Technische Hochschule Rosenheim

Modul - Fortgeschrittene Programmierkonzepte

Bachelor Informatik

07 - Design Pattern, pt. 1

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Agenda

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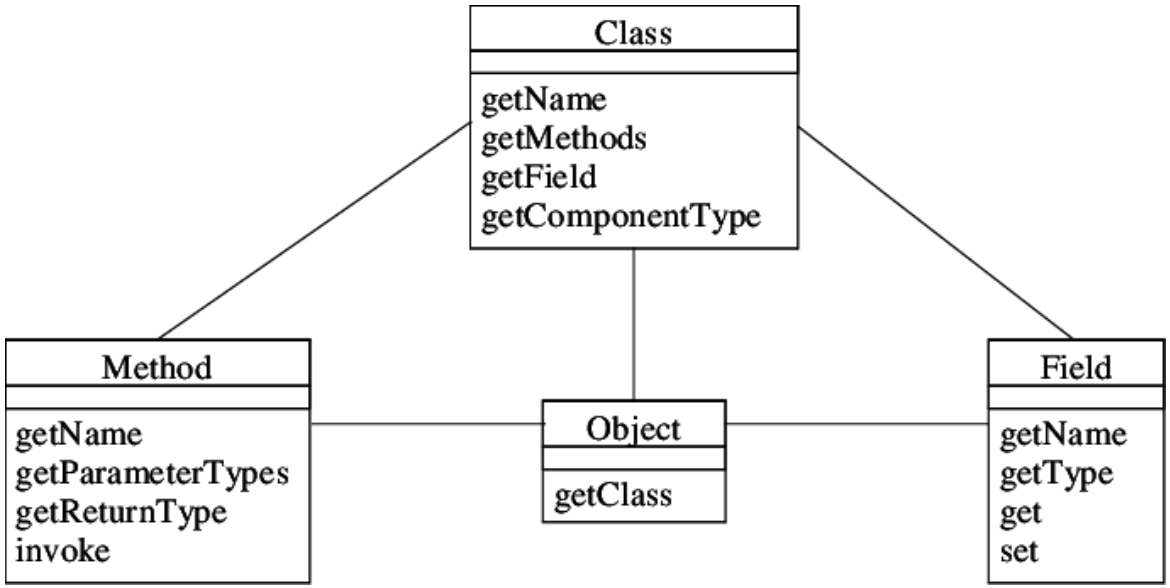
- Reflection, JSON and REST revisited!
- Design Pattern
  - Iterator
  - Composite
  - Observer
  - MVC

For your motivation: Bullshit Bingo

Recap

- Reflection
- JSON
- REST APIs and how to call things



What is JSON

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- JSON stands for *JavaScript Object Notation*.
- You can find the *spec* here: JSON
- JSON is a lightweight format for storing and transporting data
- JSON is often used when data is sent from a server to a web page
- JSON is "self-describing" and easy to understand
  - No strong schema validation, see XML and XMLSchema
  - but there is JSON Schema

```
{
    "employees":[
        {"firstName":"John", "lastName":"Doe"},
        {"firstName":"Anna", "lastName":"Smith"},
        {"firstName":"Peter", "lastName":"Jones"}
    ]
}
```

How to Convert an Object into JSON?

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- *JSON is nice for storing and transporting*: **JSON is used to serialization and deserialization**

```
public class Person {

    private String firstName;
    private String lastName;
    private int age;

    public Person(String firstName, String lastName, int age) {
        this.firstName = firstName;
        this.lastName = lastName;
        this.age = age;
    }
}
```

How to serialize an object of this class to JSON?

Use Reflection

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Idea: We can use the *reflection API* to introspect and access data!

```
public static String toJson(Object obj) {
    StringBuffer sb = new StringBuffer("{");

    Class cl = obj.getClass();
    for (Field f: cl.getDeclaredFields()) {
        f.setAccessible(true);

        sb.append("\"" + f.getName() + "\" : ");
        if (f.getType().equals(int.class))
            sb.append(f.get(obj));
        else
            sb.append("\"" + f.get(obj) + "\",");
    }

    sb.append("}");

    return sb.toString();
}
```

Would this work?

