Technische Hochschule **Rosenheim**

Modul - Fortgeschrittene Programmierkonzepte

Bachelor Informatik

07 - Design Pattern, pt. 1

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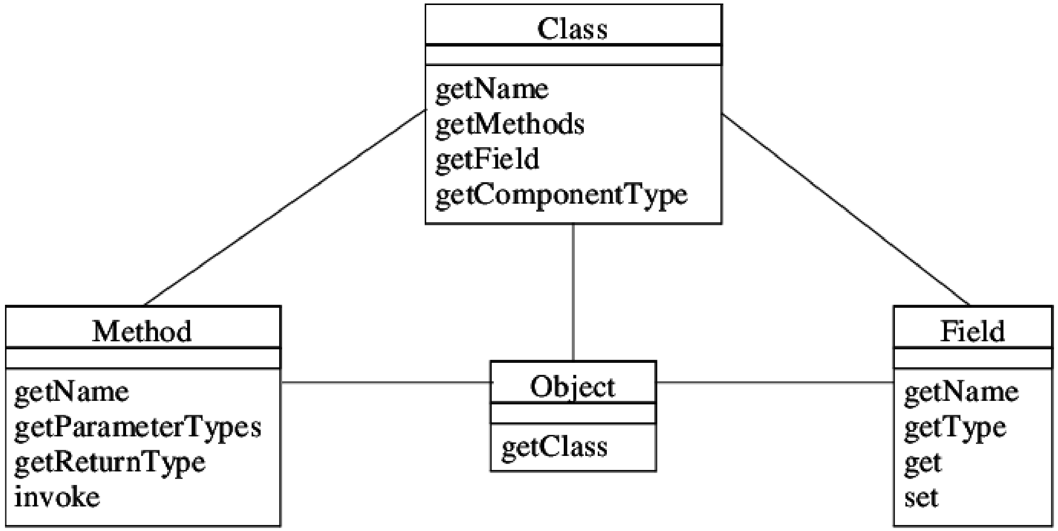
Recap

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



What is JSON

- 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?

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

```java
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

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

```java
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?

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}
}
```

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

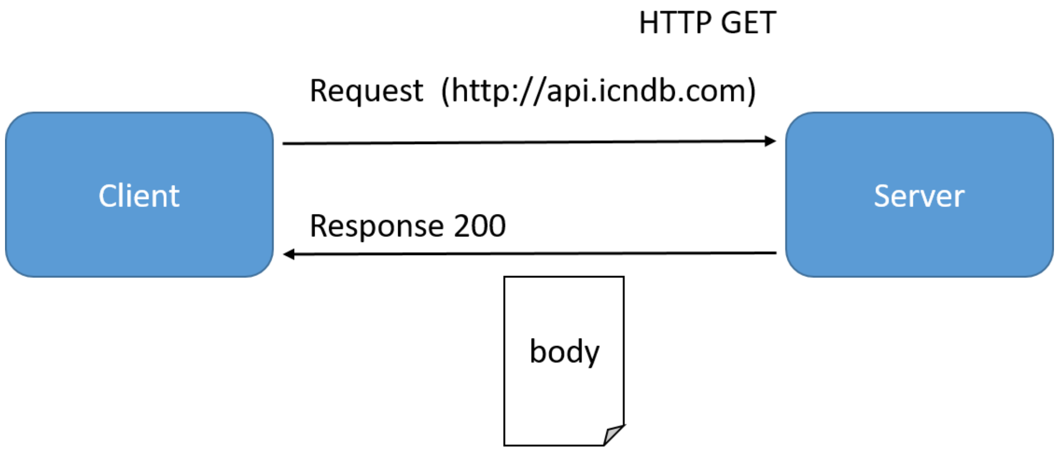
```
    public static void main(String[] args) throws Exception {
        Person p = new Person("Max", "Mustermann", 33);
        String s = toJson(p);
        System.out.println(s);
        //{"firstName" : "Max","lastName" : "Mustermann","age" : 3}

