METRO STATE UNIVERSITY

Abstraction / Information Hiding / Pre & Post Conditions

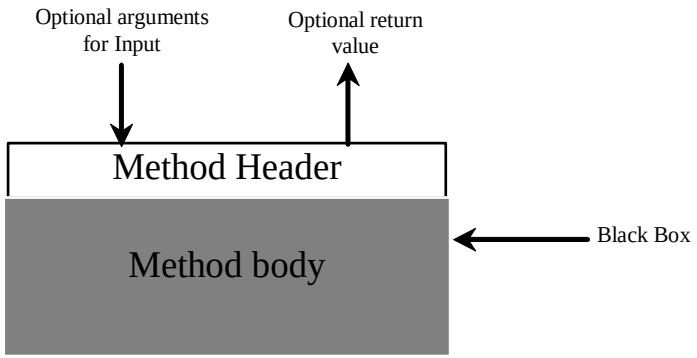
Complete: 9/5

Recall…

- Method = Function = Procedure
- A method is an agent you hire to do a job for you:
  - You give the agent some information (inputs)
  - Agent goes somewhere, does whatever calculations he needs
  - Agent comes back to you with the result (output)

Method Abstraction

You can think of a method as a black box that contains the detailed implementation for a specific task.



Notes:

- We ***don't know*** (and we ***don't care*** about) what calculations are done by the agent
- We are only interested in:
  - Information that is initially given to the agent (inputs)
  - Result that the agent will give back to us (output)

Slide provided by Thanaa M. Ghanem

Information Hiding I

- The idea of an API is to expose the interface that people will use without exposing the implementation details.
- Example: java.lang.Math class

static double	log(double a)	Returns the natural logarithm (base *e*) of a double value.
static double	log10(double a)	Returns the base 10 logarithm of a double value.

- This tells you what methods to call to find the natural or base 10 logarithms of a number.
- It doesn't (and shouldn't) tell how you they do it, although it's possible to look at the code and see it.

Method pre- and post-conditions

- Method ***preconditions*** tell a user what the method ***assumes to be true when called***, in order for the method to work correctly.

- Method ***postconditions*** tell
  - What ***values (if any) are returned***
  - What ***will be true*** when the method ***finishes execution***

- Method pre- and post-conditions ***should be documented for any nontrivial methods***.

Method pre- and post-conditions II

- Let's look at the log method from the Java API.

log

`public static double log(double a)`

Returns the natural logarithm (base *e*) of a `double` value. Special cases:

- If the argument is NaN or less than zero, then the result is NaN.
- If the argument is positive infinity, then the result is positive infinity.
- If the argument is positive zero or negative zero, then the result is negative infinity.
- If the argument is `1.0`, then the result is positive zero.

The computed result must be within 1 ulp of the exact result. Results must be semi-monotonic.

Parameters:

`a` - a value

Returns:

the value ln `a`, the natural logarithm of `a`.

Frequently a programmer must communicate precisely **what** a method accomplishes, without any indication of **how** the method does its work.

Can you think of a situation where this would occur ?

Example

You are the head of a programming team and you want one of your programmers to write a method for part of a project.

Example:

```
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
public void writeSqrt( double x)

   . . .
```

Example:

```
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
public void writeSqrt( double x)
```

- The precondition and postcondition appear as comments in your program.
- They are usually placed before the method's implementation.

Example:

```
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
public void writeSqrt( double x)
```

Here the precondition is that

x >= 0

whenever the method is called

Example

Which of these method calls meet the precondition ?

```
writeSqrt( -10 );
writeSqrt( 0 );
writeSqrt( 5.6 );
```

Example

Which of these method calls
meet the precondition ?

```
writeSqrt( -10 );
writeSqrt( 0 );
writeSqrt( 5.6 );
```

The second and third calls are fine, since the argument is greater than or equal to zero.

Example

Which of these method calls
meet the precondition ?

```
writeSqrt( -10 );
writeSqrt( 0 );
writeSqrt( 5.6 );
```

But this call violates the precondition because the argument is less than 0

Example:

```
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
public void writeSqrt( double x)
```

The post-condition indicates what work the method has accomplished.

In this example the square root of x has be written after the method completed.

Another Example

```
//   Precondition:  letter is an uppercase or
//   lowercase letter (in the range 'A' ... 'Z' or 'a' ... 'z') .
//   Postcondition:  The value returned by the
//   method is true if letter is a vowel;
//   otherwise the value returned by the method is
//   false.
public boolean isVowel( char letter )
```

. . .

