



# SOFTWARE ENGINEERING

Week 8  
Software Design Engineering I

## Agenda

1. Unified Modeling Language
2. Software Design Concepts
3. Structured Design
4. Object Oriented Design Principles
5. User Interface Design
6. Case Study: SafeHome

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1. Unified Modeling Language ←
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## Unified Modeling Language

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Analysis

## What is UML?

- Unified Modeling Language (UML) is the standard tool for visualizing, specifying, constructing, and documenting the artifacts of an object-oriented software.
- UML is not a programming language, but only a visual design notation.
- Can be used with all software development process models.
- Independent of implementation language.
- Many CASE tools use UML for automatic code generation. Examples: IBM Rational, ArgoUML, etc.
- You may be familiar with some UML concepts introduced in Object Oriented Programming course.

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## Background

- UML is the result of an effort to simplify and consolidate the large number of **Object Oriented** development methods and notations.
- Developed by the Object Management Group based on work from:
  - Grady Booch [91]
  - James Rumbaugh [91]
  - Ivar Jacobson [92]
- The latest version is UML 2.0  
(See <http://www.omg.org> or <http://www.uml.org>)

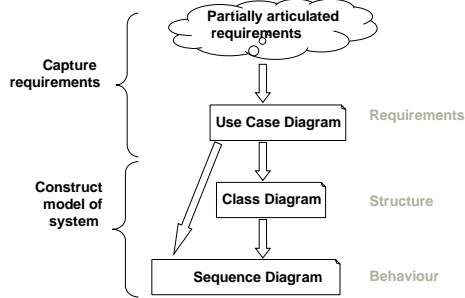
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## Types of UML Diagrams

- Use Case Diagrams (\*)
- Class Diagrams (\*)
- Interaction Diagrams
  - Sequence Diagrams (\*)
  - Collaboration Diagrams
- State Transition Diagrams
- Activity Diagrams
- Implementation Diagrams
  - Component Diagrams
  - Deployment Diagrams

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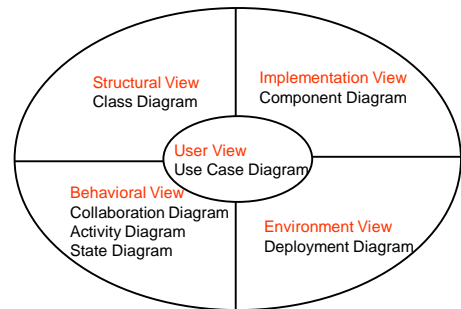
## Minimal UML Process



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## Views of UML Diagrams



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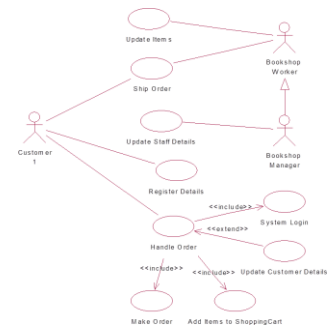
## Use Cases

- ✎ Use case diagrams are used to visualize, specify, construct, and document the (intended) behavior of the system, during requirements capture and analysis.
- ✎ Provide a way for developers, domain experts and end-users to Communicate.
- ✎ Serve as basis for testing.
- ✎ Main authors: *Booch, Rumbaugh, and Jacobson*
- ✎ The Object Management Group (OMG) is responsible for standardization. ([www.omg.org](http://www.omg.org))
- ✎ Current version is UML 2.0

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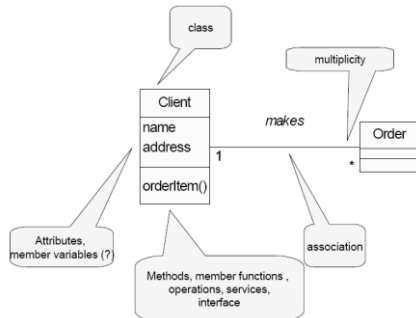
## Example : Use Case Diagram



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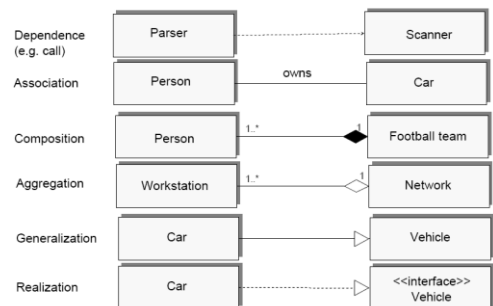
## Class Diagrams