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

A Word about REST

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

- 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

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

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

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

Get a joke from ICNDB:

```java
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?

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Because it is cumbersome...

... 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 Patterns

Patterns that emerged for solving frequent problems

Shared vocabulary for developers

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

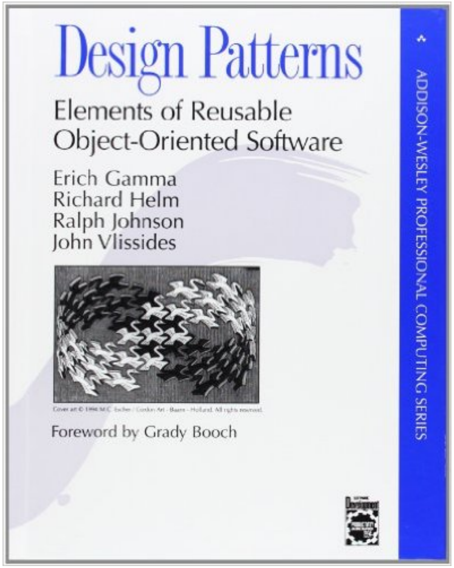
Design Patterns are based on principles of object-oriented programming.

- interfaces, inheritance
- composition, delegation and encapsulation

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

Toolset for a clear software architecture.

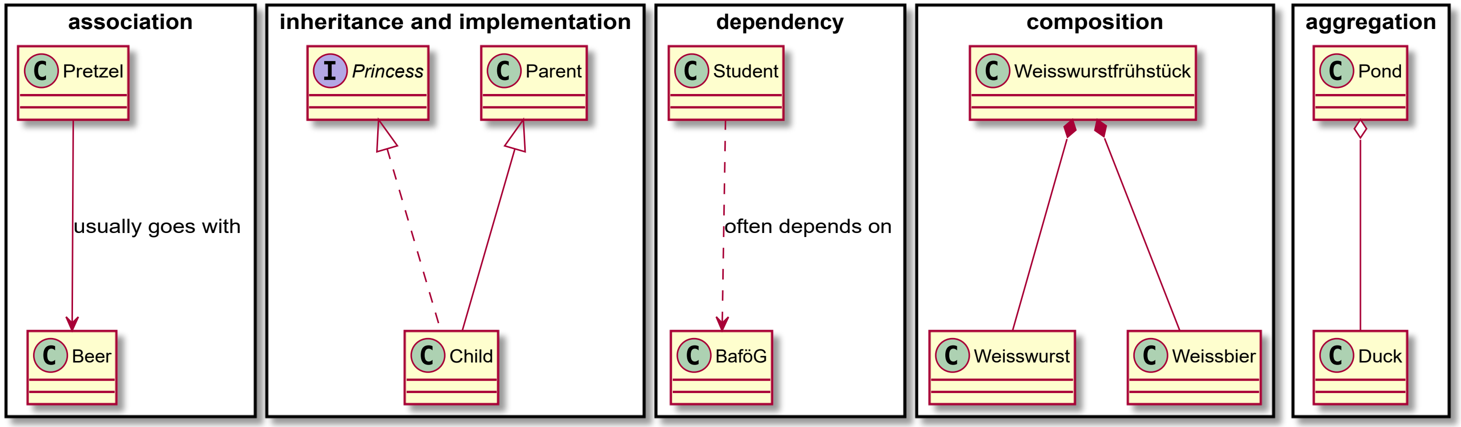
Recommended Reading


Design Patterns
Elements of Reusable Object-Oriented Software
Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides
Foreword by Grady Booch
ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

Design Patterns

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

Class Diagrams



Association: References a ...

Inheritance: *Is-A* relation

Implements: behavioral relation

Composition: real-world whole-part relation

Aggregation: "catalog" containment, can exist independently

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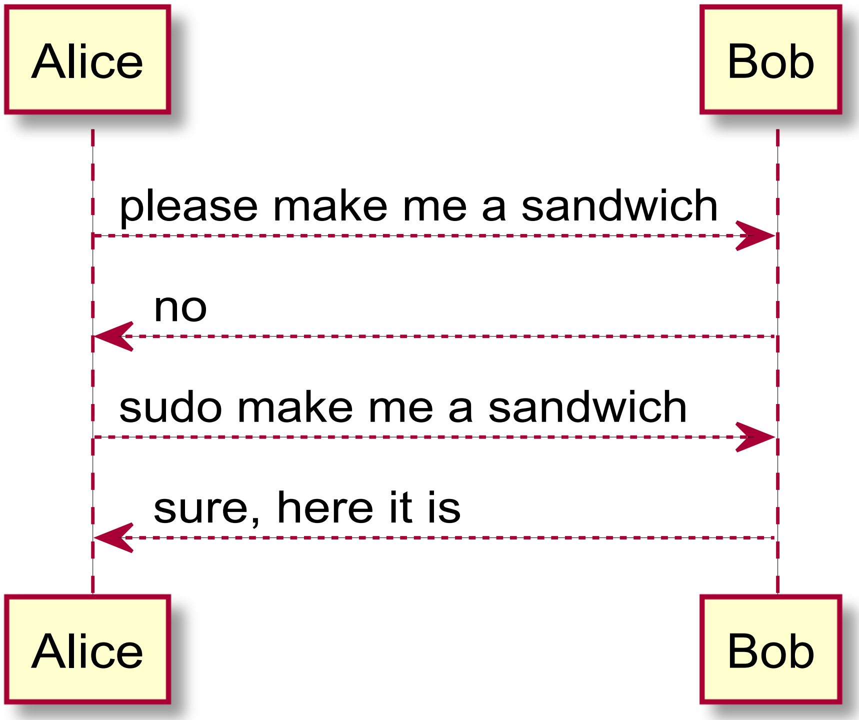
Sequence Diagrams



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

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

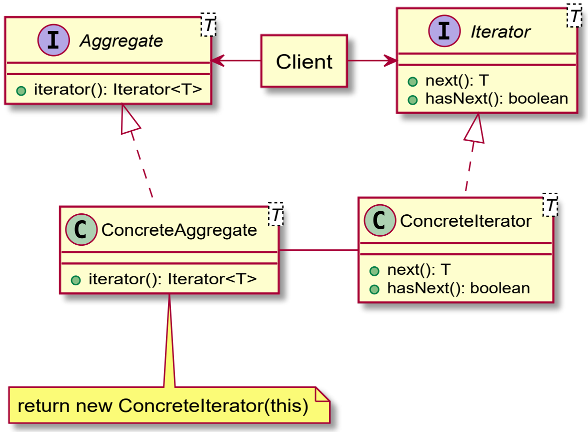
```java
class SimpleList<T> implements BasicList<T> {
    // ...
    public Iterator<T> iterator() {
        return new Iterator<T>() {
            Element it = root;
            @Override
            public boolean hasNext() {
                return it == null;
            }

