Material and some slide content from:
- Mehdi Amoui Kalareh
- Fowler Refactoring book

Code Smells & Refactoring

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Lecture 18 - Tuesday November 22 2011.

Program restructuring

- Software systems represent massive investments.
- To maintain their value, systems must evolve.
- The majority (>75%) of software development takes place on existing systems.
- Software maintenance / evolution comprises the largest proportion of a system's total budget.
- Systems are modified to:
  - Fix defects.
  - Add new features.
  - Support environmental changes.

Reasons for change

- Corrective:
- Adaptive:
- Perfective:
- Preventative:

(% from SE Matinenance, Hans van Vilet)

Reducing change frequency

- Higher quality --> less maintenance
- Predicting changes --> less maintenance
- Better requirements --> less maintenance
- Less code --> less maintenance
- Regularly perform preventative maintenance

Lehman’s Laws

- Belady & Lehman proposed 8 laws of software evolution (beginning in 1974)
- #1 - Systems must evolve
- #2 - Systems will become increasingly complex
- #6 - Systems must gain new functionality
- Lehman’s advice:
  - Complexity must be managed
  - Systems must be periodically redesigned and refined
  - System and development process is a feedback loop

Why is maintenance hard?

- Unstructured and complex code
  - Low quality
  - Poor initial design
  - Lack of preventative maintenance
- Insufficient domain knowledge
  - Change requests push original design
- Insufficient / stale documentation

Code smells

- Symptoms that hint at deeper problems
- Can also be considered anti-patterns
- Five core groups of smells:
  - Bloaters: size becomes overwhelming
    - long method, large class, prim. obsession, long param list, data clump
  - OO abusers: OO design not leveraged
    - switch statements, temp field, refused bequest, classes w/ similar interfaces
  - Change preventers: Hinder further evolution
    - divergent change, shotgun surgery, parallel inheritance hierarchy
  - Dispensables: Unnecessary complexity
    - lazy class, data class, duplicate code, dead code, speculative generality
  - Couplers: Unnecessary coupling
    - feature envy, inappropriate intimacy, message chains, middle man

Removing smells

- Using refactoring; 3 main steps:
  - Understand
  - Transform
  - Refine
- Program behaviour should be unchanged
  - Appropriate testing is crucial
- Refactorings happen in small steps
  - Test at each step to make sure everything works

Refactoring

- Should happen as you learn better techniques
- Rule of threes:
  - 1) Code it up
  - 2) Code it again (but wince)
  - 3) Refactor

OO abuser: switch

- ```
  class Animal {
     final int MAMMAL = 0, BIRD = 1, REPTILE = 2;
     int myKind;  // set in constructor
     ...
     String getSkin() {
        switch (myKind) {
           case MAMMAL: return "hair";
           case BIRD: return "feathers";
           case REPTILE: return "scales";
           default: return "integument";
        }
     }
  }
  ```

BEFORE

[adding Insect is easy]
[subclasses probably differ]
[avoid other switches]

- ```
  class Animal {
       String getSkin() { return "integument"; }
  }
  class Mammal extends Animal {
       String getSkin() { return "hair"; }
  }
  class Bird extends Animal {
       String getSkin() { return "feathers"; }
  }
  class Reptile extends Animal {
       String getSkin() { return "scales"; }
  }
  ```

AFTER

Speculative generality example

```
interface MessageStrategy {
   public void sendMessage();
}

abstract class AbstractStrategyFactory {
   public abstract MessageStrategy createStrategy(MessageBody mb);
}
```

```
class MessageBody {
   Object payload;
   public Object getPayload() {
      return payload;
   }
   public void configure(Object obj) {
      payload = obj;
   }
   public void send(MessageStrategy ms) {
      ms.sendMessage();
   }
}
```

