# CS 520

Theory and Practice of Software Engineering
Fall 2020

**Best and worst programming practices**

September 1, 2020

## Reminder

**Class website:**
https://people.cs.umass.edu/~hconboy/class/2020Fall/CS520/

**Schedule:**

(subject to change; check regularly)

| week | date | day | topic | homework | project |
|---|---|---|---|---|---|
| Week 1 | Aug 25 | Tu | Course introduction | | |
| | Aug 27 | Th | Software architecture and design | | |
| Week 2 | Sep 1 | Tu | Best and worst programming practices | | Project topic selection Due: Thu Sep 24, 2020, 9:00AM EDT |
| | Sep 3 | Th | Object oriented design principles | | |
| Week 3 | Sep 8 | Tu | Object oriented design patterns | Homework 1.1: Design & programming practices | |
| | Sep 10 | Th | User interfaces | | |
| Week 4 | Sep 15 | Tu | Version control | | |
| | Sep 17 | Th | In-class exercise: Advanced uses of git. Due Sep 22. | | |

## Reminder

**Class website:**
https://people.cs.umass.edu/~hconboy/class/2020Fall/CS520/

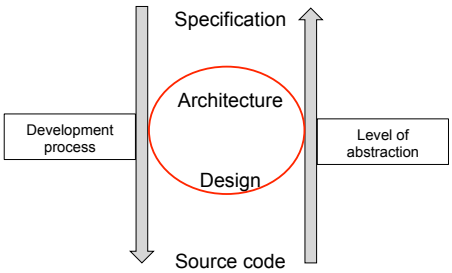
**Instructor:** Heather Conboy
Office hours:

- Mondays 1:00 – 2:00 PM
- After Thursday lectures for 1 hour
- By appointment

Email: hconboy@cs.umass.edu

**Graders:** Mitali Dave and Karishma Jain

## Recap: software architecture vs. design

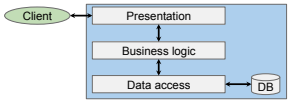



What's the difference?

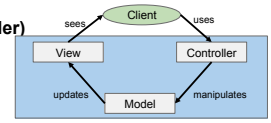
## Recap: software architecture examples

- **Pipe and filter**

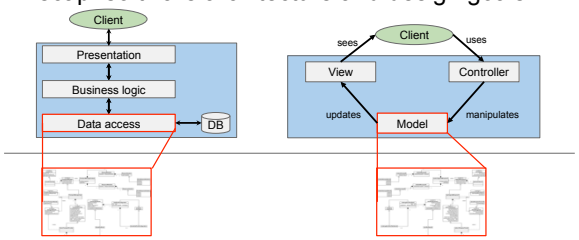

- **N-tier / client-server**




- **MVC (Model-View-Controller)**




## Recap: software architecture and design goals




**Architecture and design goals**

- Lower complexity: separation of concerns, well defined interfaces
- Simplify communication
- Allow effort estimation and progress monitoring

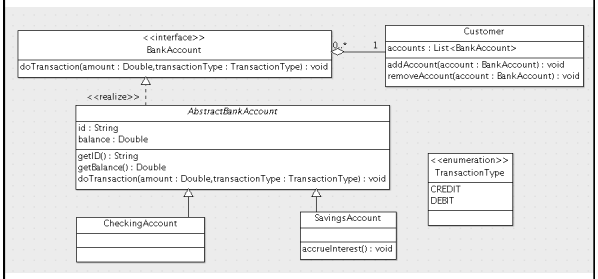
## Example: Bank Account Requirements (in Natural Language)

1. Declare an interface for a *BankAccount* with a method for *doTransaction* that takes as input an amount (as a Double) and a transaction type (either CREDIT or DEBIT)
2. Declare an abstract class for an *AbstractBankAccount* with appropriate fields
3. Declare a concrete class for *CheckingAccount*
4. Declare a concrete class for *SavingsAccount* with a method *accrueInterest*()
5. Declare a concrete class for *Customer* who may have zero or more BankAccounts

## Example: Bank Account Design (as a UML Class Diagram)

- Will use the ArgoUML editor: https://www.filehorse.com/download-argouml (for Mac or Windows)
- There are many other UML editors (and specifically UML class diagram editors)