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

UML: Iterator-Pattern

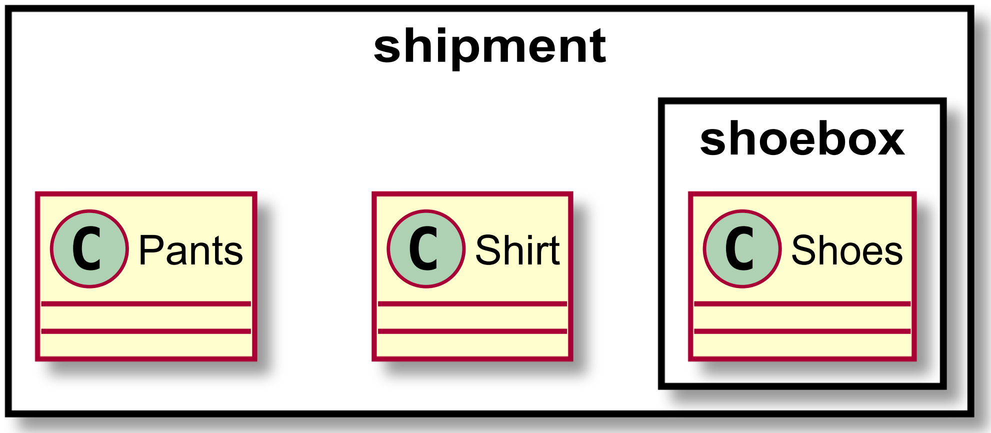
The iterator is a *behavioral* pattern.

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.



Composite-Pattern

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.