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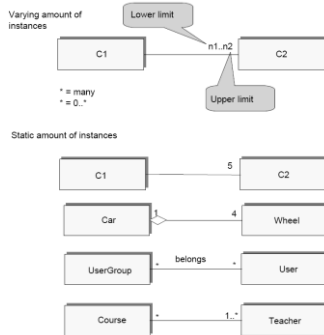
## Class Relations



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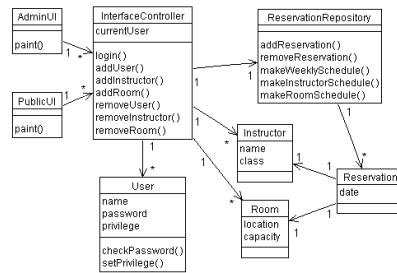
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## Cardinality

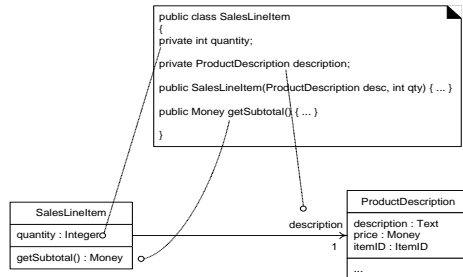


## Example : Class Diagram

A classroom scheduling system: specification perspective.



## Example : From Class Diagram to Code



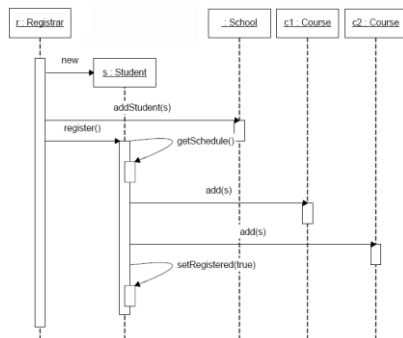
## Interaction Diagrams

UML presents two types of interaction diagrams.

1. Sequence Diagrams
2. Collaboration Diagrams

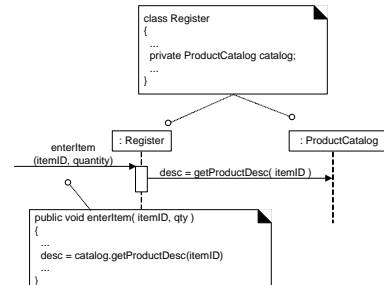
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## Sequence Diagrams

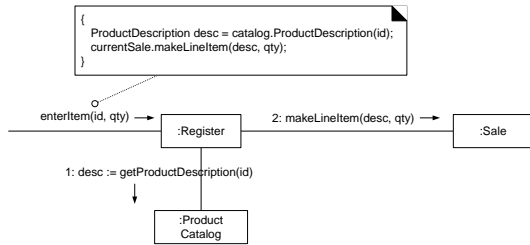


## Example : Mapping Diagram to Code

Mapping sequence diagram to Java code



## Collaboration Diagrams

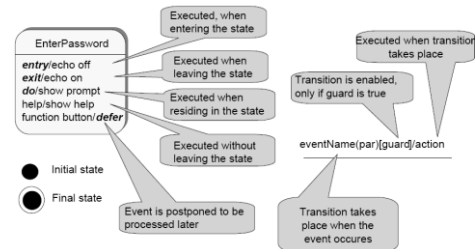


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## State Chart Notation

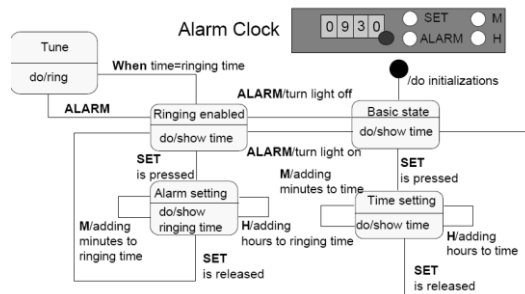
- State transition diagram shows
  - The events that cause a transition from one state to another
  - The actions that result from a state change



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## Example : State Chart Diagram

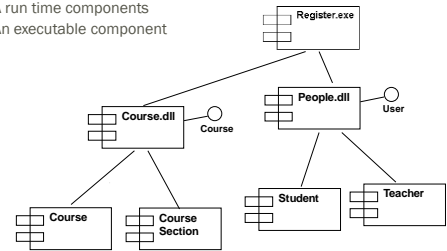


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## Package Diagrams

- Component diagrams illustrate the organizations and dependencies among software components in physical world.
- A component may be
  - A source code component
  - A run time components
  - An executable component