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Actually, this works great!

```
    public static void main(String[] args) throws Exception {
        Person p = new Person("Max", "Mustermann", 33);
        System.out.println(toJson(p));
        //{"firstName" : "Max","lastName" : "Mustermann","age" : 3}
    }
```

> BTW: This sounds like a good candidate for a Mixin!

What about `fromJson()` and other data types, e.g. Date, float, arrays ...

This is cumbersome...

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... do not reinvent the wheel!

Let's use a framework: GSON

```
    public static void main(String[] args) throws Exception {
        Person p = new Person("Max", "Mustermann", 33);
        String s = toJson(p);
        System.out.println(s);
        //{"firstName" : "Max","lastName" : "Mustermann","age" : 3}

        Gson gson = new Gson();
        Person p2 = gson.fromJson(s, Person.class);
        System.out.println(p.equals(p2));
        // true
    }
```

*RE*presentational *S*tate *T*ransfer

A Word about REST

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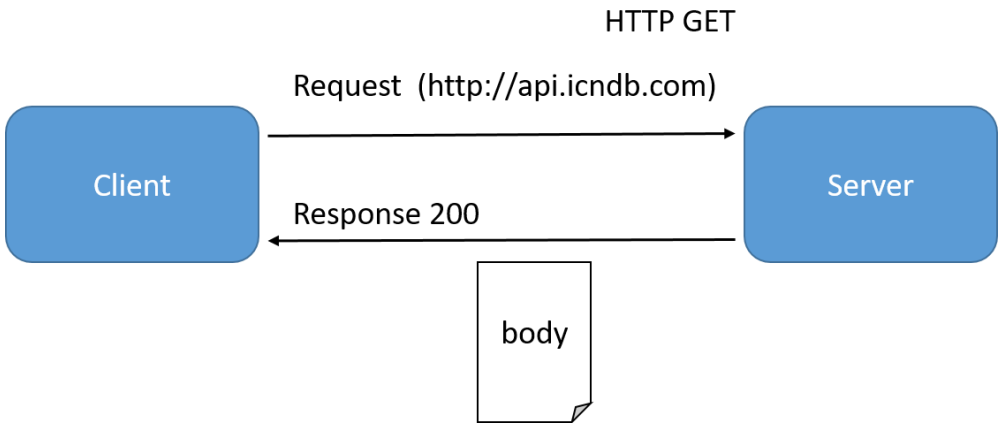
REST = REpresentational State Transfer

- REST, or **RE**presentational **S**tate **T**ransfer, is an architectural style for providing standards between computer systems on the web.
- making it easier for systems to communicate with each other.
- REST-compliant systems, often called RESTful systems, are characterized by how they are stateless and separate the concerns of client and server.



Statelessness

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- Systems that follow the REST paradigm are *stateless*
  - meaning that the server does not need to know anything about what state the client is in and vice versa.
- In this way, both the server and the client can understand any message received, **even without seeing previous messages**.
- This constraint of statelessness is enforced through the use of *resources*, rather than *commands*.
- *Resources* describe any object, document, or thing that you may need to store or send to other services.
- Because REST systems interact through standard operations (**CRUD**) on resources, they do not rely on the implementation of interfaces.

Making Requests

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REST requires that a client make a request to the server in order to retrieve or modify data on the server. A request generally consists of:

- an **HTTP verb** (Standard Operation), which defines what kind of operation to perform
- a **header**, which allows the client to pass along information about the request
- a path to a resource (URL)
- an optional message body containing data

```
curl -X GET http://heise.de
```

```
wget http://heise.de
```

```
curl -d '{"key1":"value1", "key2":"value2"}'
     -H "Content-Type: application/json"
     -X POST http://localhost:3000/data
```

HTTP Verbs

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There are 4 basic HTTP verbs we use in requests to interact with resources in a REST system:

- **GET** — retrieve a specific resource (by id) or a collection of resources
- **POST** — create a new resource
- **PUT** — update a specific resource (by id)
- **DELETE** — remove a specific resource by id

Get a random Chuck Norris Joke:

```
curl -X GET https://api.icndb.com/jokes/random
```

```
{ "type": "success",
  "value": {
      "id": 273, "joke": "Chuck Norris does not kick ass and take
      names. In fact, Chuck Norris kicks ass and assigns the corpse
      a number. It is currently recorded to be in the billions.",
  "categories": [] }
```

A WebRequest in Java

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How would we implement a HTTPRequest in Java?