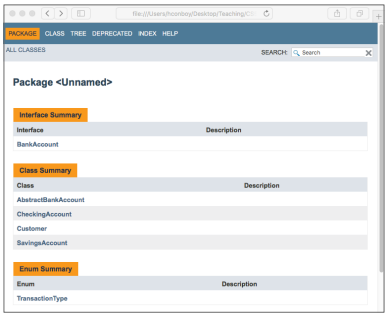
## Example: Bank Account Design (as a UML Class Diagram)




## Example: Bank Account Implementation (Written in Java)

```java
public enum TransactionType { CREDIT, DEBIT; }
public interface BankAccount {
  public void doTransaction(Double amount, TransactionType transactionType);
}
public abstract class AbstractBankAccount implements BankAccount {
  private String id;
  private Double balance;
  public String getID() { return null; }
  public Double getBalance() { return null; }
  public void doTransaction(Double amount, TransactionType transactionType) { }
}
public class CheckingAccount extends AbstractBankAccount { }
public class SavingsAccount extends AbstractBankAccount {
  public void accrueInterest() { }
}
public class Customer {
  private java.util.List<BankAccount> accounts;
  public void addAccount(BankAccount account) { }
  public void removeAccount(BankAccount account) { }
}
```

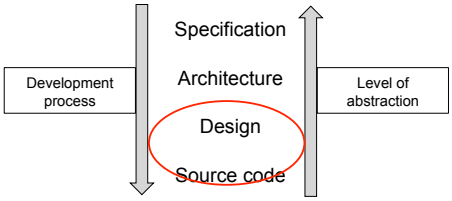
## Example: Bank Account Documentation (Generated by javadoc)




https://www.oracle.com/java/technologies/javase/javadoc-tool.html

## Today

- An in-class discussion on best and worst programming practices.



## setup and goals

- 4-person teams
- 6 code snippets
- 4 rounds
  - **First round**
    - For each of 3 code snippets, decide whether it represents good or bad practice.
    - **Goal:** discuss and reach consensus on good or bad practice.
  - **Second round** (known solutions)
    - For each code snippet, try to understand why it is good or bad practice.
    - **Goal:** come up with one or more explanations or a counter argument.

  and then repeat with 3 more code snippets

## Round 1: good or bad?

## Snippet 1: good or bad?

```
public File[] getAllLogs(Directory dir) {
   if (dir == null || !dir.exists() || dir.isEmpty()) {
      return null;
   } else {
      int numLogs = … // determine number of log files
      File[] allLogs = new File[numLogs];
      for (int i=0; i<numLogs; ++i) {
         allLogs[i] = … // populate the array
      }
      return allLogs;
   }
}
```

## Snippet 2: good or bad?

```
public void addStudent(Student student, String course) {
   if (course.equals("CS520")) {
      cs520Students.add(student);
   }
   allStudents.add(student)
}
```

## Snippet 3: good or bad?

```
public enum PaymentType {DEBIT, CREDIT}
public void doTransaction(double amount, PaymentType payType) {
  switch (payType) {
    case DEBIT:
       … // process debit card
       break;
    case CREDIT:
       … // process credit card
       break;
    default:
       throw new IllegalArgumentException("Unexpected payment type");
   }
}
```

## Solutions

- Snippet 1: bad
- Snippet 2: bad
- Snippet 3: good

## Round 2: why is it good or bad?

## Snippet 1: this is bad! why?

```
public File[] getAllLogs(Directory dir) {
   if (dir == null || !dir.exists() || dir.isEmpty()) {
      return null;
   } else {
      int numLogs = … // determine number of log files
      File[] allLogs = new File[numLogs];
      for (int i=0; i<numLogs; ++i) {
         allLogs[i] = … // populate the array
      }
      return allLogs;
   }
}
```

## Snippet 1: this is bad! why?

```
public File[] getAllLogs(Directory dir) {
   if (dir == null || !dir.exists() || dir.isEmpty()) {
      return null;
   } else {
      int numLogs = … // determine number of log files
      File[] allLogs = new File[numLogs];
      for (int i=0; i<numLogs; ++i) {
         allLogs[i] = … // populate the array
      }
      return allLogs;
   }
}
```

```
File[] files = getAllLogs();
for (File f : files) {
   …
}
```

Don't return null; return an empty array instead.

## Snippet 2: short but bad! why?

```
public void addStudent(Student student, String course) {
   if (course.equals("CS520")) {
      cs520Students.add(student);
   }
   allStudents.add(student)
}
```

## Snippet 2: short but bad! why?

```
public void addStudent(Student student, String course) {
   if (course.equals("CS520")) {
      cs520Students.add(student);
   }
   allStudents.add(student)
}
```

Defensive programming: write the literal first (or add an explicit assertion).