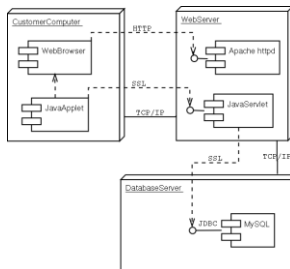


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## Deployment Diagrams

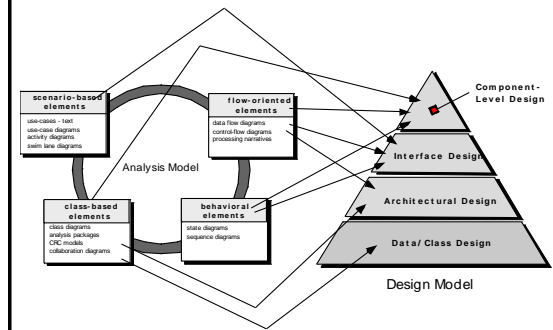
- Captures the distinct number of computers involved
- Shows the communication modes employed
- Component diagrams can be embedded into deployment diagrams effectively



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## Analysis Model → Design Model



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## Software Design Concepts

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### Design Concepts (1)

#### Component:

- Any piece of software or hardware that has a clear role.
- A component can be isolated, allowing you to replace it with a different component that has equivalent functionality.
- Many components are designed to be reusable.
- Conversely, others perform special-purpose functions.

#### Module:

- A component that is defined at the programming language level.
- For example, functions are modules in C.
- For example, methods, classes and packages are modules in Java.

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### Design Concepts (2)

#### Modularity:

- A complex system may be divided into simpler pieces called *modules*.
- A system that is composed of modules is called *modular*.
- When dealing with a module we can ignore details of other modules.
- Use divide and conquer method for modularity.
- For two modules m1 and m2, the effort relation is as follows:

$$E(m1) + E(m2) < E(m1+m2)$$

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### Design Concepts (3)

#### Abstraction:

- Abstraction is a means of achieving stepwise refinement by suppressing unnecessary details.
- It is to conceptualize problem at a higher level.
- Abstractions allow you to understand and concentrate on the essence of a subsystem without having to know unnecessary details.
- The designer should keep the level of abstraction as high as possible.

#### Data abstraction (Abstract Data Type):

- A data type together with the operations performed on instantiations of that data type.

#### Procedural abstraction:

- The designer defines a procedure at a higher level.

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#### Example: C definition without Data Abstraction

```
struct personel
{
    long int TCNum;
    char Ad[20], Soyad[20];
    int DTarihi_gun, DTarihi_ay, DTarihi_yil;
    int IGTarihi_gun, IGTarihi_ay, IGTarihi_yil;
};
```

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#### Example: C definition with Data Abstraction

```
typedef struct
{
    int gun, ay, yil;
} tarih;

struct personel
{
    long int TCNum;
    char Ad[20], Soyad[20];
    tarih DogumTarihi; //abstraction
    tarih IseGirisTarihi; //abstraction
};
```

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## Example: C program without Procedural Abstraction

```
#include <stdio.h>
#include <stdlib.h>
#define N 5
int main()
{
    int a[N] = {10,20,30,40,50};
    int b[N] = {15,25,35,45,55};
    int i;
    for (i=0; i < N; i++) printf("%d \t", a[i]);
    printf("\n");
    for (i=0; i < N; i++) printf("%d \t", b[i]);
    return 0;
}
```

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## Example: C program with Procedural Abstraction

```
#include <stdio.h>
#include <stdlib.h>
#define N 5

void yaz(int dizi[], int M) {
    int i;
    for (i=0; i < M; i++)
        printf("%d \t", dizi[i]);
    printf("\n");
}

int main() {
    int a[N] = {10,20,30,40,50};
    int b[N] = {15,25,35,45,55};
    yaz(a, N); //abstraction
    yaz(b, N); //abstraction
    return 0;
}
```

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## Layers of Software Design

## 1. Architectural Design

## 2. Modular Design

## 1. Data Design

- Transforms the information domain model created during the analysis into the data structures, file structures, database structures that will be required to implement software.
- Data objects and relationships in ERD and the detailed data content depicted in the data dictionary provide the basis.

## 2. Behavioral Design

- Transforms structural elements of the program architecture into a procedural description of software components.
- Information obtained from PDL (Algorithms / Flowcharts) serve as basis.