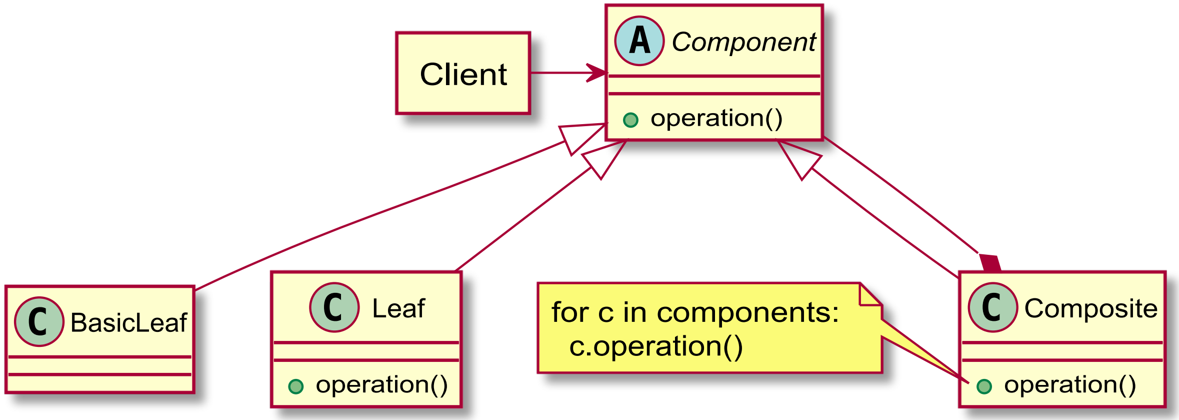
So obviously, a box can contain a box can contain a box, etc. If we wanted to count of all the *individual items* (rather than the boxes), we would need to unbox if we hit a box.

UML: Composite-Pattern

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

- 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`

Observer-Pattern

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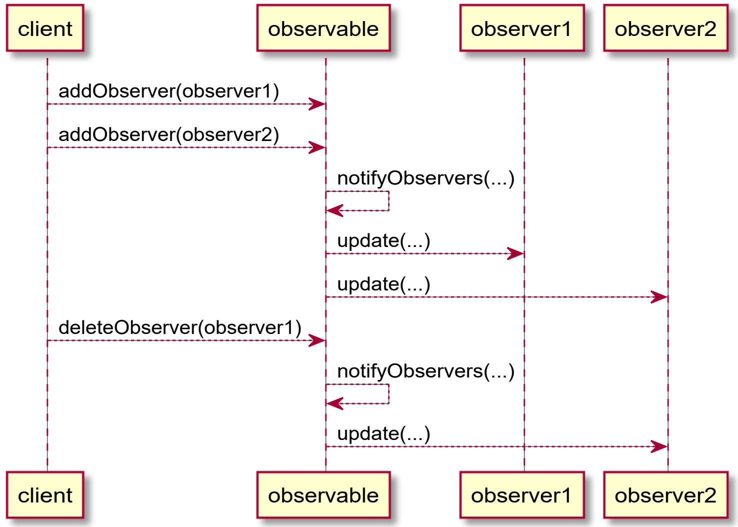
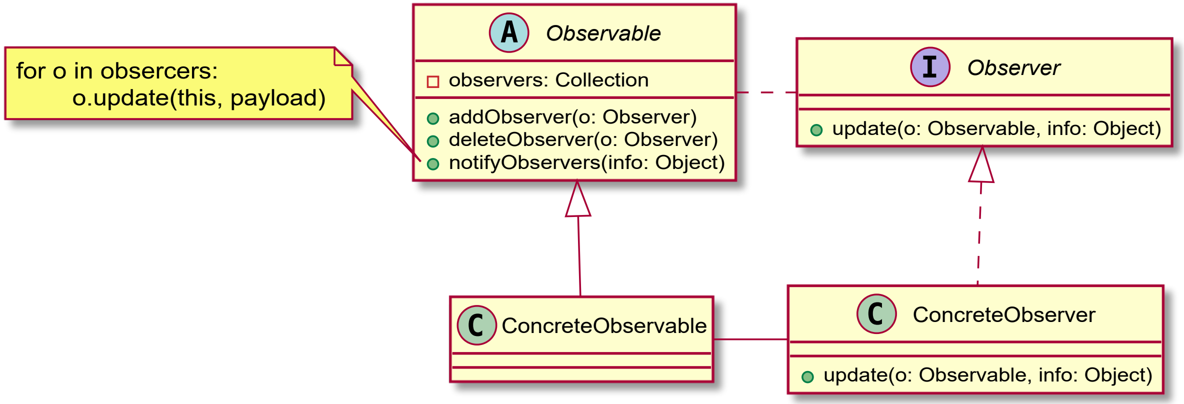
The classic example for the observer pattern used to be newspapers. But it seems the new classic is to "follow" somebody's updates on social networks, or join a messenger broadcast group (formerly: mailing lists, listserve).

