Object Oriented System Analysis and Design

Chapter Six: Determining how to build your system: System Design

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Contents

- System design
- System design process
- Object oriented design
- Architectural design
- Class, Database modeling and
- Deployment diagrams/modeling

System Design

- System design: mainly focuses on the data structures, and components necessary to implement the system.
- System design process: transforms the analysis model into design model/system design.
  - Is a process that focuses on decomposing the system into manageable parts, and then collecting the decomposed components to work in collaboration for a desired goal.
- Like analysis, system design is an evolutionary and iterative activity.
- We need to ensure that the system design model is correct, complete, consistent, realistic, and readable.
- The system design model will be correct if the correct analysis model can be fully mapped to the system design model.

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- During design we will:
  - Refine the analysis and system design models.
  - Make implementation decisions, especially, object design serves as the basis of implementation.
  - Fully define the main classes in the system.
  - Evaluate implementation alternatives and chosen algorithms.
  - Optimize access paths and controls to data during external interactions.
  - Adjust class structure and associations to increase inheritance.
- As a result, the design model can be partitioned into sets of classes such that they can be implemented by individual developers.

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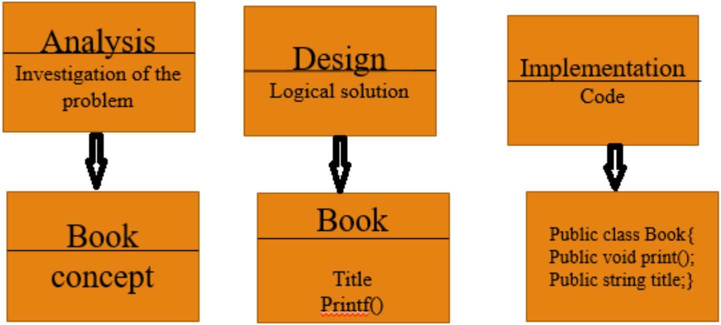
- A software design specifies how a program will accomplish the specified requirements.
- That is, a software design determines:
    - How the solution can be broken down into manageable pieces?
    - What each piece will do?
- Design transforms requirements into:
    - An architecture diagram
    - Subsystems, modules and their relationships
    - Detailed system specification

From Analysis to Design

- Each element of the analysis model provides information that is necessary to create design models.
- The data/class modeling transforms analysis classes into design classes along with the data structures & algorithms required to implement the software.
- Architectural styles and design patterns help to analyze and refine the requirements defined for the system.
- The interface design describes how the software communicates with systems that interoperate with it and with human beings that use it.

From Analysis to Design and implementation

- Fig: from analysis to design and implementation (what we do at each stage)



Analysis

Investigation of the problem

Book

concept

Design

Logical solution

Book

Title

Printf()

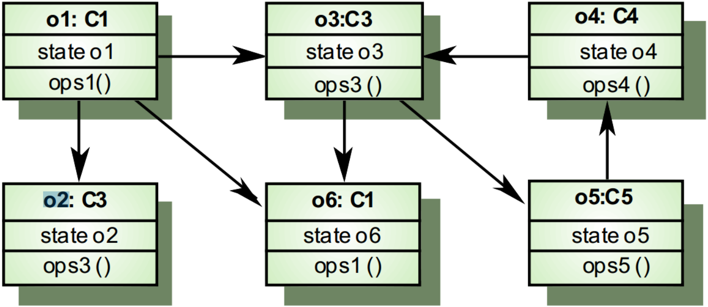
Implementation

Code

```
Public class Book{
Public void print();
Public string title;}
```

Interacting Objects

- Conceptually, objects communicate by message passing.
- Messages are often implemented by method calls.
- Name = method name.
- Information = parameter list.



OOD Activities

- Identification of existing components
- Full definition of associations
- Full definition of classes
- Specifying the contract for each component
- Choosing algorithms and data structures
- Identifying possibilities of reuse

Purpose of Design

- To transform customer requirements, business needs, and technical considerations to a product or system.
- The design model provides detail information about the software's architecture, interface, classes, objects, nodes and components.
- The design model can be assessed for quality and be improved before code is generated and tests are conducted.

Architectural Design

- An early stage of the system design process.
- Represents the link between specification and detailed design.
- Often carried out in parallel with some specification activities.
- It involves identifying major system components and their communications.