- Use `URL`-class to represnet the Url
- Use `HttpURLConnection`-class to connect to the server
- `BufferedReader`and `InputStream` to read the request

HTTPRequest in Java

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Get a joke from ICNDB:

```
public static void main(String[] args) throws Exception {
    URL url = new URL("https://api.icndb.com/jokes/random");
    HttpURLConnection con = (HttpURLConnection) url.openConnection();
    con.setRequestMethod("GET");
    con.connect();
    BufferedReader in = new BufferedReader(
            new InputStreamReader(con.getInputStream()));
    String inputLine;
    StringBuffer content = new StringBuffer();
    while ((inputLine = in.readLine()) != null) {
        content.append(inputLine);
    }
    // close resources here!
}
```

Can you make it a base class and design your own typed version?

Because it is cumbersome...

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... we can use a framework.

Retrofit: consume REST interfaces without any pain

```
public interface ICNDBApi {
  @GET("jokes/random")
  Call<Sring>> getRandomJoke();
}
```

```
Retrofit retrofit = new Retrofit.Builder()
        .baseUrl("https://api.icndb.com/")
        .addConverterFactory(ScalarsConverterFactory.create())
        .build();
ICNDBApi2 service = retrofit.create(ICNDBApi2.class);
Call<String> repos = service.getRandomJoke();
String s = repos.execute().body();
```

Design Pattern

Design Patterns

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Patterns that emerged for solving frequent problems

Shared vocabulary for developers

- common ground for talking about architecture
- less talking, more doing

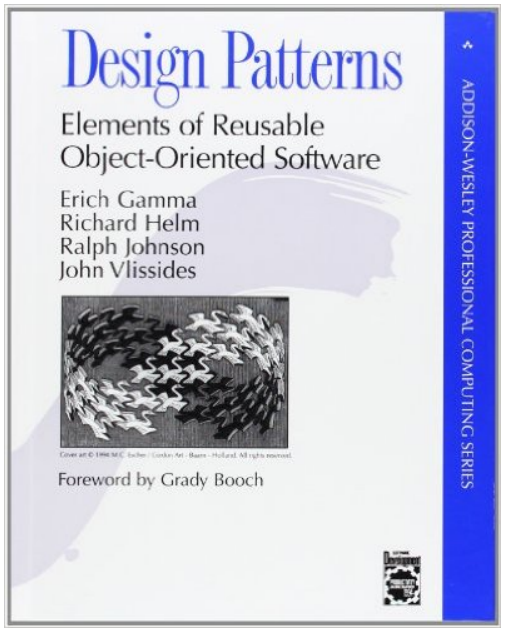
Design Patterns are based on principles of object-oriented programming.

- interfaces, inheritance
- composition, delegation and encapsulation

There are 23 established patterns in different categories: creational, structural and behavioral.

Toolset for a clear software architecture.

