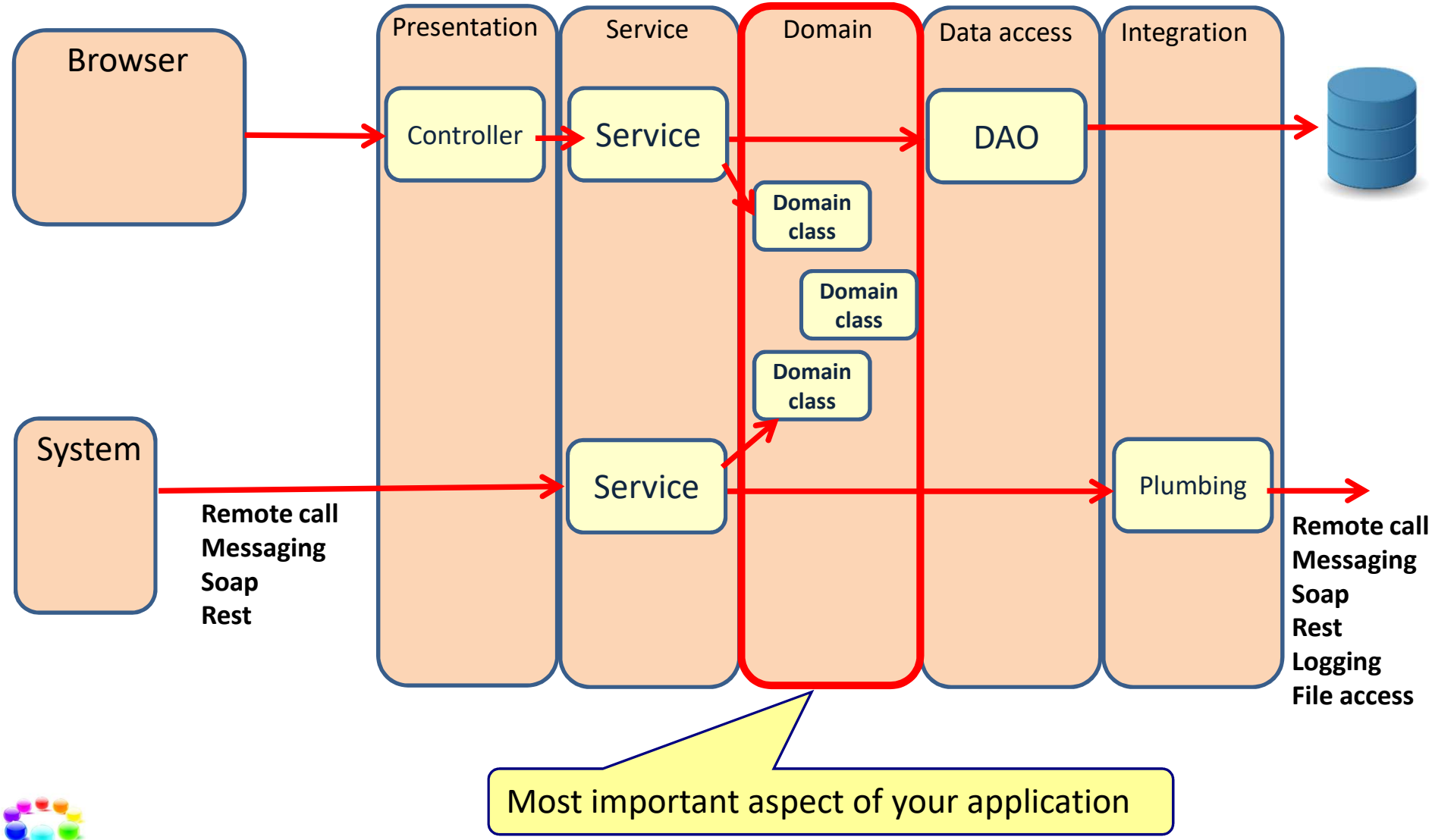
Lesson 3

DOMAIN DRIVEN DESIGN

Domain Driven Design



Building software

- Before you can start writing code you have to understand the domain first

The hardest single part of building a software system is deciding precisely what to build.

