Software Engineering Processes

Course Code: XB_0089

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Part 1: What is Software Quality?

What is Software Quality?

Software quality refers to the degree to which software conforms to its requirements and meets the needs of its users.

What is Software Quality?

Definition 1: "The capability of a software product to satisfy stated and implied needs when used under specified conditions."

Definition 2: Software quality depends on "the degree to which those established requirements accurately represent stakeholder needs, wants, and expectations."

What is Software Quality?

- High quality software meets its requirements, which in turn should accurately reflect stakeholder needs.
- Quality is about aligning the software with both its formal requirements as well as true user needs.

Part 2: Errors, Defects, Failures

What Are Errors, Defects, Failures?

- **Error** A human mistake made by a developer.
 - An example is misunderstanding a requirement and coding to the wrong specification.
- **Defect** A flaw or imperfection inserted into a software due to an error.
 - An example is a bug in the code or issues with other artifacts like requirements. Defects get inserted when errors are made.
- **Failure** The termination of the software's ability to function as intended.
 - Occur when the software executing encounters a defect.
 - The user experiences the software failing in some unintended way.

Part 3: Software Quality Management

Software Quality Management

- Quality planning Defining quality objectives, requirements, targets, and planning of quality assurance.
- Quality control Techniques to measure quality characteristics, review work products, and find defects.
- Quality assurance Processes to ensure compliance with procedures.
- Quality improvement Defect analysis and process enhancements.
- Resources Infrastructure, tools, training that enable quality processes.
- ☐ Standards Regulations, models, certifications that guide quality work.
- Culture Values, behaviors that encourage quality mindset.

How to Control Software Quality?

- Testing the software
- Static analysis of software
- Dynamic analysis of software
- **...**

Part 4: Software Evaluation

What is Evaluation?

- The making of a judgement about the amount, number, or value of something
- Assessment, judgement, rating, ...

How is Software Evaluated?

- Various points of view:
 - Functionality
 - Performance
 - Quality
 - Usability
 - Maintainability

- Various approaches:
 - Quantitative
 - Qualitative
 - □ ...

Part 4: Software Metrics

What Represents a Good Software Metric?

- Comparability
 - Allows comparisons between software systems
 - Metric values can be compared
- Intuitive interpretation
 - Concerns what the metric tells you about the system
 - A metric should be interpreted also by a non-expert in the domain
- Simple and efficient computation
 - Compute the metric with little effort

Examples of Software Metrics

■ LOC – lines of code (or NLOC – number of lines of code)

Examples of Software Metrics

- Chidamber and Kemerer (**CK**) Metrics Suite
 - Metrics for object-oriented software
 - Examples:
 - Weighted Methods per Class (WMC): measures the complexity of a class by assessing the sum of complexities of its methods
 - Number Of Children (NOC): represents the number of immediate subclasses a class has; provides an understanding of class reuse and potential dependencies
 - Coupling Between Object Classes (CBO): measures the number of classes to which a class is coupled; helps in evaluating the level of interdependence among classes

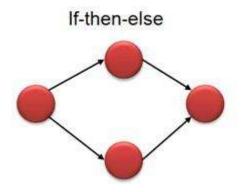


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Examples of Software Metrics

- McCabe Cyclomatic Complexity Metric
 - A quantitative measure of independent paths in the source code of the software product
 - An independent path is that path which has at least one edge that has not been yet traversed in any other path

- V(G) = E N + 2
 - E = number of edges,
 - N = number of nodes



Tools for Software Evaluation & Quality Assessment

- Understand
- SonarQube





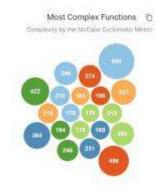
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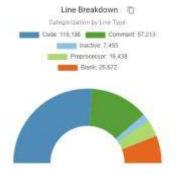


Understand code.