Recommended Reading



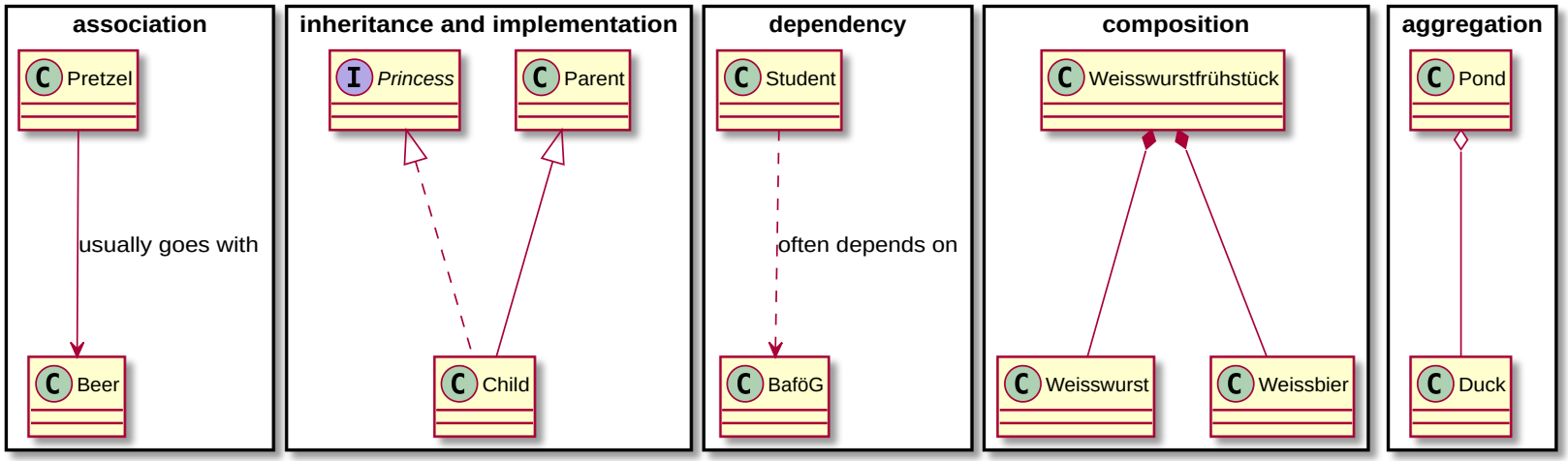
Design Patterns

by Gamma/Helm/Johnson/Vlissides (*Gang of Four*).

... and several others!

A fantastic web resource: Refactoring Guru

Class Diagrams



Association: References a …

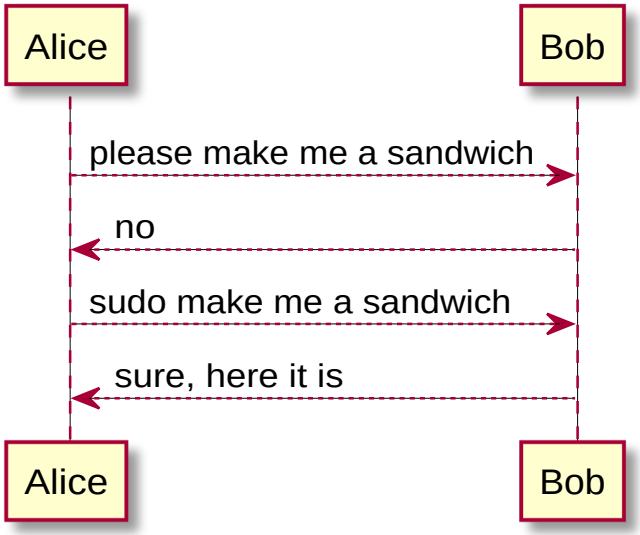
Inheritance: *Is-A* relation

Implements: behavioral relation

Composition: real-world whole-part relation

Aggregation: "catalog" containment, can exist independently

Sequence Diagrams



In contrast to class diagrams, *sequence diagrams* (sometimes: interaction diagrams) describe how *objects* interact with each other. They are read top to bottom, and following the arrows

Iterator-Pattern

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Let's assume, you want to provide a way to iterator over your own data structure wihtout exposing the internals (*information hiding*):

```
SimpleList<Integer> list = SimpleList<>(3, 1, 3, 3, 7);
```

```
int i = 0;
for ( ; i < list.size(); ) {
    System.out.println(list.get(i));
    i++;
}
```

```
Iterator<Integer> it = list.???;

while (it.hasNext()) {
    Integer v = it.next();
}
```

How does an iterator look like?