Fred Brooks - "No Silver Bullet“ 1987

If you don’t get the requirements right, it does not matter how well you do anything else.

Karl Wiegers

People use their own language

- Business process
- Business events
- Business rules
- Business structure

domain expert

- Objects
- Databases
- HTML
- SQL
- XML messages

developer

- Applications
- Components
- Protocols
- Platforms
- Tooling

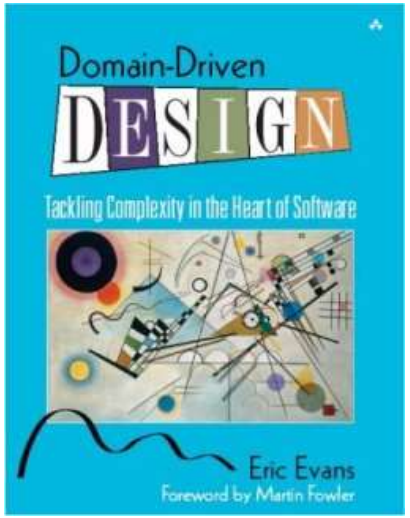
architect

Business and IT working close together

- Both use a different language
- The code/design often does not reflect the business
  - But reflects the developers view
- The business does not understand the developers view
  - A lot of translation need to be done

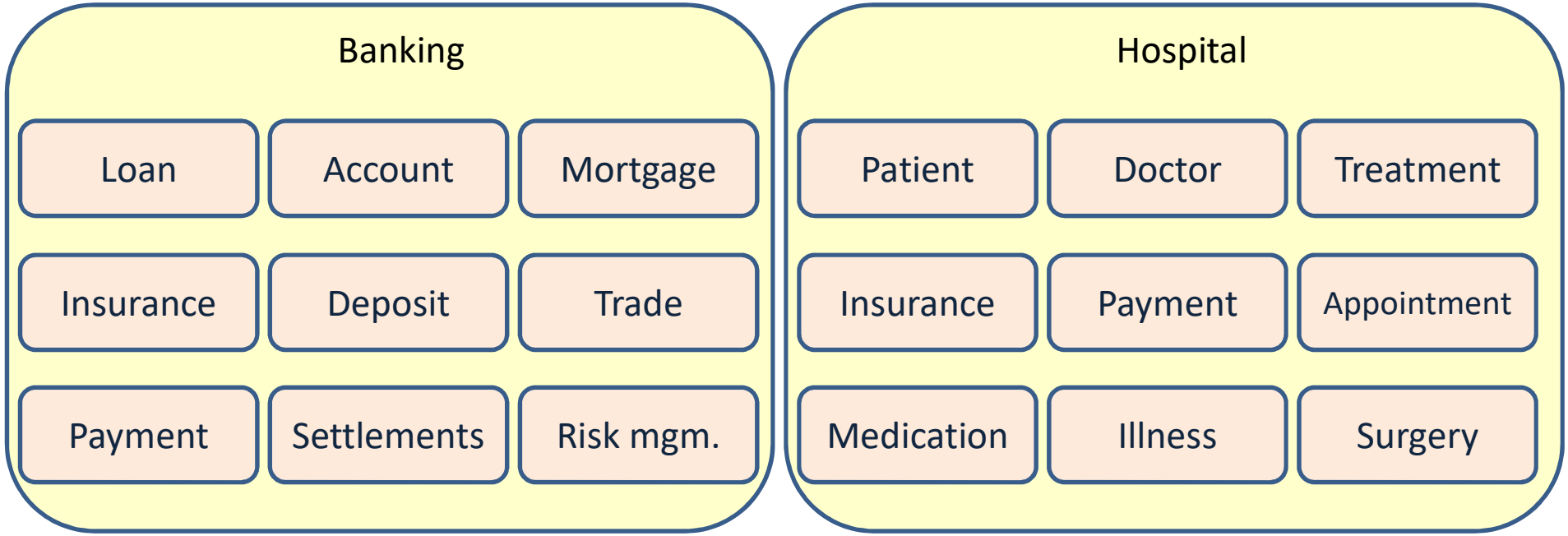
What is Domain Driven Design?