## 3. User Interface Design

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## Structured Design Approach

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## Data-Oriented Design

## Basic principle

- The structure of a product must conform to the structure of its data

## Three very similar methods

- Michael Jackson [1975], Warnier [1976], Orr [1981]

## Data-oriented design

- Has never been as popular as action-oriented design
- With the rise of OOD, data-oriented design has largely fallen out of fashion

## Operation-Oriented Design

## Data flow analysis

- Use it with most specification methods (Structured Systems Analysis here)

## Key point: We have detailed action information from the DFD

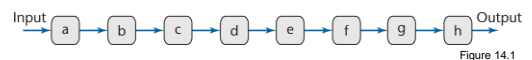


Figure 14.1

## Data Flow Analysis

- Every product transforms input into output
- Determine
  - "Point of highest abstraction of input"
  - "Point of highest abstraction of output"

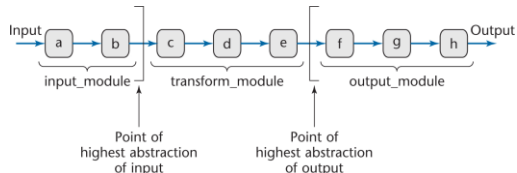


Figure 14.2

## Data Flow Analysis (contd)

- Decompose the product into three modules
- Repeat stepwise until each module has high cohesion
  - Minor modifications may be needed to lower the coupling

## Mini Case Study: Word Counting

### ➤ Example:

Design a product which takes as input a file name, and returns the number of words in that file (like UNIX wc)

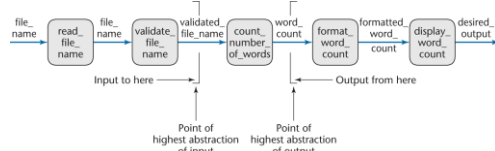
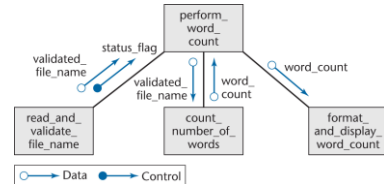


Figure 14.3

## Mini Case Study: Word Counting

### ➤ First refinement



- Now refine the two modules of communicational coupling

## Mini Case Study: Word Counting

### ➤ Second refinement

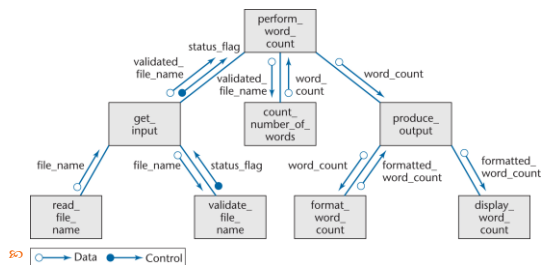


Figure 14.5

## Word Counting: Detailed Design

- The architectural design is complete
  - So proceed to the detailed design
- Two formats for representing the detailed design:
  - Tabular
  - Pseudocode (PDL – program design language)

## Detailed Design: Tabular Format

Module name	count_number_of_words
Module type	Function
Return type	integer
Input arguments	validated_file_name : string
Output arguments	None
Error messages	None
Files accessed	None
Files changed	None
Modules called	None
Narrative	This module determines whether <b>validated_file_name</b> is a text file, that is, divided into lines of characters. If so, the module returns the number of words in the text file; otherwise, the module returns -1.

Figure 14.6(c)

## Detailed Design: PDL Format

```

void perform_word_count ()
{
    String validated_file_name;
    int word_count;

    if (get_input (validated_file_name) is null)
        print "error 1: file does not exist";
    else
    {
        set word_count equal to count_number_of_words (validated_file_name);
        if (word_count is equal to -1)
            print "error 2: file is not a text file";
        else
            produce output (word_count);
    }

    String get_input ()
    {
        String file_name;

        file_name = read_file_name ();
        if (validate_file_name (file_name) is true)
            return file_name;
        else
            return null;
    }

    void display_word_count (String formatted_word_count)
    {
        print formatted_word_count; for j=0; j<10; j++
    }

    String format_word_count (int word_count)
    {
        return "file contains " + word_count + " words";
    }
}

```

Figure 14.7

## Data Flow Analysis Extensions

8. In real-world products, there is
- More than one input stream, and
  - More than one output stream

## Data Flow Analysis Extensions

8. Find the point of highest abstraction for each stream

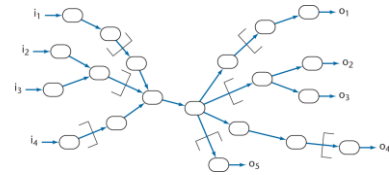


Figure 14.8

8. Continue until each module Works on a single responsibility