Iterator-Pattern

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```
class SimpleList<T> implements BasicList<T> {
    // ...
    public Iterator<T> iterator() {
        return new Iterator<T>() {
            Element it = root;
            @Override
            public boolean hasNext() {
                return it == null;
            }

            @Override
            public T next() {
                T value = it.value;
                it = it.next;
                return value;
            }
        };
    }
}
```

UML: Iterator-Pattern

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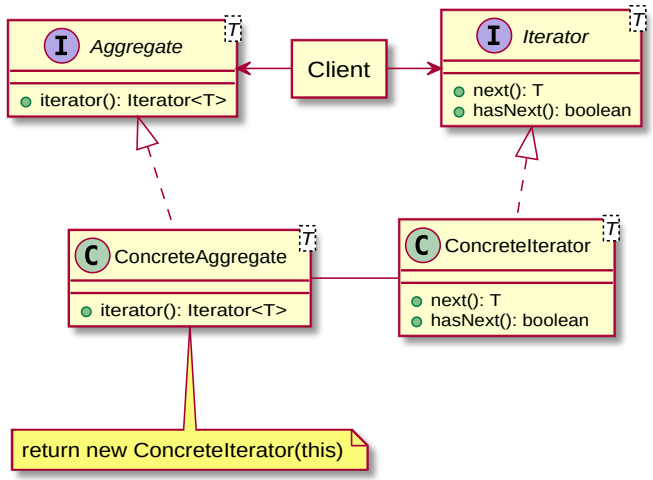
The iterator is a *behavioral* pattern.

Typically, the `ConcreteIterator<T>` is implemented as an inner, local or anonymous class within the `ConcreteAggregate<T>`, since intimate knowledge (and access!) of the data structure is required.



Design Pattern

- The Composite Pattern -

Composite-Pattern

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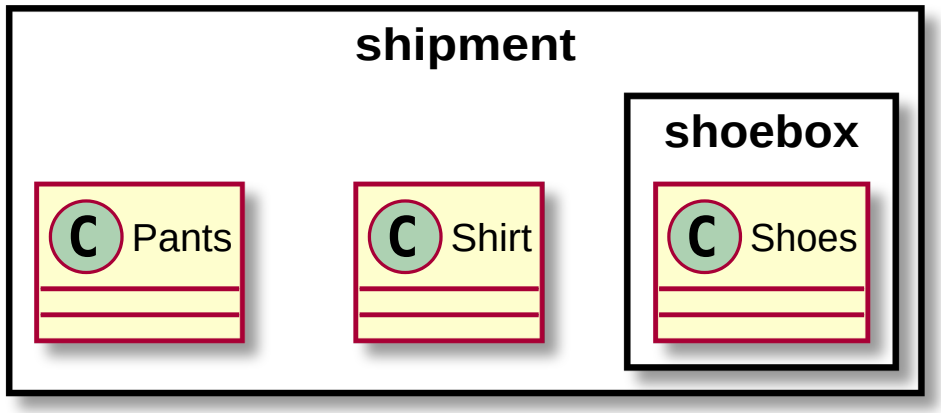
Let's say, you shop for fashion online and order a shirt, pants and a pair of shoes. Most likely, you will get shipped one package, that contains the shirt, pants and another box, that contains the shoes.



So obviously, a box can contain a box can contain a box, etc. If we wanted to count of all the *individual items* (rather than the boxes), we would need to unbox if we hit a box.

UML: Composite-Pattern

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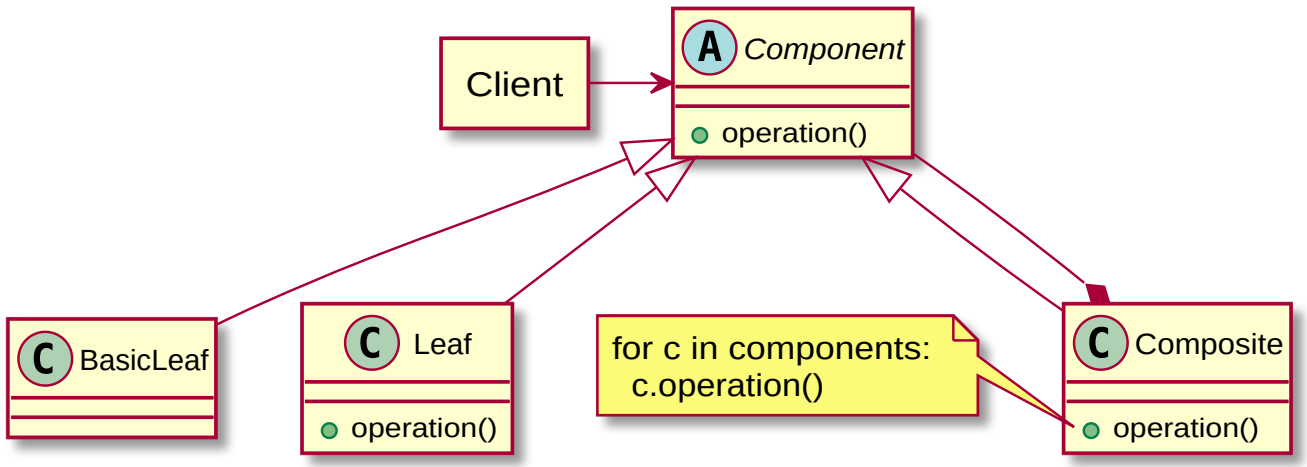
The composite is a *structural* pattern.

This architecture separates the data *structure* (the potential nesting of objects) from the *logic* (how many items per piece).

The composite is characterized by an inheriting class that overwrites a (often abstract) method, while being composed of instances of the base class.



Composite Examples

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- file systems: identifier, directory, file, link
- JUnit:
  - component: *test*
  - composite: *test suite* comprised of multiple tests
  - leaf: individual test case
- HTML documents:
  - component: *element*
  - composite: containers (`div`, `p`, etc.)
  - leaf: *text nodes*
- GUI libraries (such as Android)
  - component: `android.view.View`
  - composite: `android.view.ViewGroup`
  - leaf: individual widgets, e.g. `Button`

Design Pattern

- The Observer Pattern -

Observer-Pattern

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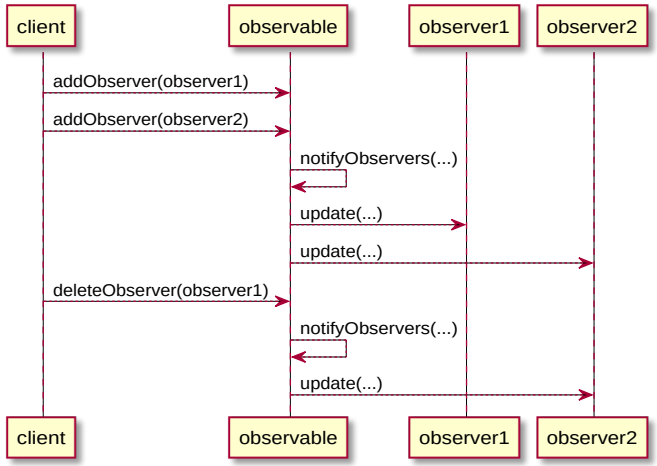