- An approach to software development where the focus is on the core Domain.
  - We create a domain model to communicate the domain
  - Everything we do (discussions, design, coding, testing, documenting, etc.) is based on the domain model.



Domain

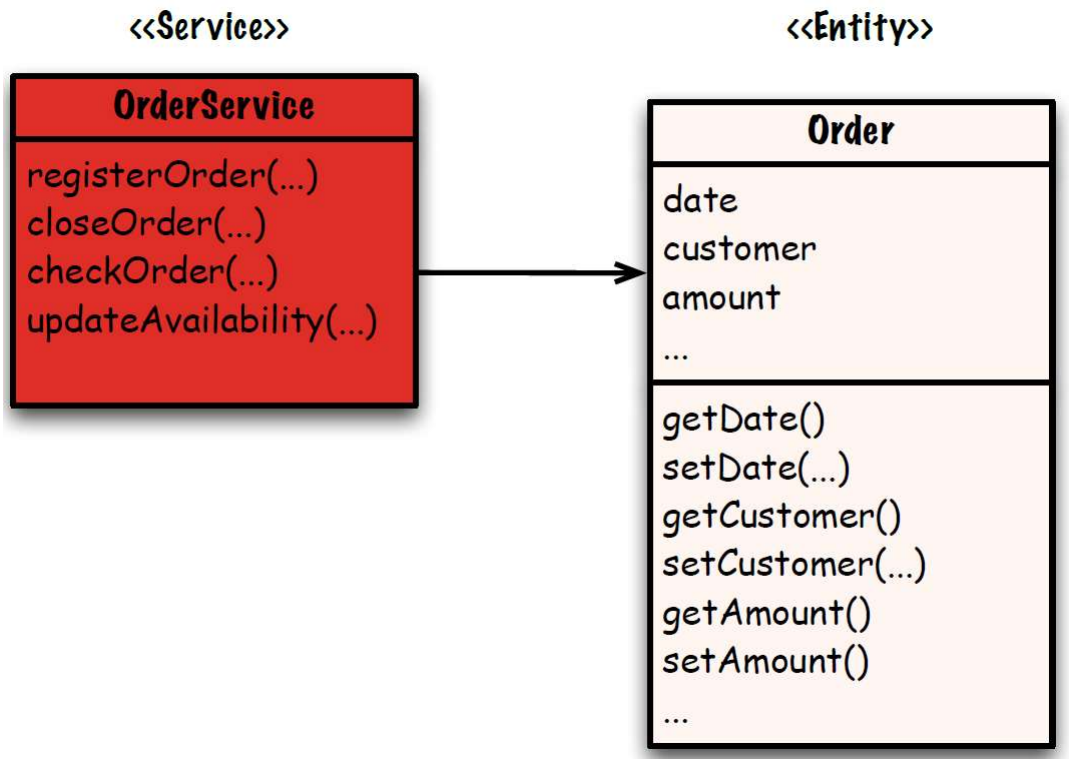
What a business does and the world it does it in.