Another Example

```
//   Precondition:  letter is an uppercase or
//   lowercase letter (in the range 'A' ... 'Z' or 'a' ... 'z') .
//   Postcondition:  The value returned by the
//   method is true if letter is a vowel;
//   otherwise the value returned by the method is
//   false.
public boolean isVowel( char letter )
```

. . .

Another Example

What values will be returned
by these method calls ?

```
isVowel( 'A' );
isVowel(' Z' );
isVowel( '?' );
```

Another Example

What values will be returned by these method calls ?

```
isVowel( 'A' );
isVowel(' Z' );
isVowel( '?' );
```

true

false

Nobody knows, because the precondition has been violated.

Another Example

What values will be returned by these method calls ?

```
isVowel( '?' );
```

Violating the precondition might even crash the program.

Always make sure the precondition is valid . . .

- The programmer who calls the method is responsible for **ensuring that the precondition is valid** when the method is called.

. . . so the post-condition becomes true at the method's end.

- The programmer who writes the method counts on the precondition being valid, and **ensures that the postcondition becomes true** at the method's end.

A Quiz

Suppose that you call a method, and you neglect to make sure that the precondition is valid.
Who is responsible if this inadvertently causes a 40-day flood or other disaster?

- You
- The programmer who wrote that torrential method
- Noah

A Quiz

Suppose that you call a method, and you neglect to make sure that the precondition is valid.
Who is responsible if this inadvertently causes a 40-day flood or other disaster?

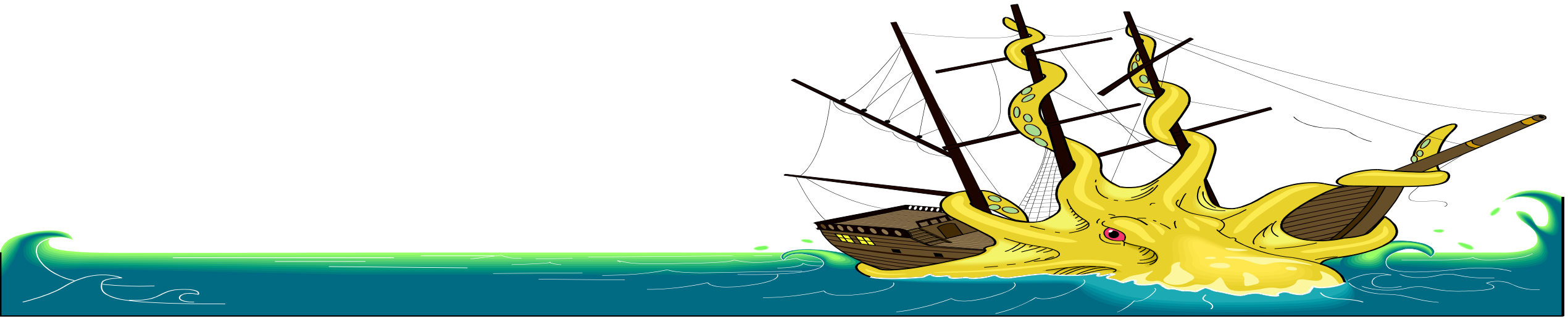
- **You**
- The programmer who wrote that torrential method
- Noah

On the other hand, careful programmers also follow these rules:

- When you write a method, you should make every effort to detect when a precondition has been violated.
- If you detect that a precondition has been violated, then print an error message and halt the program...

On the other hand, careful programmers also follow these rules:

- When you write a method, you should make every effort to detect when a precondition has been violated.
- If you detect that a precondition has been violated, then print an error message and halt the program...
- ...rather than causing a disaster.



Our Previous Example

```
//   Precondition:  x  >=  0.
//   Postcondition:  The square root of x has
//   been written to the standard output.
public void writeSqrt( double x)
{
    if (x < 0)
       throw new IllegalArgumentException("Negative x");

   . . .
```

Throwing an exception can be useful

Advantages of Using Preconditions and Postconditions

- Succinctly describes the behavior of a method…
- … without cluttering up your thinking with details of how the method works.
- At a later point, you may reimplement the method in a new way …
- … but programs (which only depend on the precondition/postcondition) will still work with no changes.

Summary about pre/post-conditions

Precondition

- The programmer who calls a method ensures that the precondition is valid.
- The programmer who writes a method can bank on the precondition being true when the method begins execution.

Postcondition

- The programmer who writes a method ensures that the post-condition is true when the method finishes executing.

Q3

- Consider the methods you wrote in Q2:
  - Can you write the preconditions
  - Can you write the post-conditions?
  - Can you write some statements that detect when the precondition is violated and print a message?