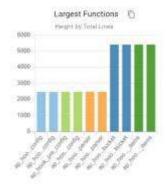
- Discover how Legacy Code fits together
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- Cain valuable insight with Metrics
- Onboard new team members quickly

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Part 5: Quality Attributes

Quality Attributes

- ISO/IEC 25010
- https://iso25000.com/index.php/en/iso-25000-standards/iso-25010

		SOFTWARE PRODUCT QUALITY						
FUNCTIONAL SUITABILITY	PERFORMANCE EFFICIENCY	COMPATIBILITY	INTERACTION CAPABILITY	RELIABILITY	SECURITY	MAINTAINABILITY	FLEXIBILITY	SAFETY
FUNCTIONAL COMPLETENESS FUNCTIONAL CORRECTNESS FUNCTIONAL APPROPRIATENESS	TIME BEHAVIOUR RESOURCE UTILIZATION CAPACITY	CO-EXISTENCE INTEROPERABILITY	APPROPRIATENESS RECOGNIZABILITY LEARNABILITY OPERABILITY USER ERROR PROTECTION USER ENGAGEMENT INCLUSIVITY USER ASSISTANCE SELF- DESCRIPTIVENESS	FAULTLESSNESS AVAILABILITY FAULT TOLERANCE RECOVERABILITY	CONFIDENTIALITY INTEGRITY NON-REPUDIATION ACCOUNTABILITY AUTHENTICITY RESISTANCE	MODULARITY REUSABILITY ANALYSABILITY MODIFIABILITY TESTABILITY	ADAPTABILITY SCALABILITY INSTALLABILITY REPLACEABILITY	OPERATIONAL CONSTRAINT RISK IDENTIFICATION FAIL SAFE HAZARD WARNING SAFE INTEGRATION

Performance Efficiency

- Represents the degree to which a software performs its functions within specified time and is efficient in the use of resources (such as CPU, memory, storage, network devices, energy, materials...) under specified conditions.
- **Time behaviour -** Degree to which the response time and throughput rates of a software, when performing its functions, meet requirements.
- **Resource utilization -** Degree to which the amounts and types of resources used by a software, when performing its functions, meet requirements.
- Capacity Degree to which the maximum limits of a software parameter meet requirements.

Part 5: Code Smells and Refactoring

Code Smells

- Indicators of potential issues (deeper problems) in the code over time
- Results of poor or misguided programming (e.g., not conforming to the SOLID principles)
 - 1. Single Responsibility
 - 2. Open/Closed
 - 3. Liskov Substitution
 - 4. Interface Segregation
 - 5. Dependency Inversion

Examples of Code Smells

- Large/God Class
- Long Method
- Duplicated Code
- Switch Statement
- Feature Envy

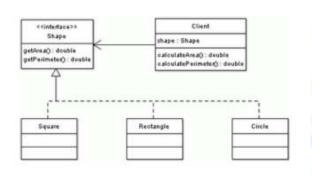
Example 1

```
Large Class Code Smell
public class Student {
          private String name, surname;
          private String streetName;
          private int streetNumber;
          private int grades[];
          public void Student () {...}
          public boolean addGrade (int grade) {...}
          public boolean removeGrade (int grade) {...}
          public void listGrade () {...}
          public boolean changeAddress (String newName, int newNumber) {...}
```

Example 2

```
public class Client {
private double a;
private double b;
private double r;
         ble calculateArea(int shape) {
publ c
                           tatement Code Smell
           break:
       case RECTANGLE:
           area = a * b;
           break;
       case CIRCLE:
           area = Math.PI * r * r;
           break;
    return area;
public double calculatePerimeter(int shape) {
    double perimeter = 0;
    switch(shape) {
       case SQUARE:
           perimeter = 4 * a;
           break;
       case RECTANGLE:
           perimeter = 2 * (a + b);
           break;
       case CIRCLE:
           perimeter = 2 * Math.PI * r;
           break;
    return perimeter;
                                                                                             29
```

