HSLU Hochschule Luzern

Software Architecture and Techniques

Architecture Of Components And Subsystems

Alexandra Junghans, Marcel Baumann, tangly llc

Truths (1/2)

Architecture is a **hypothesis**, that needs to be proven by **implementation** and **measurement**.
- Tom Gilb

The only way to go fast, is to go well.
- Robert C. Martin

Attitude and aptitudes – you can always learn the latter, seldom the former
- Marcel Baumann

Truths (2/2)

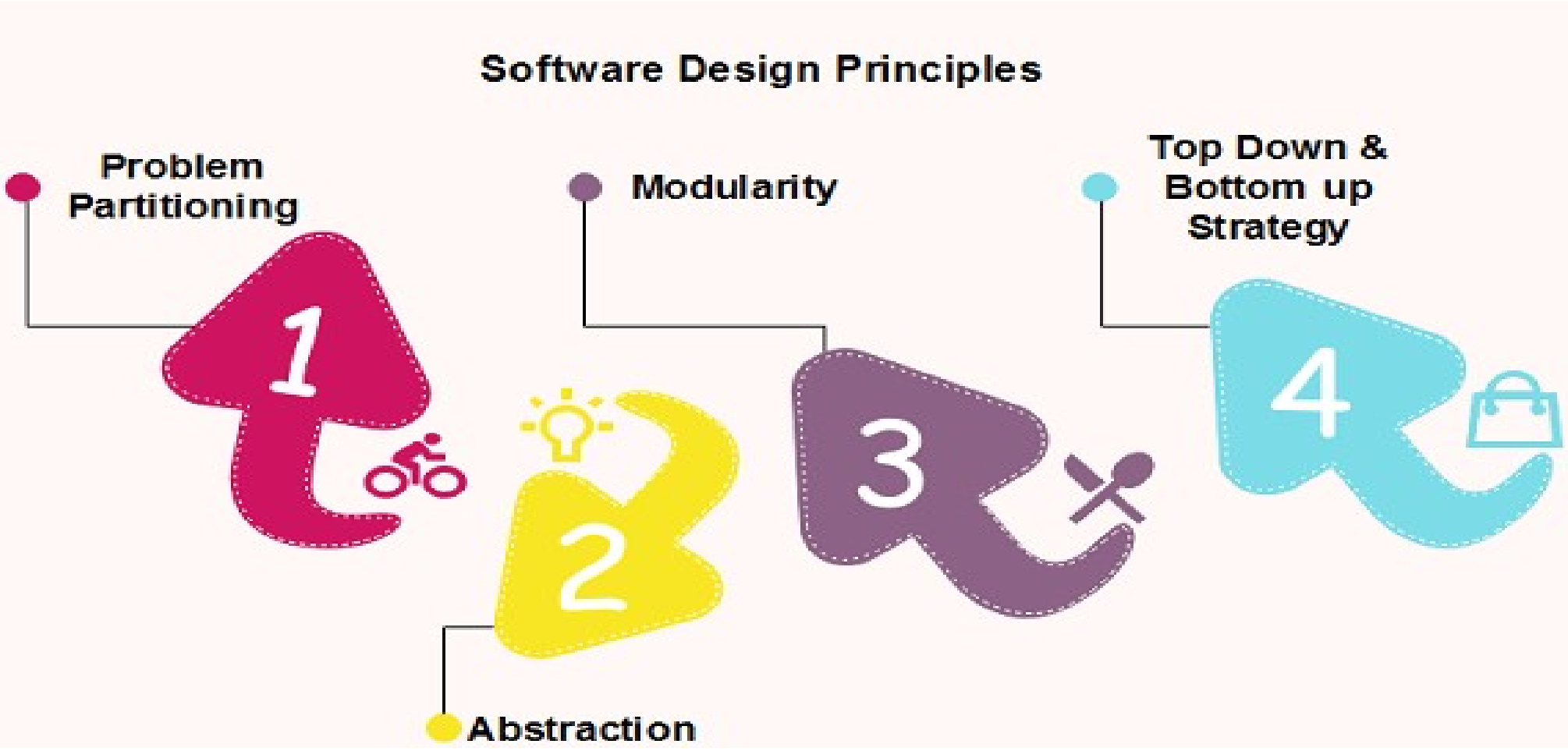
The goal of software architecture is to **minimize** the human resources required to build and maintain the required system.
- *Robert Martin*