Anemic domain model

- Classes in the model have no business logic

NOT OK



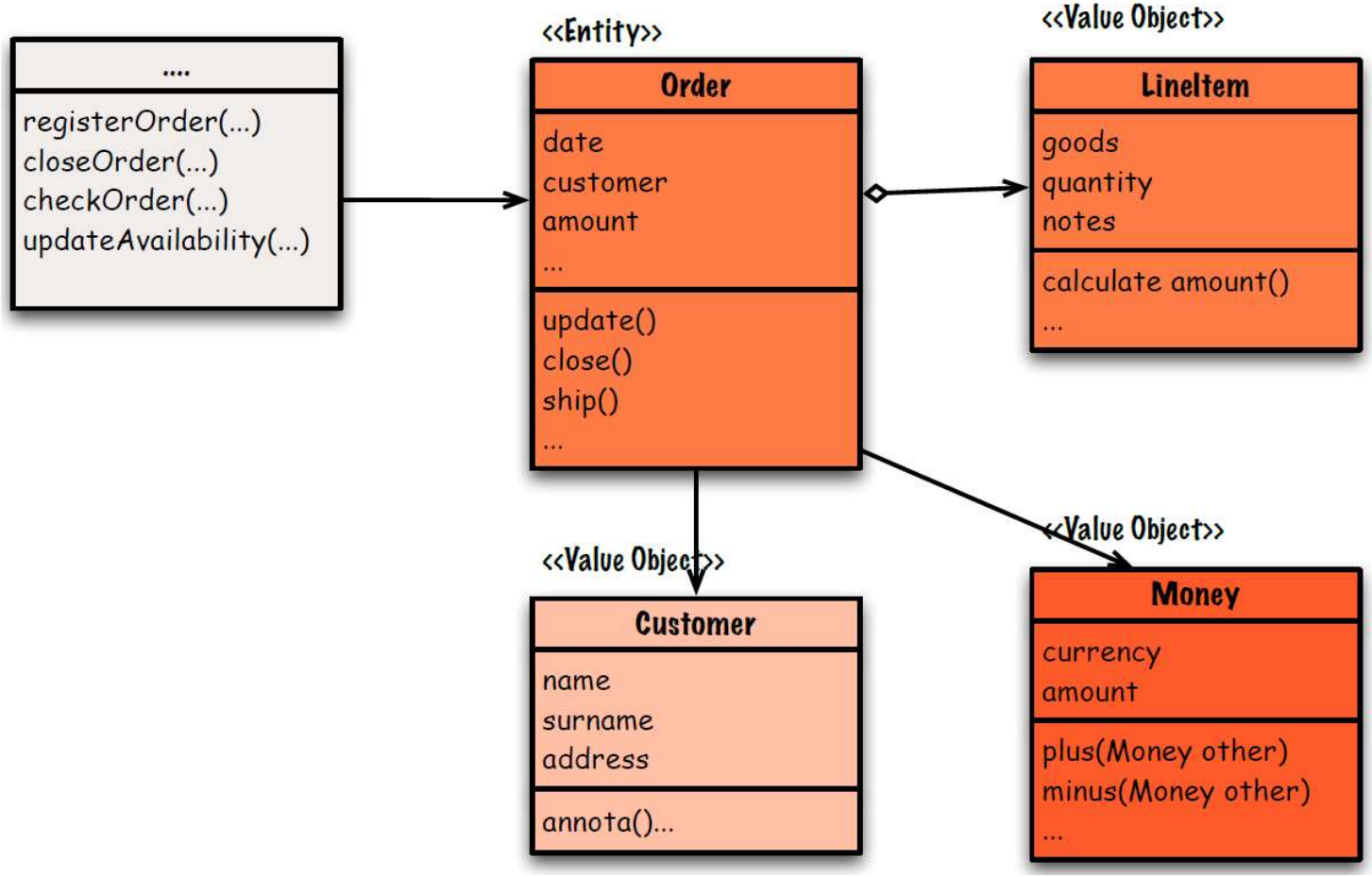
Disadvantages anemic domain model

- You do not use the powerful OO techniques to organize complex logic.
- Business logic (rules) is hard to find, understand, reuse, modify.
- The software reflects the data structure of the business, but not the behavioral organization
- The service classes become too complex
  - No single responsibility
  - No separation of concern

