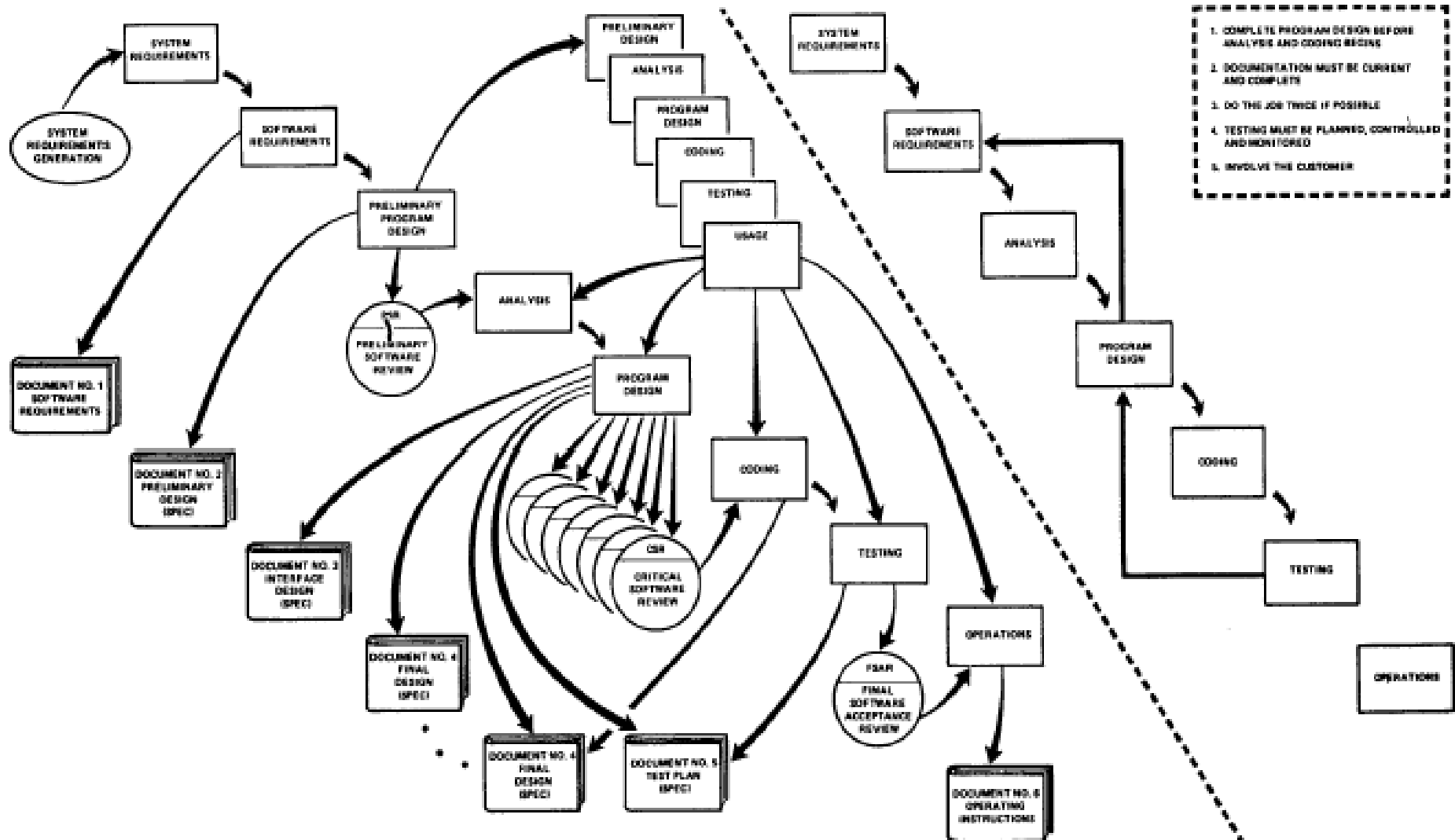
Design

- There are many different ways to write a program to do the same thing
- Good design choices make code easier to understand, test, debug, maintain, and extend
- Large-scale projects require teamwork
- Theory vs Practice: “Waterfall” model
 - Presented by Winston Royce (1970) as flawed
 - <http://www.cs.umd.edu/class/spring2003/cmsc838p/Process/waterfall.pdf>
 - Linked on resources page

Waterfall model



More realistic model



More on initializing fields

- Default initial values for fields:
 - Numeric primitives: zero
 - Booleans: false
 - Chars: ' '
 - Reference variables: null
- Non-default initialization
 - Instance fields can be initialized when declared
 - If final fields are initialized in every constructor, they do not need to be initialized when declared
- Local variables in methods (not static or instance fields) are not initialized by default.