## Snippet 3: this is good, but why?

```
public enum PaymentType {DEBIT, CREDIT}
public void doTransaction(double amount, PaymentType payType) {
  switch (payType) {
    case DEBIT:
       … // process debit card
       break;
    case CREDIT:
       … // process credit card
       break;
    default:
       throw new IllegalArgumentException("Unexpected payment type");
   }
}
```

## Snippet 3: this is good, but why?

```
public enum PaymentType {DEBIT, CREDIT}
public void doTransaction(double amount, PaymentType payType){
  switch (payType) {
    case DEBIT:
       … // process debit card
       break;
    case CREDIT:
       … // process credit card
       break;
    default:
      throw new IllegalArgumentException("Unexpected payment type");
  }
}
```

Type safety using an enum; throws an exception for unexpected cases (e.g., future extensions of PaymentType).

## Round 3: more snippets

## Snippet 4: good or bad?

```
public int getAbsMax(int x, int y) {
  if (x<0) {
    x = -x;
  }
  if (y<0) {
    y = -y;
  }
  return Math.max(x, y);
}
```

## Snippet 5: good or bad?

```
public class ArrayList<E> {
   public E remove(int index) {
      …
   }
   public boolean remove(Object o) {
      …
   }
   …
}
```

## Snippet 6: good or bad?

```
public class Point {
   private final int x;
   private final int y;
   public Point(int x, int y) {
      this.x = x;
      this.y = y;
   }
   public int getX() {
      return this.x;
   }
   public int getY() {
      return this.y;
   }
}
```

## Solutions

- Snippet 1: bad
- Snippet 2: bad
- Snippet 3: good
- Snippet 4: bad
- Snippet 5: bad
- Snippet 6: good

## Round 4: why is it good or bad?

## Snippet 4: also bad! huh?

```
public int getAbsMax(int x, int y) {
  if (x<0) {
    x = -x;
  }
  if (y<0) {
    y = -y;
  }
  return Math.max(x, y);
}
```

## Snippet 4: also bad! huh?

```
public int getAbsMax(int x, int y){
  if (x<0) {
    x = -x;
  }
  if (y<0) {
    y = -y;
  }
  return Math.max(x, y);
}
```

Method parameters should be final; use local variables to sanitize inputs.

## Snippet 5: Java API, but still bad! why?

```
public class ArrayList<E> {
   public E remove(int index) {
      …
   }
   public boolean remove(Object o) {
      …
   }
   …
}
```

## Snippet 5: Java API, but still bad! why?

```
public class ArrayList<E> {
   public E remove(int index) {
      …
   }
   public boolean remove(Object o) {
      …
   }
   …
}
```

```
ArrayList<String> l = new ArrayList<>();
Integer index = new Integer(1);
l.remove(index);
```

Avoid method overloading, which is statically resolved. Autoboxing/unboxing adds additional confusion.

## Snippet 6: this is good, but why?

```
public class Point {
   private final int x;
   private final int y;
   public Point(int x, int y) {
      this.x = x;
      this.y = y;
   }
   public int getX() {
      return this.x;
   }
   public int getY() {
      return this.y;
   }
}
```

## Snippet 6: this is good, but why?

```
public class Point {
   private final int x;
   private final int y;
   public Point(int x, int y) {
      this.x = x;
      this.y = y;
   }
   public int getX() {
      return this.x;
   }
   public int getY() {
      return this.y;
   }
}
```

Good encapsulation; immutable object.

## Code reviewing

## Code reviewing

Illustrated by the snippets:

- Decomposition into modules/packages, classes, and methods
- Encapsulation of methods and fields
- Type safety for methods (e.g., enum types instead of ints)
- Pre- and post-conditions for methods (e.g., defensive programming techniques, assertions)

Additionally should consider:

- Naming conversions
- Internal comments?
- Test suite?

## Final project description

- Each team of 4-5 will carry out **one** of the following projects:
  - MSR 2020 Mining Challenge
  - Replication Study
  - Model Inference for Inferring Processes
  - EleNa: Elevation-based Navigation
- The key phases of the project are: topic selection, mid-point presentation, final presentation (and documentation)
- More details available here: https://people.cs.umass.edu/~hconboy/class/2020Fall/CS520/finalProject.pdf