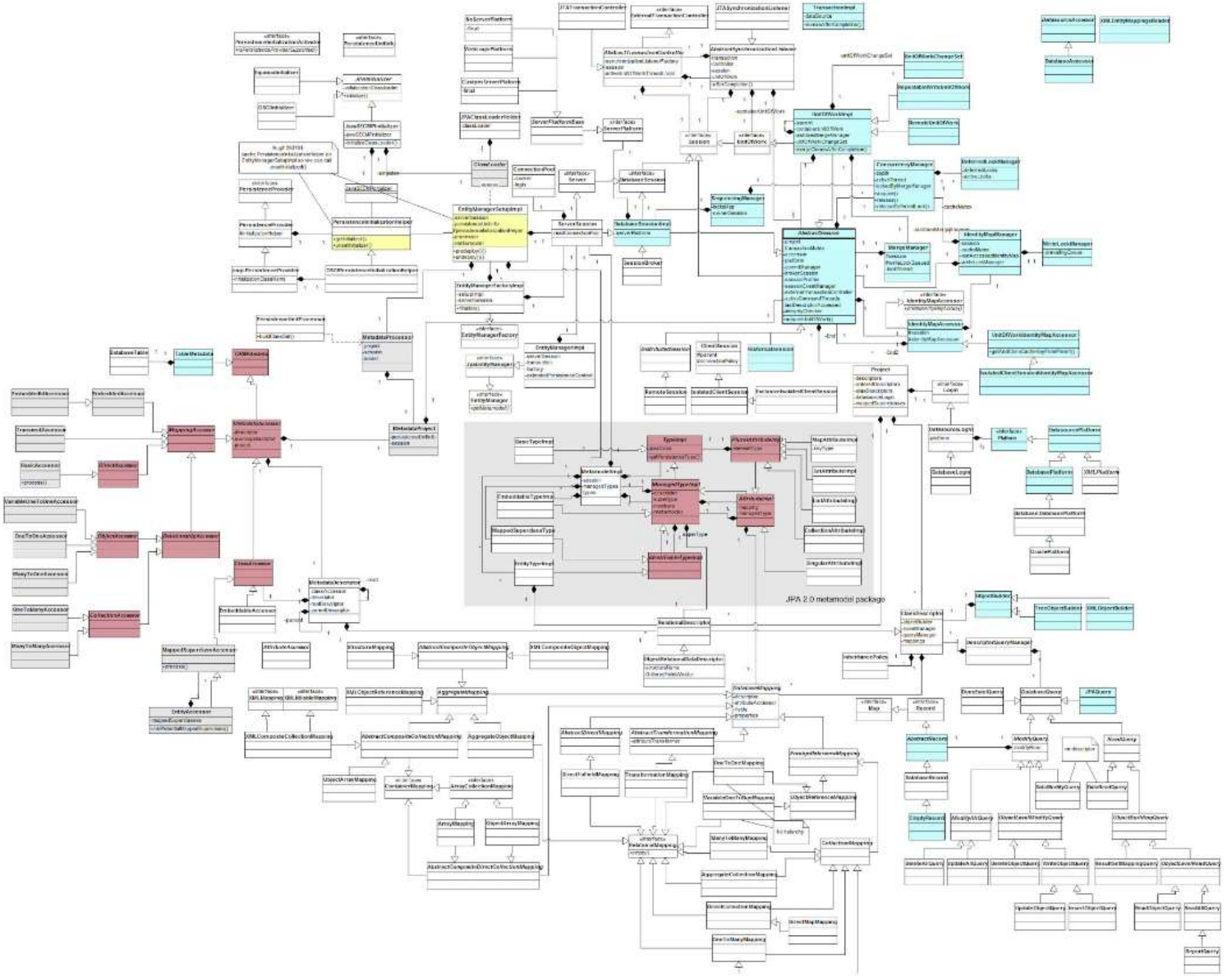
Rich domain model

- Classes with business logic

OK



How to deal with complex domain models?