Architectural Types (layered approach)

- "Tier" can be defined as "one of two or more rows, levels, or ranks arranged one above another".
- 1-Tier Architecture:
  - The simplest, single tier with single user.
  - Is an equivalent of running an application on a personal computer.
  - All the required components to run the application are located within a single machine.
  - User interface and data storage are all located on the same machine.
  - They are the easiest to design, but the least scalable.
  - Because they are not part of a network, they are useless for designing web applications.

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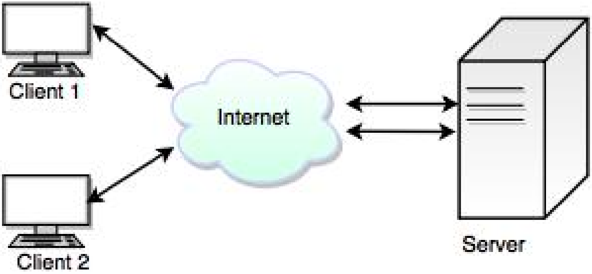
- 2-Tier Architectures:
  - Supply a basic network between a client and a server.
  - For example, the basic web model is a 2-tier architecture.
  - A web browser makes request from a web server, which then processes the request and returns the desired response, in this case, web pages.



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- 3-Tier Architecture:
    - An architectural type, where an application consists of 3 hierarchically ordered subsystems.
    - So the 3 layers are commonly known as:
    - User interface: Presentation Layer(PL/UI)
    - Middleware: Business Logic Layer(BLL) &
    - Database system: Data Access Layer(DAL).
- It is most commonly used to build web applications.
- This approach separates business logic from display and data.
- The middleware subsystem services data requests between the user interface and the database subsystem.

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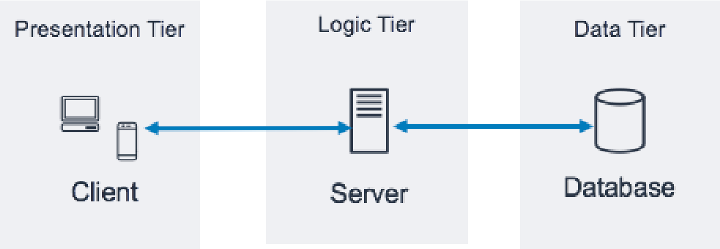
- Three-Layer architectural types are often used for the development of Websites:
  - The web browser represents the user interface.
  - The web server serves requests from the web browser.
  - The database manages and provides access to the persistent data.



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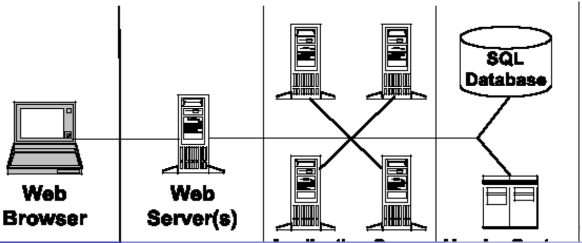
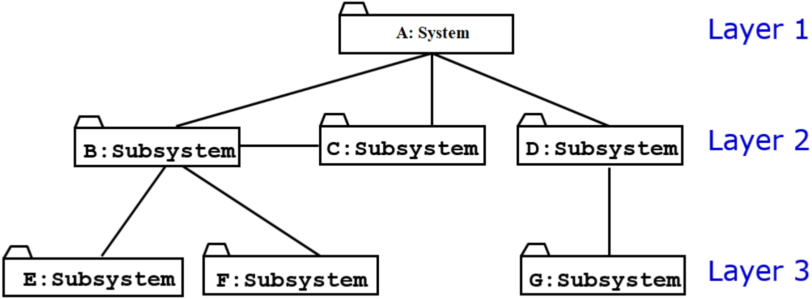
- 4-Layer-architectural type (4-Tier Architectures): are usually used for the development of electronic commerce sites.
- The layers are
  - The web browser, providing the user interface.
  - A web server, serving static HTML requests.
  - An Application server, providing session management (for example the contents of an electronic shopping cart) and processing of dynamic HTML requests.
  - A back end database, that manages and provides access to the persistent data.



System Decomposition

- System decomposition begins by decomposing the system into cohesive, well-defined subsystems.
- Sub-systems are then decomposed into small sub sub components.
- Sub-system: collection of classes, associations, operations, events and constraints that are closely interrelated with each other.
- In UML subsystems are modeled as small packages.



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- Subsystem decomposition: is the identification of subsystems, services, and their relationship to each other.
- Sub system decomposition is a very essential task in system development.
- It helps project managers to assign system components/modules to the available team members.
- It is also advantageous for detailed system understanding by the individuals that take part in the system development.