Big design up front is dumb, but doing no design up front is even dumber.
- *Dave Thomas*

Approaches

- The system you are building already have siblings
- Open source solutions and articles give you access to huge amount of information
- Copy, mutate, improve
  - Avoid Not Invented Here Syndrome *NIH*

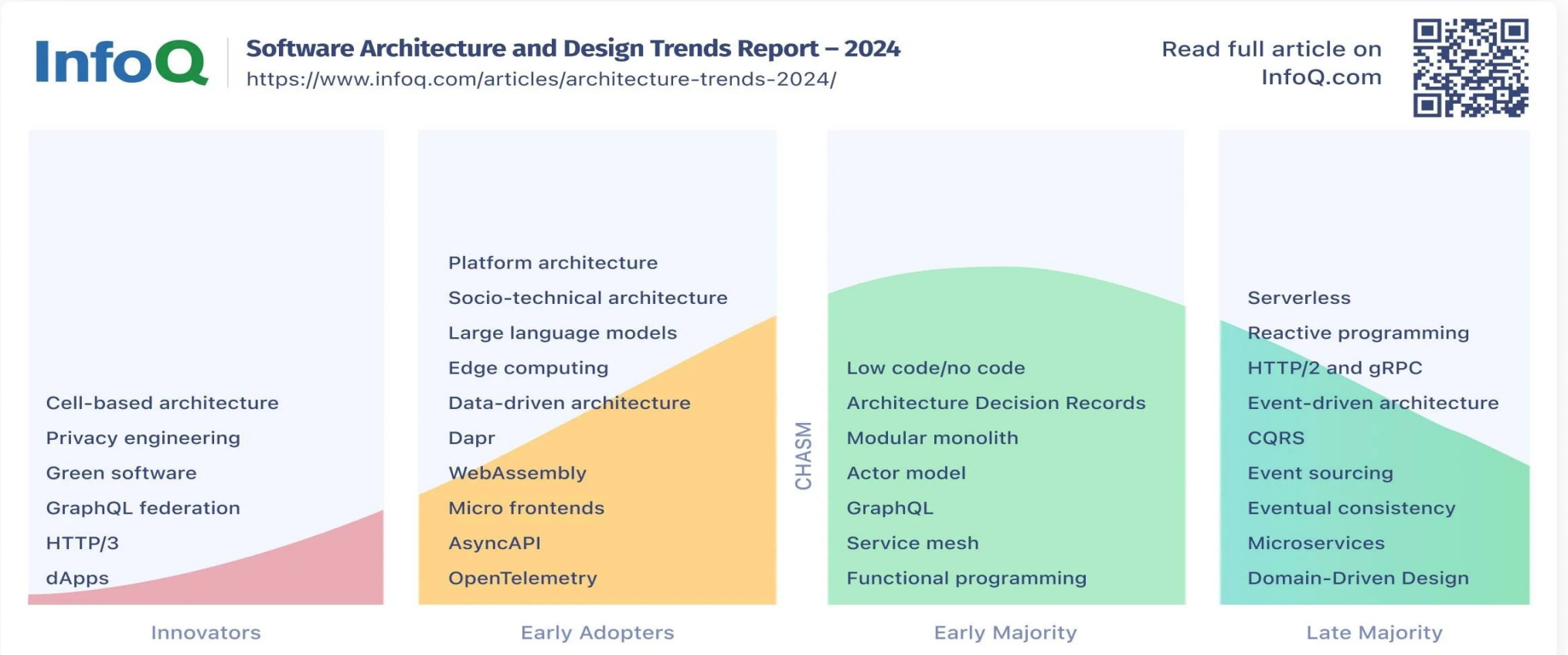
Software Design Principles



Design Approaches

- Divide and Conquer
- Increase Cohesion
- Reduce Coupling
- Increase Abstraction
- Increase Reusability
- Design for Flexibility
- Anticipate Obsolescence
- Design for Portability
- Design for Testability
- Design Defensively

Design Trends



Architecture Types

Monolithic

- Pipeline architecture
- Microkernel architecture
- *Layered architecture*
- **Modular Monolith**

