FINAL REVIEW

Stronger vs Weaker (one more time!)

- Requires more?

weaker

- Promises more? (stricter specifications on what the effects entail)

stronger

Stronger vs Weaker

```
@requires key is a key in this
@return the value associated with key
@throws NullPointerException if key is null
```

A. `@requires key is a key in this and key != null`
   `@return the value associated with key`
   WEAKER

B. `@return the value associated with key if key is a key in this, or null if key is not associated with any value`
   NEITHER

C. `@return the value associated with key`
   `@throws NullPointerException if key is null`
   `@throws NoSuchElementException if key is not a key this`
   STRONGER

Subtypes & Subclasses

- Subtypes are substitutable for supertypes
- If `Foo` is a subtype of `Bar`, `G<Foo>` is a **NOT** a subtype of `G<Bar>`
  - Aliasing resulting from this would let you add objects of type `Bar` to `G<Foo>`, which would be bad!
  - Example:

```
List<String> ls = new ArrayList<String>();
List<Object> lo = ls;
lo.add(new Object());
String s = ls.get(0);
```

- Subclassing is done to reuse code (extends)
  - A subclass can override methods in its superclass

Typing and Generics

- <?> is a wildcard for unknown
  - Upper bounded wildcard: type is wildcard or subclass
    - Eg: `List<? extends Shape>`
    - Illegal to write into (no calls to add!) because we can't guarantee type safety.
  - Lower bounded wildcard: type is wildcard or superclass
    - Eg: `List<? super Integer>`
    - May be safe to write into.

Subtypes & Subclasses

```
class Student extends Object { ... }
class CSEStudent extends Student { ... }
```

```
List<Student> ls;
List<? extends Student> les;
List<? super Student> lss;
List<CSEStudent> lcse;
List<? extends CSEStudent> lecse;
List<? super CSEStudent> lscse;
Student scholar;
CSEStudent hacker;
```

ls = lcse; ✗

les = lscse; ✗

lcse = lscse; ✗

les.add(scholar); ✗

lscse.add(scholar); ✗

lss.add(hacker); ✓

scholar = lscse.get(0); ✗

hacker = lecse.get(0); ✓

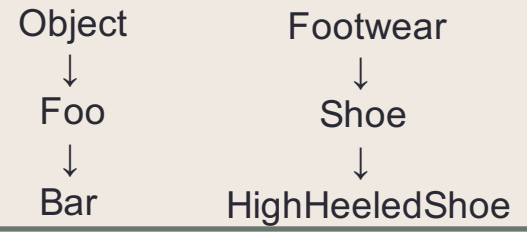
Subclasses & Overriding

```
class Foo extends Object {
     Shoe m(Shoe x, Shoe y){ ... }
}

class Bar extends Foo {...}
```

Method Declarations in Bar

- The result is method overriding
- The result is method overloading
- The result is a type-error
- None of the above



- FootWear m(Shoe x, Shoe y) { ... } **type-error**
- Shoe m(Shoe q, Shoe z) { ... } **overriding**
- HighHeeledShoe m(Shoe x, Shoe y) { ... } **overriding**
- Shoe m(FootWear x, HighHeeledShoe y) { ... } **overloading**
- Shoe m(FootWear x, FootWear y) { ... } **overloading**
- Shoe m(Shoe x, Shoe y) { ... } **overriding**
- Shoe m(HighHeeledShoe x, HighHeeledShoe y) { ... } **overloading**
- Shoe m(Shoe y) { ... } **overloading**
- Shoe z(Shoe x, Shoe y) { ... } **none (new method declaration)**

Design Patterns

- Creational patterns: get around Java constructor inflexibility
  - Sharing: singleton, interning, flyweight
  - Telescoping constructor fix: builder
  - Returning a subtype: factories
- Structural patterns: translate between interfaces
  - Adapter: same functionality, different interface
  - Decorator: different functionality, same interface
  - Proxy: same functionality, same interface, restrict access
  - All of these are types of wrappers

Design Patterns

- Interpreter pattern:
  - Collects code for similar objects, spreads apart code for operations (classes for objects with operations as methods in each class)
  - Easy to add objects, hard to add methods
  - Instance of Composite pattern
- Procedural patterns:
  - Collects code for similar operations, spreads apart code for objects (classes for operations, method for each operand type)
  - Easy to add methods, hard to add objects
  - Ex: Visitor pattern

Design Patterns

Adapter, Builder, Composite, Decorator, Factory, Flyweight, Iterator, Intern, Interpreter, Model-View-Controller (MVC), Observer, Procedural, Prototype, Proxy, Singleton, Visitor, Wrapper

- What pattern would you use to…
  - add a scroll bar to an existing window object in Swing
    - Decorator
  - We have an existing object that controls a communications channel. We would like to provide the same interface to clients but transmit and receive encrypted data over the existing channel.
    - Proxy
  - When the user clicks the “find path” button in the Campus Maps application (hw9), the path appears on the screen.
    - MVC
    - Observer