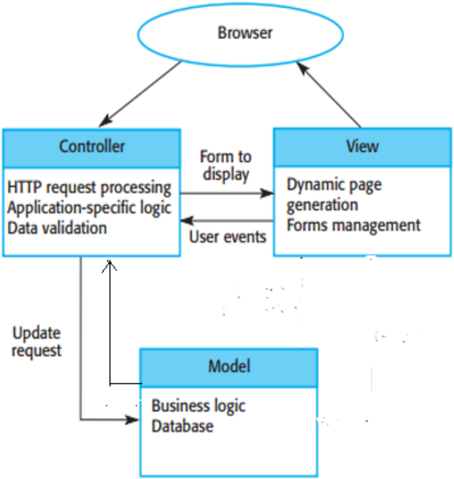
Architectural Styles

- Model/View/Controller
- Client/Server
- Peer-To-Peer
- Service-Oriented Architecture (SOA)

Model-View-Controller Architectural Style

- Subsystems are classified into 3 different types
- Model subsystem:
  - Responsible for application domain knowledge
  - Used for keeping persistent data
- View subsystem:
  - Responsible for displaying application domain objects to the user
  - Used for visualizing/viewing the persistent data
- Controller subsystem:
  - Responsible for sequence of interactions with the user and notifying views of changes in the model
  - Used for managing user interactions with the system
  - Helps to make communication between front end and back end.

Web application architecture using the MVC



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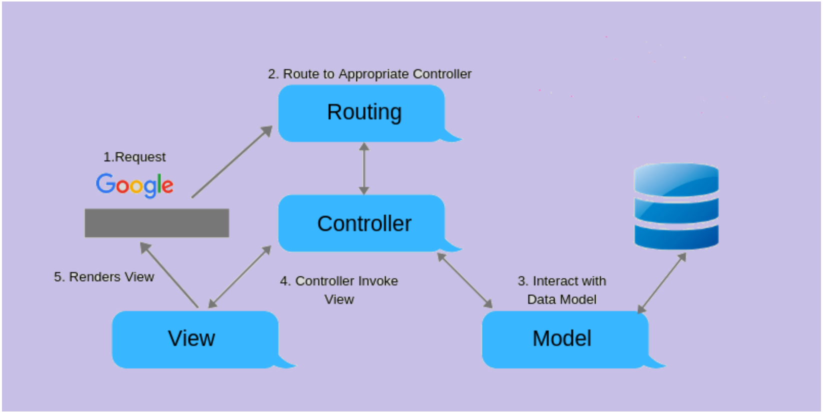
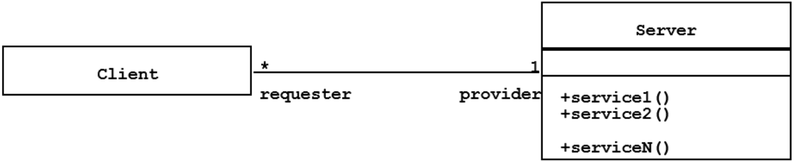

2. Route to Appropriate Controller
Routing
1.Request
Google
Controller
5. Renders View
4. Controller Invoke View
3. Interact with Data Model
View
Model

Client/Server Architectural Style

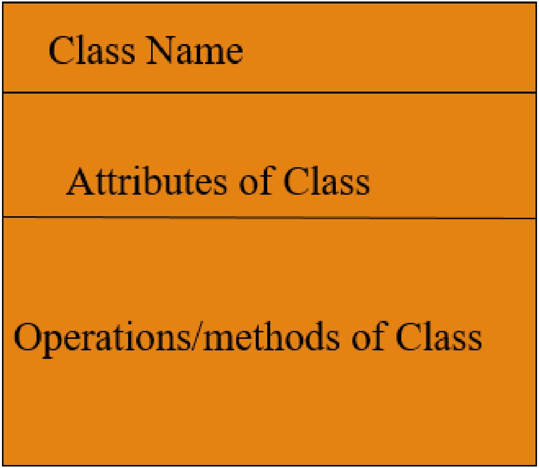
- One or many servers provide services to instances of subsystems, called clients.
- Each client calls on the server, which performs some service and returns the result.
  - The response in general is immediate.
  - End users interact only with the client.