The classic example for the observer pattern used to be newspapers. But it seems the new classic is to "follow" somebody's updates on social networks, or join a messenger broadcast group (formerly: mailing lists, listserve).

Let's consider the latter: you join (*subscribe to*) a messenger broadcast group. From then on, you receive (*observe*) all messages, until you leave (*unsubscribe from*) the group.



Observer-Pattern

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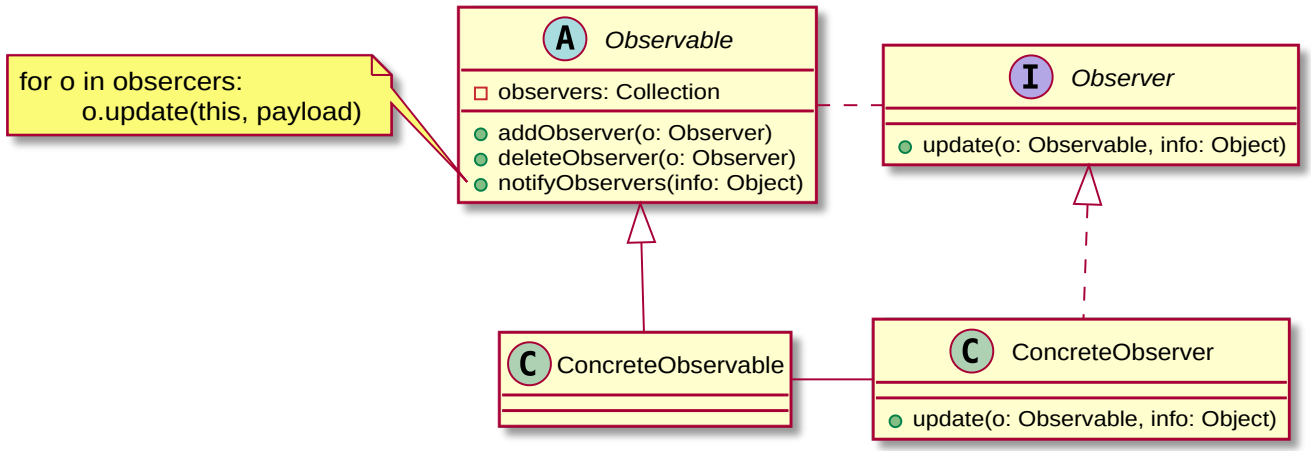
As you can see, there is some basic logic to be implemented for managing and notifying the subscribers. The Java library provides us with the [abstract class `java.util.Observable`] and the [interface `java.util.Observer`]. The following class diagram illustrates their relation:



The observer is a *behavioral* pattern, and sometimes referred to as publish/subscribe. It is most used to react to events that are not in control of the program (user interactions, networking errors, etc.)

Examples and Variants

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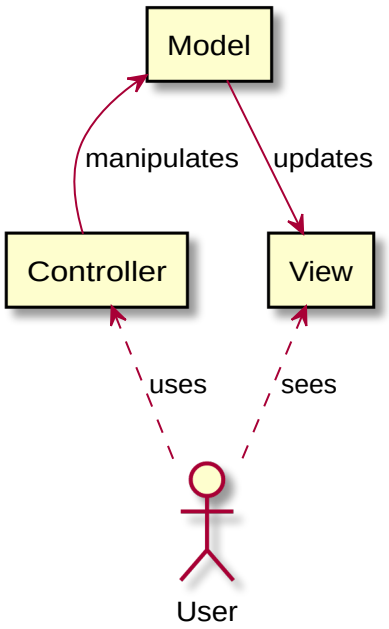
- Excel: The Graph subscribes to the cells, updates on change.
- some variants use `update()` without reference or info data
- GUI: user interactions such as `OnClickListener`, `OnSelectionChanged`, etc.
- I/O: device (disk) or connection (network) changes
- interrupts: power, usb, etc.
- databases: inserts, updates, deletes

Design Pattern

- The Model-View-Controller Pattern -

Model-View-Controller Pattern



Model:

- current data and state of the app
- Java program

View:

- visualization of data and state
- Android widget library

Controller:

- business logic (by you)
- user input (provided by Android OS)

Sometimes you will see Model-View-Viewcontroller (MVVC) or Model-View-ViewModel (MVVM), adding an intermediate layer.

Model

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- Data structures, entity types, auxiliary types.
- Core algorithms to load, store, organize and transform data.
- Typically implemented in (pure) Java.

Examples:

- `Joke` class to store jokes from ICNDB
- networking code to retrieve jokes from ICNDB
- internal cache to store jokes

Strictly speaking, *model* only refers to data; that's why some talk of MVVM or MVVC

View

- What you *see* on when you open the app.
- Text views, buttons, lists, images, etc.
- Typically implemented using a certain XML format, which is then "inflated" by a loader program.