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

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:

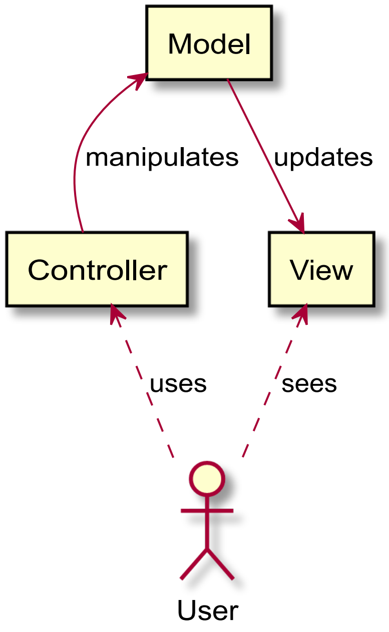


The observer is a *behavioral* pattern, and sometimes referred to as publish/subscribe. It is most used to react to events that are not in control of the program (user interactions, networking errors, etc.)

Examples and Variants

- 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

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

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

Manipulate 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.

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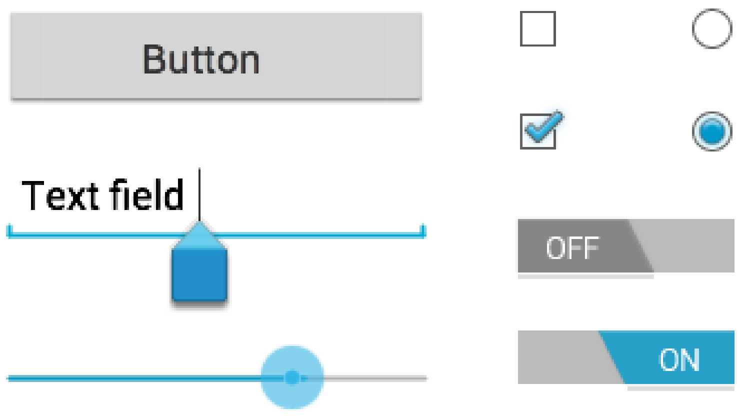
JavaFX: Basic Building Blocks (1)

- 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

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

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

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

Use system logging services (rendered to logcat):

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

Use a *toast* (Android Apps) instead:

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

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

Some Peculiarities

- 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!

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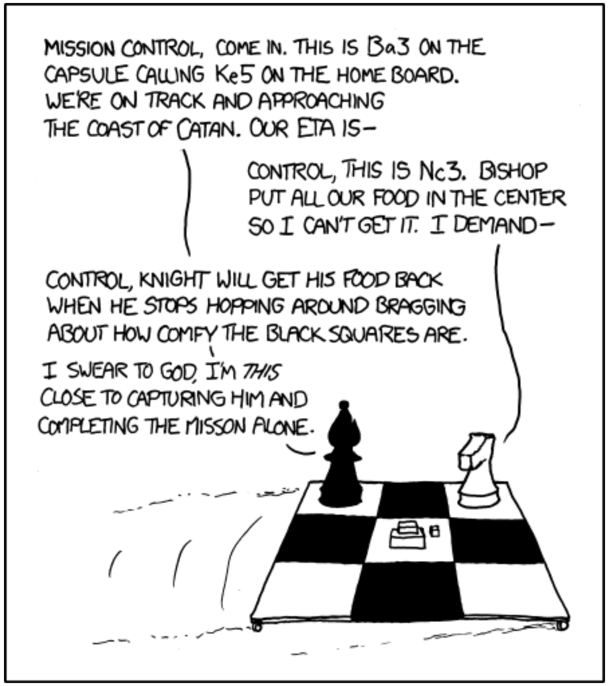
MISSION CONTROL, COME IN. THIS IS Ba3 ON THE CAPSULE CALLING Ke5 ON THE HOME BOARD. WE'RE ON TRACK AND APPROACHING THE COAST OF CATAN. OUR ETA IS–
CONTROL, THIS IS Nc3. BISHOP PUT ALL OUR FOOD IN THE CENTER SO I CAN'T GET IT. I DEMAND–
CONTROL, KNIGHT WILL GET HIS FOOD BACK WHEN HE STOPS HOPPING AROUND BRAGGING ABOUT HOW COMFY THE BLACK SQUARES ARE.
I SWEAR TO GOD, I'M *THIS* CLOSE TO CAPTURING HIM AND COMPLETING THE MISSON ALONE.