Client/Server Architectures

- Often used in the design of small scale database systems
  - Front-end: user application (client)
  - Back end: database access and manipulation (server)
- Functions performed by client:
  - Input from the user (customized user interface)
  - Front-end processing of input data
- Functions performed by the database server:
  - Centralized data management
  - Data integrity and database consistency
  - Database security

Class Modeling

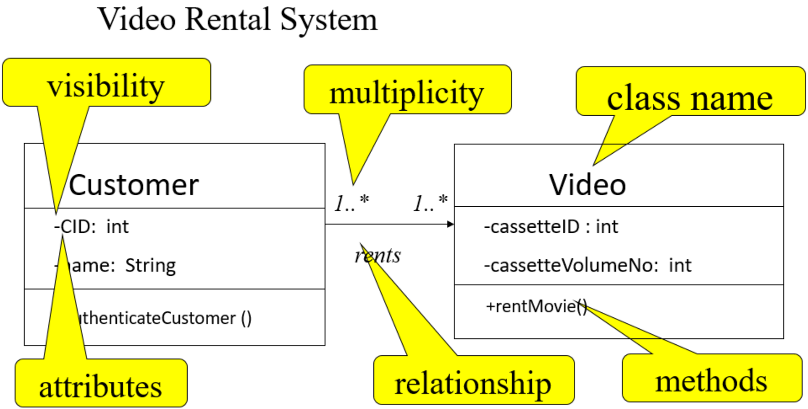


Class Name

Attributes of Class

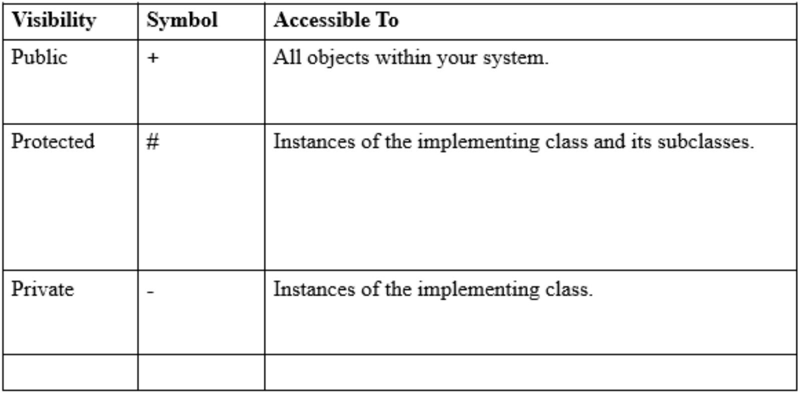
Operations/methods of Class

Example of a Class Diagram



Visibility of Attributes and Operations

- Relates to the level of information hiding to be enforced



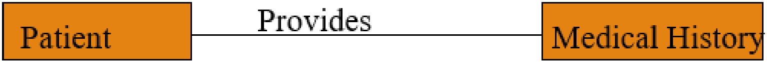
Visibility	Symbol	Accessible To
Public	+	All objects within your system.
Protected	#	Instances of the implementing class and its subclasses.
Private	-	Instances of the implementing class.

Applying Design patterns effectively

- In class diagram modeling you have to select the appropriate design pattern that fits with your system.
- Read in detail about design patterns that we have seen in chapter two briefly!

Relationships among Classes

- Represents a connection between multiple classes.
- A bidirectional semantic connection between classes
- Guideline:
  - Drawing line between classes
  - Name of relationship
  - Role that classes play in the relationship