STRATEGY

ABSTRACT FACTORY

SINGLETON

```
class DefaultFactory extends AbstractStrategyFactory {
   private DefaultFactory() {
   }
   static DefaultFactory instance;
   public static AbstractStrategyFactory getInstance() {
      if (instance == null)
         instance = new DefaultFactory();
      return instance;
   }
   public MessageStrategy createStrategy(final MessageBody mb) {
      return new MessageStrategy() {
         MessageBody body = mb;
         public void sendMessage() {
            Object obj = body.getPayload();
            System.out.println(obj);
         }
      };
   }
}
```

```
public class HelloWorld {
   public static void main(String[] args) {
      MessageBody mb = new MessageBody();
      mb.configure("Hello World!");
      AbstractStrategyFactory asf = DefaultFactory.getInstance();
      MessageStrategy strategy = asf.createStrategy(mb);
      mb.send(strategy);
   }
}
```

Bloater: long method

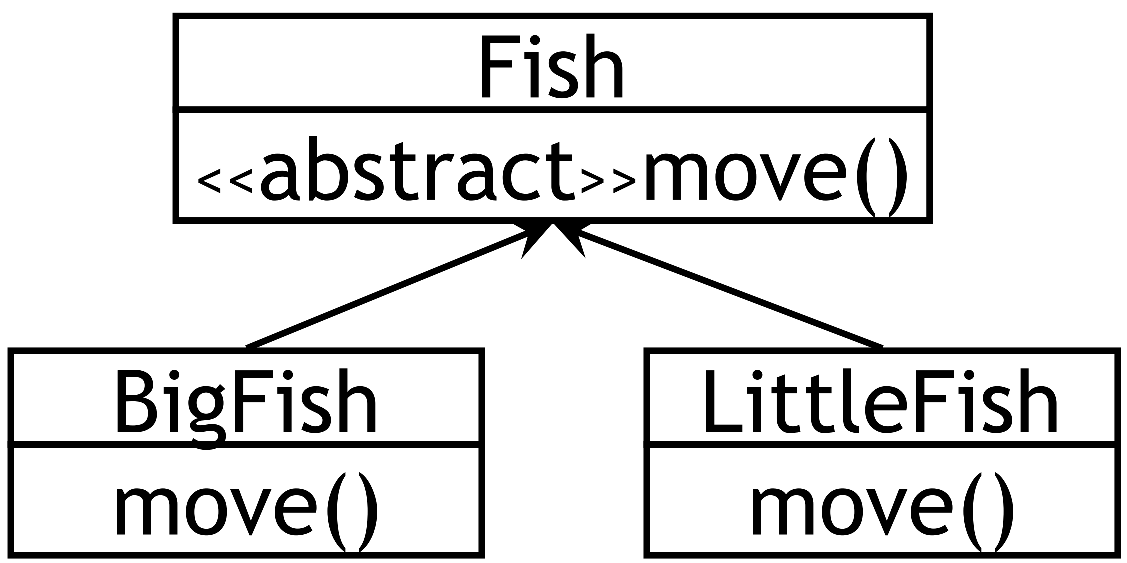
```
public void add(Object element) {
  if (!readOnly) {
    int newSize = size + 1;
    if (newSize > elements.length) {
      Object[] newElements =
        new Object[elements.length + 10];
      for (int i = 0; i < size; i++)
        newElements[i] = elements[i];
      elements = newElements;
    }
    elements[size++] = element;
  }
}
```

→

```
public void add(Object element) {
  if (readOnly)
    return;
  if (atCapacity())
    grow();
  addElement(element);
}
```

Dispensables: duplicate code

- Template method can reduce duplicate code.
- Consider two fish:
    - Big fish randomly move anywhere
    - Little fish move anywhere except where big fish are.