Distributed

- Micro-services architecture
- *Service-based architecture*
- **Event-driven architecture**
- Space-based architecture

SOLID

- S – Single responsibility principle
  high cohesion, only one reason to change
- O – Open/close principle
  open for extension, closed for change
- L – Liskov substitution principle
  subclasses fulfill superclasses or interfaces role,
  see covariance and contra-variance
- I – Interface segregation principle
  clients should not be forced to depend on features they do not use
- D – Dependency inversion principle
  high-level classes should not depend upon low-level classes,
  both should depend on abstraction

DRY

- Do not Repeat Yourself
- This principle states that each small pieces of knowledge (code) may only occur exactly once in the entire system. This helps us to write scalable, maintainable and reusable code.

KISS

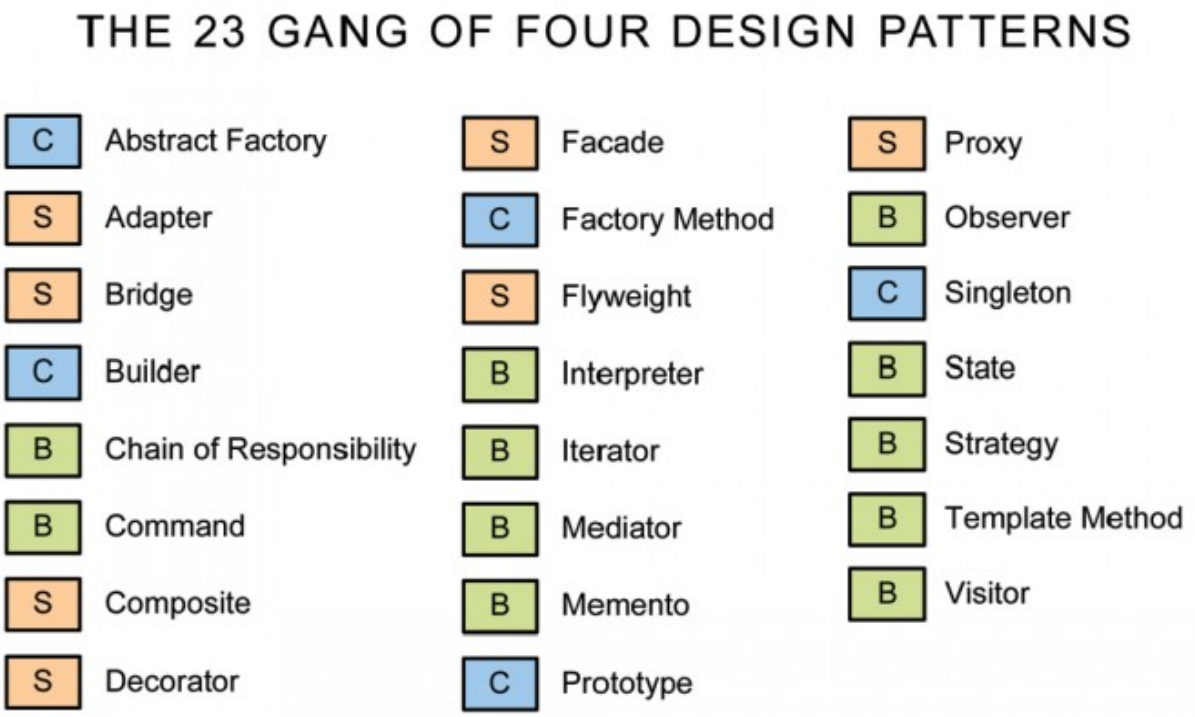
- Keep it Simple, Stupid!
- This principle states that try to keep each small piece of software simple and unnecessary complexity should be avoided. This helps us to write easy maintainable code.

YAGNI

- You ain't gonna need it
- This principle states that always implement things when you actually need them never implements things before you need them.