Enumerated types

<http://docs.oracle.com/javase/tutorial/java/javaOO/enum.html>

- A type for representing categorical data
 - Days of the week
 - Months
 - Compass directions
- Similar to named constants but more type-safe
 - `BattleField.EMPTY == BasicSoldier.UP`

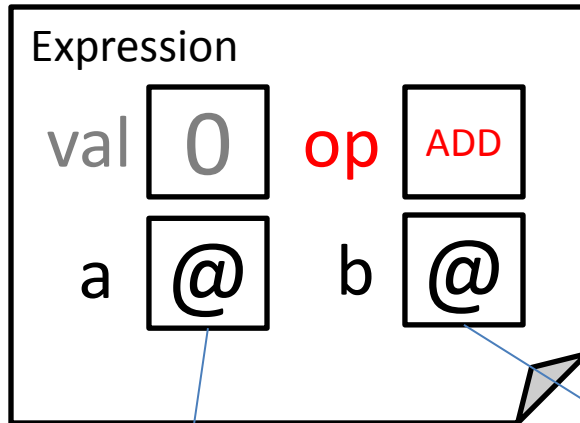
Enumerated types

- Declared with “enum” instead of “class”
- Similarities to classes:
 - Fields
 - Constructors
 - Methods
- Dissimilarities:
 - Instances are constant
 - Switchable

Direction Example

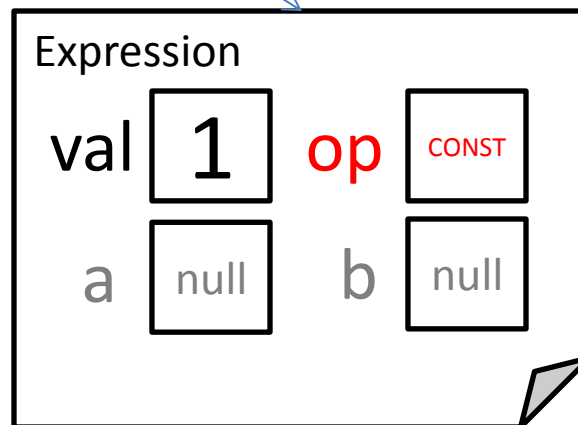
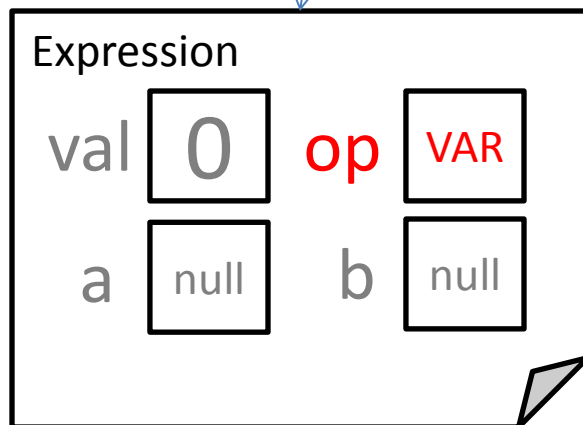
- Position: (row, col)
- Direction: UP, LEFT, DOWN, RIGHT
 - Position p = new Position(row, col);
 - p.move(UP); //(row + 0, col + 1)
- Compare with IntVector
 - Classes vs enums?

Expression example



Ops using enum

$$x + 1 \Big|_{x=3} = 4$$



String parsing

- String methods
 - <http://docs.oracle.com/javase/7/docs/api/java/lang/String.html>
 - indexOf: find first occurrence of character
 - Substring: extract the substring in the given range
- Double methods
 - parseDouble: convert a string to double
- Code examples

Immutable Classes

- Immutable objects can never be changed once they are constructed
 - Strings (vs StringBuffer)
 - Integers
 - IntLists and CharLists?
- Advantages:
 - Simple, bug-resistant, tamper-resistant
 - Never need to be copied
- Immutable classes vs enums?

Immutable design

- Classes are immutable *by design*
- Designing immutable classes:
 - Declare the class with the final keyword (more on this later)
 - Fields must be private or final
 - No setter methods
 - All mutable reference fields must be copied
 - When initialized
 - When returned by getters
 - Multi-threading considerations

Immutability examples

- Position/IntVector example revisited
- Privacy leaks: Primate/Dog example
 - If not designed carefully, private variables might still be accessible.

Complex number review

- Links through the project spec
- MIT open courseware:
 - <http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/lecture-6-complex-numbers-and-complex-exponentials/>
 - Linked on resources page