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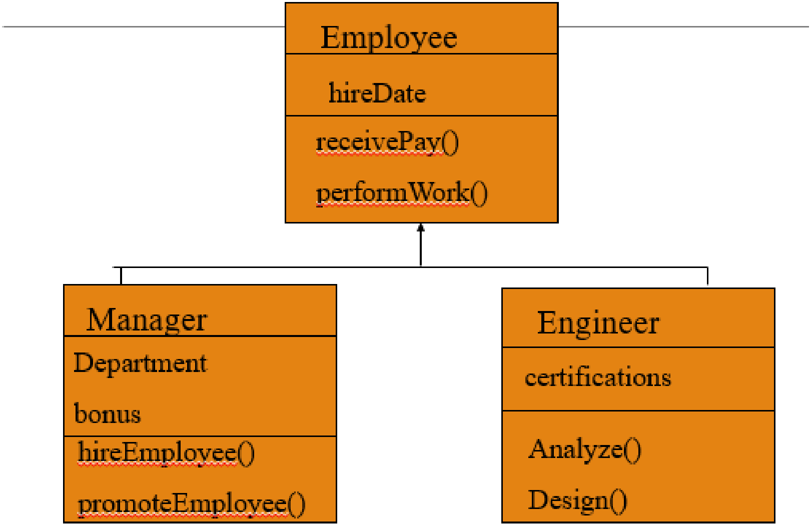
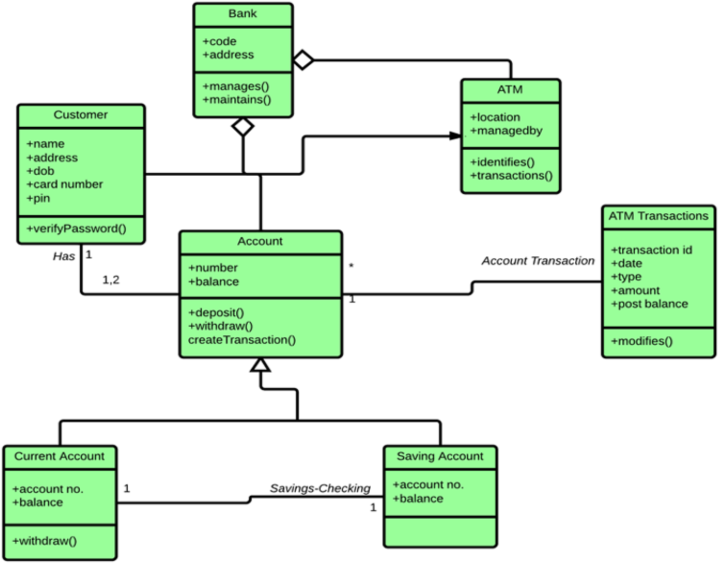

Employee
hireDate
receivePay()
performWork()
Manager
Department
bonus
hireEmployee()
promoteEmployee()
Engineer
certifications
Analyze()
Design()

Multiplicity

- Denotes the minimum number.. maximum number of instances
  - Exactly one 1
  - Zero or more 0..* or 0..m
  - One or more 1..* or 1..m
  - Zero or one 0..1
  - Specified range 2..4
  - Multiple, disjoint ranges 1..3, 5

Class Diagrams to Design a System



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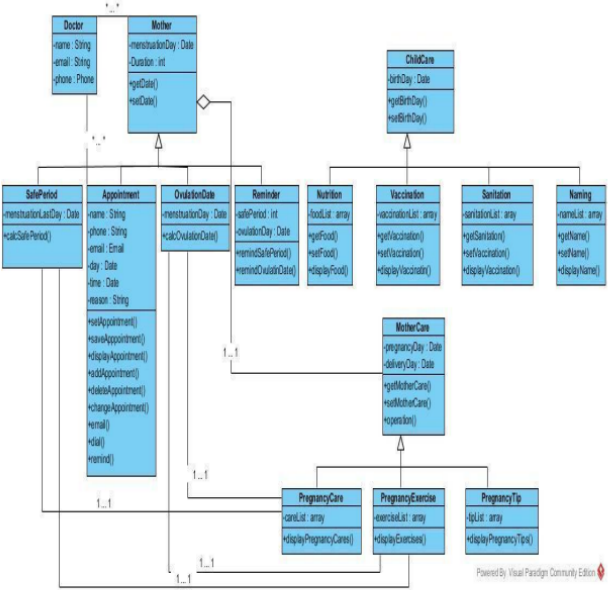

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Doctor
-name : String
-email : String
-phone : Phone
Mother
-menstruationDay : Date
-Duration : int
+getDate()
+setDate()
..
ChildCare
-birthDay : Date
+getBirthDay()
+setBirthDay()
SafePeriod
-menstuationLastDay : Date
+calcSafePeriod()
Appointment
-name : String
-phone : String
-email : Email
-day : Date
-time : Date
-reason : String
+setAppointment()
+saveAppointment()
+displayAppointment()
+addAppointment()
+deleteAppointment()
+changeAppointment()
+email()
+dial()
+remind()
OvulationDate
-menstruationDay : Date
+calcOvulationDate()
Reminder
-safePeriod : int
-ovulationDay : Date
+remindSafePeriod()
+remindOvulatinDate()
Nutrition
-foodList : array
+getFood()
+setFood()
+displayFood()
Vaccination
-vaccinationList : array
+getVaccination()
+setVaccination()
+displayVaccinatin()
Sanitation
-sanitationList : aray
+getSanitation()
+setVaccination()
+displayVaccination()
Naming
-nameList : array
+getName()
+setName()
+displayName()
1...1
MotherCare
-pregnancyDay : Date
-deliveryDay : Date
+getMotherCare()
+setMotherCare()
+operation()
1...1
1...1
PregnancyCare
-careList : array
+displayPregnancyCares()
PregnancyExercise
-exerciseList : array
+displayExercises()
PregnancyTip
-tipList : array
+displayPregnancyTips()
1...1
1...1
Powered By Visual Paradigm Community Edition

Deployment Diagrams

- Deployment diagrams are kinds of UML models that show the static structure of a system.
- UML deployment diagrams show how software components are physically deployed on processors/ nodes.
- It shows the hardware and software node components in the system.
- Describes the physical resources on which the system component run.
- Software runs on nodes.
- Shows physical arrangement of run-time computational resources such as computer and other interconnected devices.