Fish example

General outline of the method:

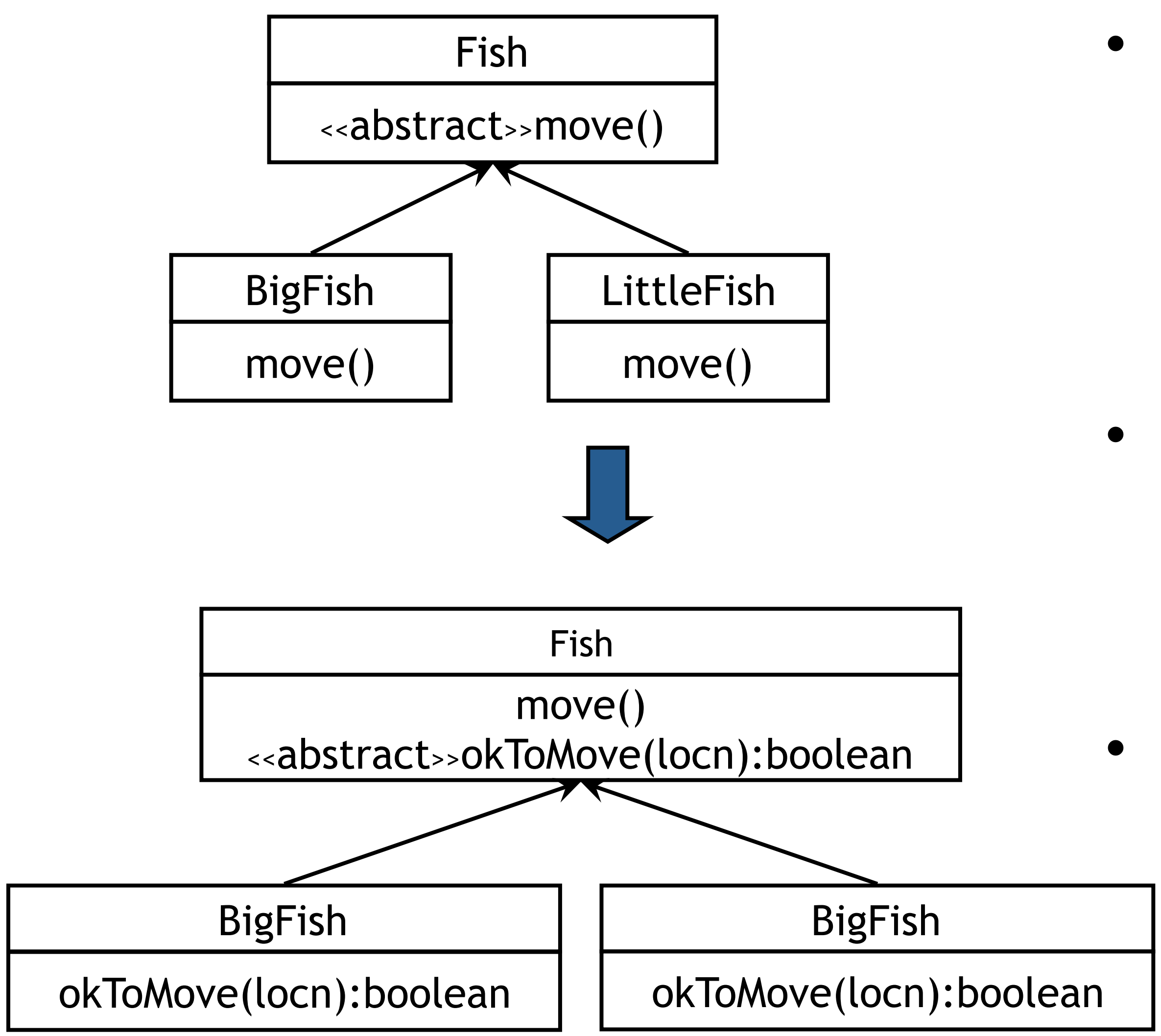
```
public void move() {
    choose a random direction;           // same for both
    find the location in that direction; // same for both
    check if it's ok to move there;      // different
    if it's ok, make the move;           // same for both
}
```

Solution:

- Extract the check on whether it's ok to move
- In the Fish class, put the actual (template) move() method
- Create an abstract okToMove() method in the Fish class
- Implement okToMove() in each subclass

Fish example

- Use a template to vary specific detail without duplicating code.



- Note how this works: When a BigFish tries to move, it uses the move() method in Fish
- But the move() method in Fish uses the okToMove(locn) method in BigFish
- And similarly for LittleFish