Domain Model Patterns

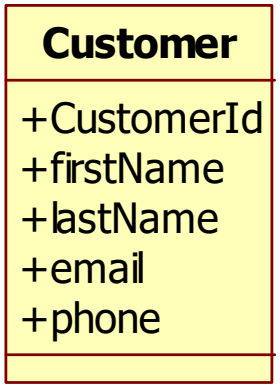
- Entities
- Value objects
- Domain services
- Domain events
- Aggregates

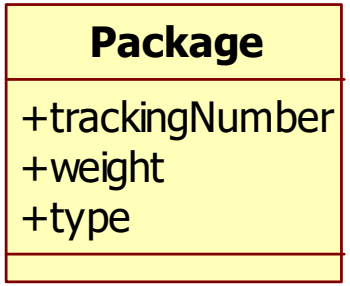
ENTITIES

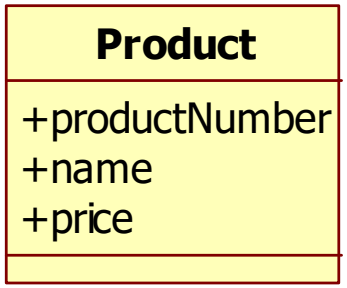
Entities

- A class with identity
- Mutable
  - State may change after instantiation
  - The entity has an lifecycle
    - The order is placed
    - The order is paid
    - The order is fulfilled

Example entity classes







Entities

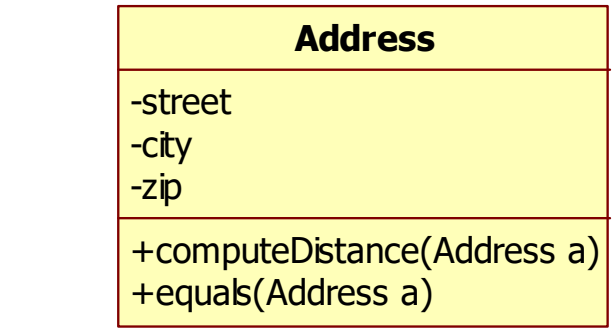
- Changing attributes doesn't change which one we're talking about
  - Identity remains constant throughout its lifetime

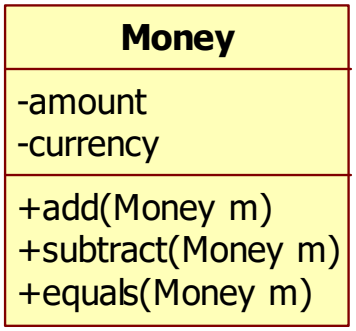
VALUE OBJECTS

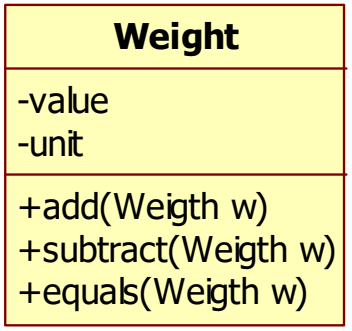
Value objects

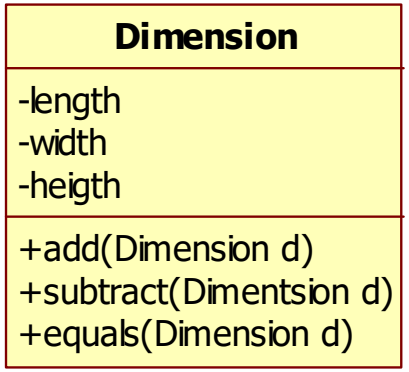
- Has no identity
  - Identity is based on composition of its values
- Immutable
  - State cannot be changed after instantiation