Patterns

Creational → blue
Structural → sand
Behavioral → green



Patterns

- Patterns tell **stories** of repeatedly **successful** engineering
- Honest pattern descriptions tell you the **drawbacks** as well as the **benefits**
- Applying patterns is **never** mechanical
- Patterns allow more **conscious** and efficient engineering by discussing **alternatives**
- Patterns give a **common vocabulary** which makes communication about design more efficient

Builder Pattern Example (1/3)

```
static Letter of(String returnAddress, String insideAddress,
    LocalDate date, String salutation, String body, String closing) {
        return new Letter(returnAddress, insideAddress, date, salutation,
            body, closing);
}
```

Builder Pattern Example (2/3)

```
// All interfaces are SAM – Single Abstract Method

public static class Builder {
    public static ReturnAddress builder() {
       return returnAddress -> insideAddress -> dateOfLetter -> salutation -> body -> closing ->
                                        new Letter(returnAddress, insideAddress, dateOfLetter, salutation, body,
closing);
    }

    public interface ReturnAddress {
        InsideAddress withReturnAddress(String returnAddress);
    }

    public interface InsideAddress {
        DateOfLetter withInsideAddress(String insideAddress);
    }

    public interface DateOfLetter {
        Salutation withDateOfLetter(LocalDate dateOfLetter);
    }

    public interface Salutation {
        Body withSalutation(String salutation);
    }

    public interface Body {
        Closing withBody(String body);
    }

    public interface Closing {
        Letter withClosing(String closing);
    }
}
```

Builder Pattern Example (3/3)

```
// create a letter with the traditional factory method builder

var letter = Letter.of(returnAddress, insideAddress, date, salutation,
                       body, closing);
```

```
// create a letter with the functional builder

var letter = Letter.Builder.builder().
        .withReturnAddress(returnAddress)
        .withInsideAddress(insideAddress)
        .withDateOfLetter(date)
        .withSalutation(salutation)
        .withBody(body)
        .withClosing(closing);
```

Layered Architecture

This point is somewhat redundant and maybe theoretical but is worth mentioning. The Layered Architecture breaks almost all rules and idioms of object-orientation. Here are just a few:

- **Encapsulation**: Encapsulation does not survive crossing layers, because the interfaces between layers are defined in terms of data.
- **Abstraction**: There is very little to no abstraction because every layer has to understand all concepts nearly equally.
- **Cohesion and Coupling**: Cohesive parts of the same "thing" are broken up because of the potentially differing technologies involved. So it makes the code less cohesive and more coupled.
- **Law of Demeter**: Access to data, using DTOs, for example, almost always leads to violations.
- **Tell don't ask**: Objects don't get told what to do in the Layered Architecture; they are asked for data, and then, things happen with that data somewhere else out of the control of the object producing or holding the data.