```
<?xml version="1.0" encoding="UTF-8"?>
<GridPane fx:controller="MainController">
    <columnConstraints>
        <ColumnConstraints hgrow="NEVER" />
        <ColumnConstraints hgrow="ALWAYS" />
    </columnConstraints>
    <Button fx:id="btnRefresh" text="Refresh"
            GridPane.columnIndex="0" GridPane.rowIndex="0">
    <ListView fx:id="mealsL    ist"
            GridPane.columnIndex="0" GridPane.columnSpan="3"
            GridPane.hgrow="ALWAYS" GridPane.rowIndex="1"
            GridPane.vgrow="ALWAYS" />
</GridPane>
```

Controller

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- Manipulates the model using user or system input.
- User input: button clicks, swipe-for-refresh, etc.
- System signals: power or network configuration changes, interrupts
- Typically implemented in Java, by triggering certain logic on a certain event.

JavaFX: Basic Building Blocks (1)

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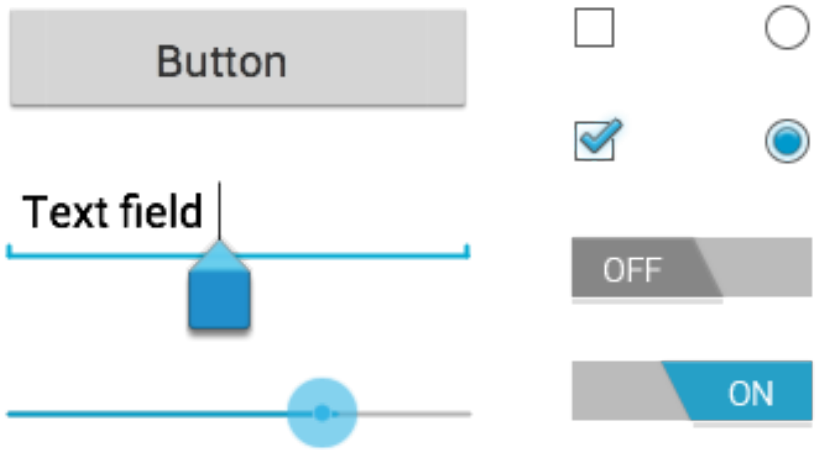
- see the base project for this weeks assignment
- Main entry point is the *Application*
- Still nice that the Application is still launched via `public static void main(String... args)`