Example value object classes







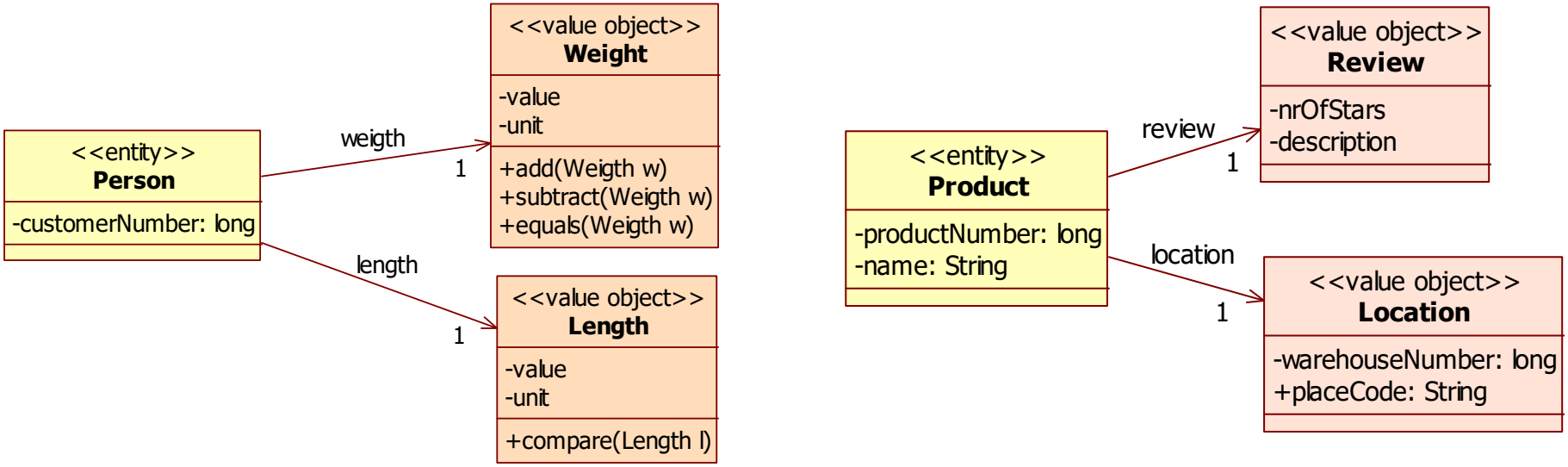


Value object characteristics

- No identity
- Attribute-based equality
- Behavior rich
- Cohesive
- Immutable
- Combinable
- Self-validating
- Testable

No identity

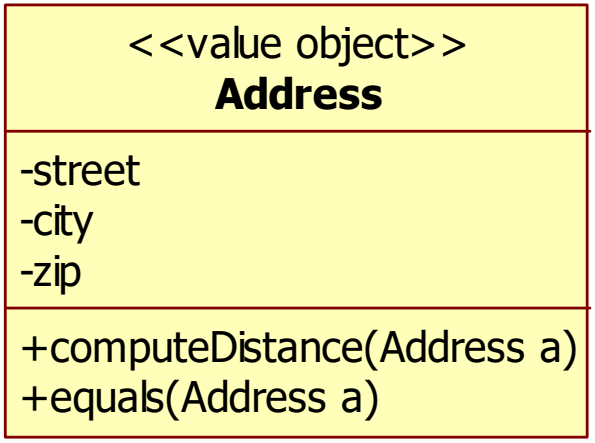
- Value objects tell something about another object

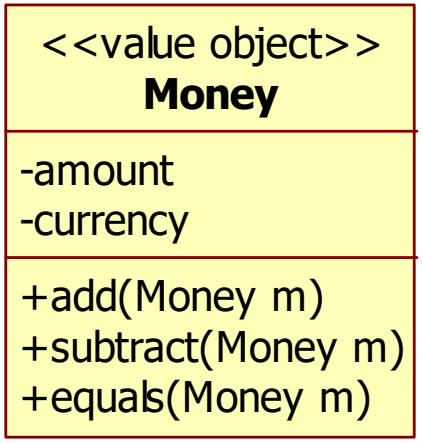


- Technically, value objects may have IDs using some database persistence strategies.
  - But they have no identity in the domain.