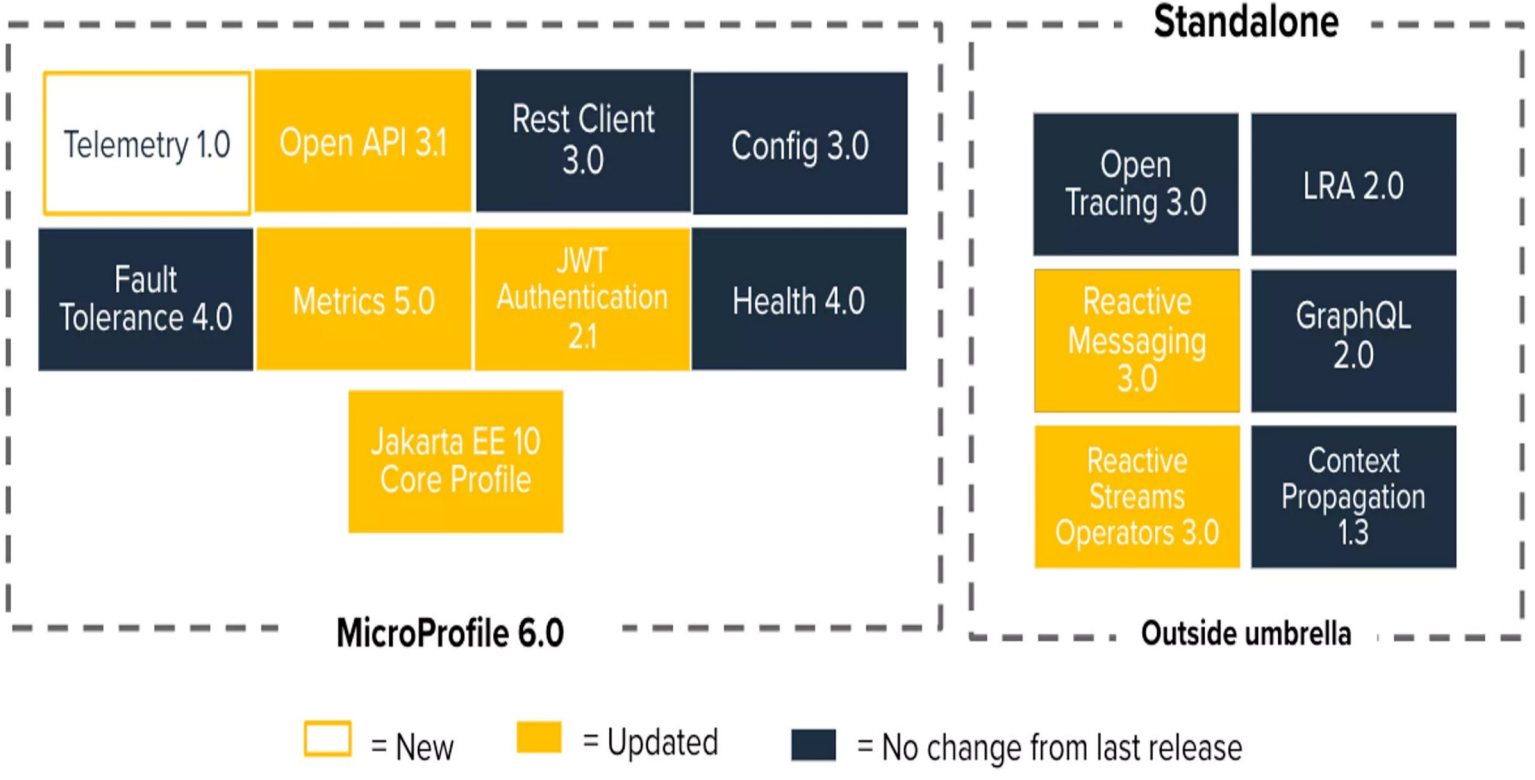
Hexagon Architecture

- It promotes mocking of connectors
  - Improves testability
  - Simplify integration
- It promotes domain models
- It could promote event based approaches

Java Ecosystem (1/3)

- Patterns in Java
- Streams in Java
  - e.g. filtering, composing of collectors
- Functional programming
  - e.g. strategy pattern, function composing, complex predicate expressions
- Reactive programming

Java Ecosystem (2/3)

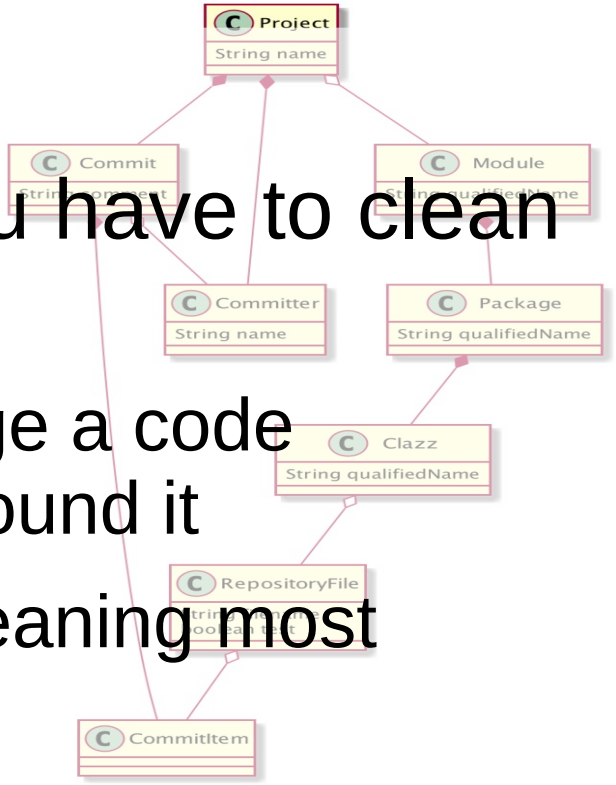


Java Ecosystem (3/3)

- Exception Handling – prefer runtime exceptions -
- Multi-Threading *java.util.concurrent*
- Patterns in API
- Immutability in API (*see also* ***record****)*
- Java Trends
  - functional programming, immutability, reification, memory-efficiency, heterogeneous processors, virtual threads