```
public class App extends Application {

    public static void main(String[] args) {
        launch(args);
    }
    @Override
    public void start(Stage stage) throws Exception {
        Parent root = FXMLLoader.load(getClass().
            getResource("views/main.fxml"));
        stage.setTitle("My App");
        stage.show();
    }
}}
```

Basic Components



- `TextField` and `TextArea`
- `Button`
- `CheckBox` and `RadioButton`
- `ListView`

Referencing Components on the Screen

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You can get a handle on the components rendered on the screen.

- set the `fx:id` field in the XML layout
- inside the controller code, use the `@FXML` annotation with that correct `fx:id` name

```
public class MainController implements Initializable {

    // use annotation to tie to component in XML
    @FXML
    private Button btnRefresh;

    @FXML
    private ListView<String> mealsList;
```

Wiring Components and User Input

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Components can react to certain user input, for example

- *click*, using the `setOnAction()`

```
public class MainController implements Initializable {

...
    public void initialize(URL location, ResourceBundle resources) {
        // set the event handler (callback)
        btnRefresh.setOnAction(new EventHandler<ActionEvent>() {
            @Override
            public void handle(ActionEvent event) {
                // here you can react on the event
            }
        });
    }
}
```

A Word on Logging

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`System.out` etc. normally doesn't work (no terminal, no service!)

Use system logging services (rendered to logcat):

```
import import java.util.logging.Logger;
// ...
Logger logger = Logger.getLogger(OpenMensaAPITests.class.getName());
logger.info("Hello, world!");
```

Use a *toast* (Android Apps) instead:

```
Context context = getApplicationContext();
CharSequence text = "Hello toast!";
int duration = Toast.LENGTH_SHORT;

Toast toast = Toast.makeText(context, text, duration);
toast.show();
```

Some Peculiarities

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- unless you actively terminate apps, they won't terminate (until the OS decides to kill them)
- when you launch an app, you actually launch an activity (the app may already be running)
- when cycling activities, they may actually be recreated
- rotation events cause activities to be recreated
- apps (sic!) have separate threads for GUI, services and logic
  - you can't run IO (networking, files) on the GUI thread
  - you can run services without an open activity (think Dropbox!)
- getting from one activity to another, you need to understand the intent mechanism

Final Thought!