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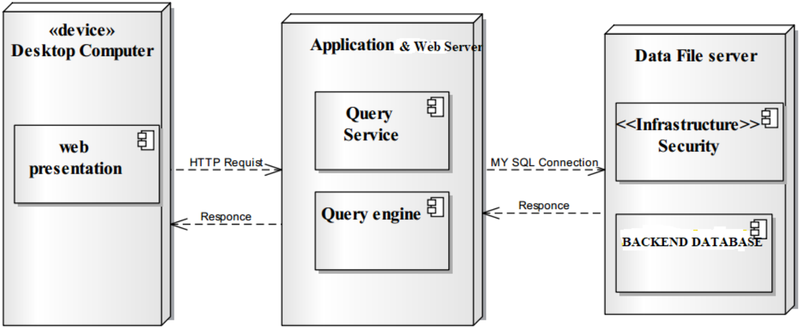
- Nodes in a deployment diagram can show hardware devices such as sensors, printers, storage devices, servers etc... that support the runtime environment of a system.
- Deployment diagrams are probably most useful when you are designing an embedded system which works on hardwares.

Example: Deployment Diagram

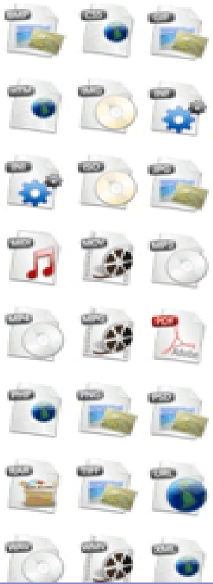


- Read about persistence modeling/diagrams

UI Design-Specific Widget Guidelines

- Menu Design
    - Common functions should be easy to reach.
    - $>$ 8 options is too much, to grouping and organize
    - Opposite and dangerous operators should be physically separated to avoid accidents.
- Icon Design
    - Immediately recognizable (small and simple)
    - Easily distinguishable from others
    - Should be very descriptive

Example



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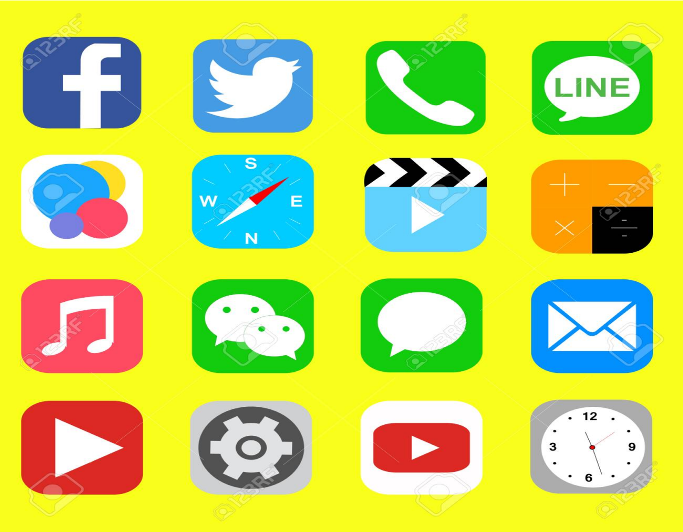

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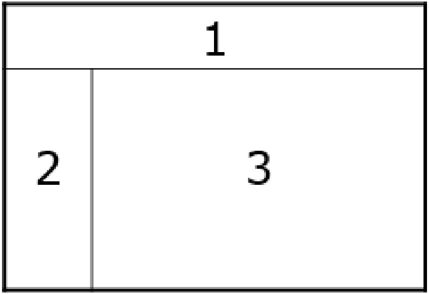
- Web UI design specifics
  - Hyperlink nature
  - Menu positions
  - Sidebar placements
  - Key questions web pages should answer at design phase.
    - ★ Where am I?
    - ★ Where can I go?
    - ★ Whats here?



Thank you!!!