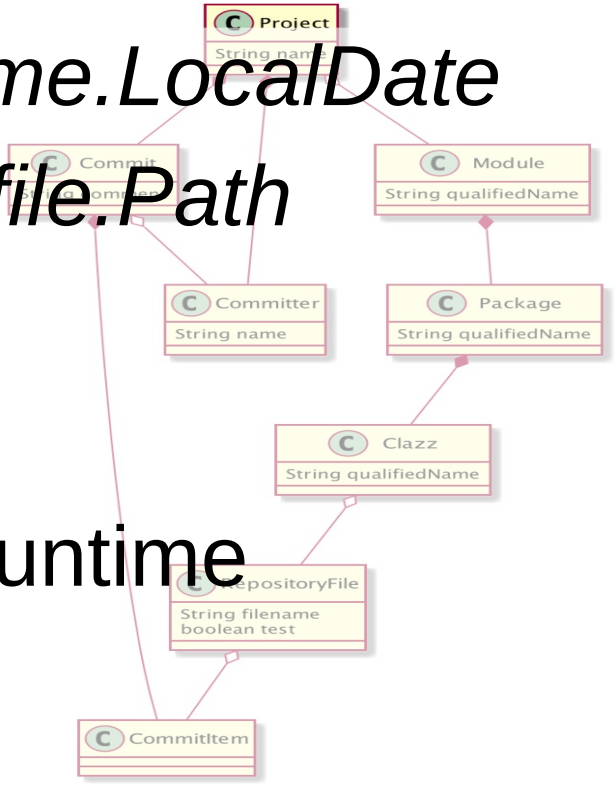
Clean Code

- You shall only produce clean code
- If you inherit dirty components, you have to clean them
  - *Boy scout rule*: Each time you change a code segment, leave it cleaner than you found it
  - It is similar to improve hot code – meaning most valuable or most updated -



Clean Code Examples

- Remove *java.util.Date*, use *java.time.LocalDate*
- Remove *java.io.File*, use *java.nio.file.Path*
- Use *Stream.toList()*
- Use try with resources
- Remove checked exception, use runtime exception
- Remove XML, use JSON



Refactor

- Aggressively refactor your code
- Aggressively refactor your design
- Remember the cone of uncertainty
- Developing a product means learning
- Agile means improving

OOP Anti-Pattern Examples (1/2)

- Singletons are **evil**
- Never return a **null value**
- Returning modifiable collections is evil
- Anemic domain classes are worthless
- DTO *Data Transfer Objects* are waste

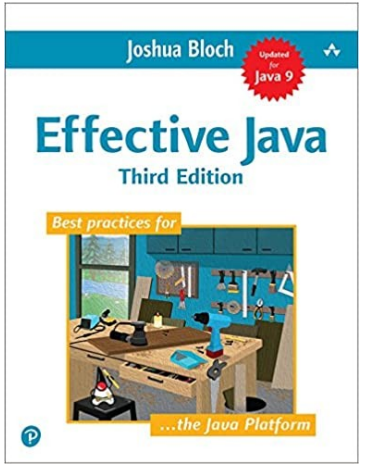
OOP Anti-Pattern Examples (2/2)

- Class casting is an object-oriented design error
  - *instanceof* operator is a crime (*see **pattern matching** for reasonable use of instanceof in Java 14+)*
- Public static methods are often suspect
- Abuse of utility classes is procedural design
- God classes shall be forbidden

Links

- Blog *Agile Component Design*
- Patterns used in Java API (Stackoverflow article) and in a blog article

All the patterns you are using daily



Exercises (1/2)

- Analyse your Java packages and refactor them to fulfill SOLID
- Analyse your Java packages and identify the used patterns
- Can you improve your code with Java idioms and patterns?
- How do you handle errors and exceptions?

Exercises (2/2)

- Read the optional paper on Java Patterns
  - Understand Builder, Facade, Strategy, Factory method patterns and how to use lambda expressions to implement them
  - *RAII* pattern *Resource Acquisition Is Initialization* and Java try with resources
  - Iterator pattern as implemented in Java
- Coding Dojo - Code examples of students
  - Replace custom methods and classes with standard API methods and classes
  - Implement a Java Pattern