Example 2 Solution



```
Shape.java file
                                                      public class Client {
public interface Shape {
                                                      private double a;
public double getArea();
                                                      private double b;
                                                      private double r;
 public double getPerimeter();
                                                      public double calculateArea(int shape) {
                                                          double area = 0;
                                                          switch(shape) {
Square.java file
                                                              case SQUARE:
public class Square implements Shape {
                                                                  area = a * a;
 private double a;
                                                                  break;
                                                              case RECTANGLE:
                                                                  area = a * b;
 public double getArea() {
                                                                  break;
     return a * a;
                                                              case CIRCLE:
                                                                  area = Math.PI * r * r;
                                                                  break;
 public double getPerimeter() {
     return 4 * a;
                                                          return area;
                                                      public double calculatePerimeter(int shape) {
                                                          double perimeter = 0:
Rectangle.java file
                                                          switch(shape) {
public class Rectangle implements Shape {
                                                              case SOUARE:
                                                                  perimeter = 4 * a;
 private double a;
                                                                  break:
 private double b;
                                                              case RECTANGLE:
                                                                  perimeter = 2 * (a + b);
 . . .
                                                                  break;
 public double getArea() {
                                                              case CIRCLE:
     return a * b;
                                                                  perimeter = 2 * Math.PI * r;
                                                                  break;
 public double getPerimeter() {
                                                          return perimeter;
     return 2 * (a + b);
                                                       . . .
```

Example 3

```
public class Er
     [...]
     public String getMailingAddre
       StringBuilder mailingAddress = new StringBuilder();
       mailingAddress.append(officeAddress.Build a e +
                                                             "-" + officeAddress.Office):
       mailingAddress.append("\n");
       mailingAddress.append(officeAddress.BuildingNumber
                                                                         ddress.StreetName);
       mailingAddress.append("\n");
       mailingAddress.append(officeAddress.City + ", " + officeAddress.State);
       mailingAddress.append("\n");
       mailingAddress.append(officeAddress.PostalCode);
       return mailingAddress.toString();
     [...]
```

Example 3 - Solution

```
public class Address {
     [...]
      public String getMailingAddress() {
            StringBuilder address = new StringBuilder();
            address.append(BuildingName + " - " + Office);
            address.append("\n");
            address.append(BuildingNumber + " " + StreetName);
            address.append("\n");
            address.append(City + ", " + State);
            address.append("\n");
            address.append(PostalCode);
           return address.toString();
      [...]
```

```
public class Employee {
    private Address officeAddress = null;
    [...]
    public String getMailingAddress() {
        return officeAddress.getMailingAddress();
    }
    [...]
}
```

Example 4

```
array1 = \{0,1,2,3\};
int[] array2 = \{4,5,2,35\};
int average1
int average2
                iverray1.length; i++)
   sum1 += array1[i];
average1 = sum1/array2.length;
for (int i = 0; i < array2.length; i++)
   sum2 += array2[i];
average2 = sum2/array2.length;
```

Example 4 - Solution

```
int[] array1 = \{0,1,2,3\};
int[] array2 = \{4,5,2,35\};
int average1 = calcAverage(array1);
int avarage2 = calcAverage(array2);
pubic int calcAverage(int[] array) {
   int sum = 0;
   for (int i = 0; i < array.length; i++)
      sum += array[i];
   return sum/array.length;
```

Refactoring

- Performs structural changes to improve the quality of the code
- The external behavior remains unchanged

- Have a look at:
 - https://refactoring.guru/refactoring/what-is-refactoring

Code Smells and Refactoring

Smells to Refactorings Ouick Reference Guide



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To Do

Reading – For the 3rd Lecture

- Exam material:
 - Shyam R. Chidamber, Chris F. Kemerer, A METRICS SUITE FOR OBJECT ORIENTED DESIGN

- Additional reading (highly recommended):
 - All the links indicated in the presentation

Takeaways?