Attribute-based equality

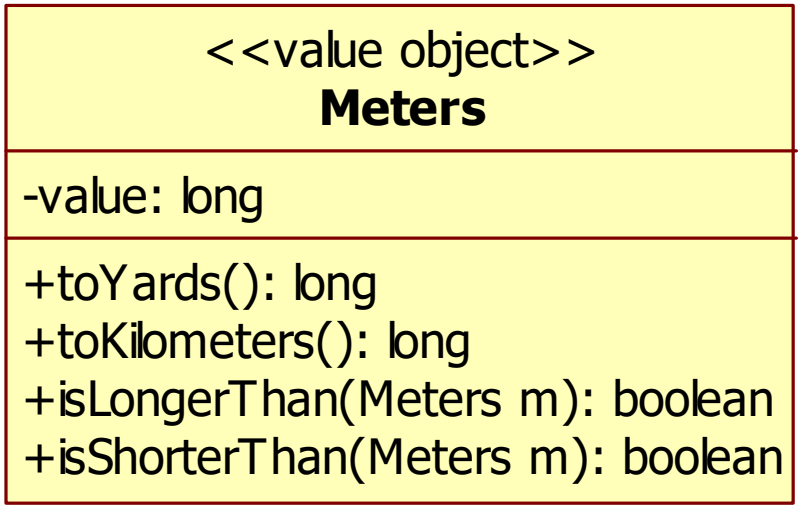
- 2 value objects are equal if they have the same attribute values





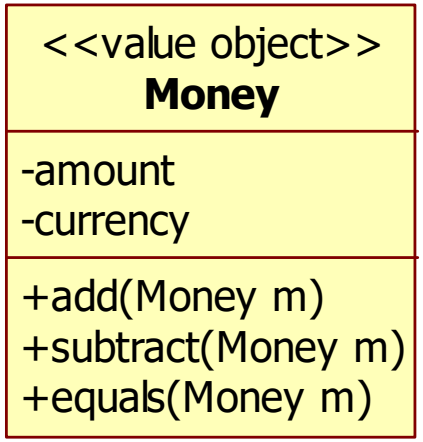
Behavior rich

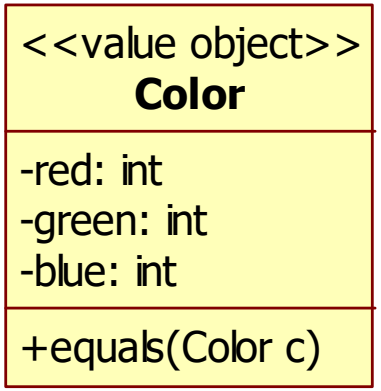
- Value objects should expose expressive domain-oriented behavior



Cohesive

- Encapsulate cohesive attributes





Immutable

- Once created, a value object can never be changed

```
public class Money {
  private BigDecimal value;

  public Money(BigDecimal value) {
    this.value = value;
  }

  public Money add(Money money){
    return new Money(value.add(money.getValue()));
  }

  public Money subtract(Money money){
    return new Money(value.subtract(money.getValue()));
  }

  public BigDecimal getValue() {
    return value;
  }
}
```

No setter methods

Mutation leads to the creation of new instances

Minimize Mutability

- Reasons to make a class immutable:
  - Less prone to errors
  - Easier to share
  - Thread safe
  - Combinable
  - Self-validating
  - Testable

Combinable

- Can often be combined to create new values

```
public class Money {
  private BigDecimal value;

  public Money(BigDecimal value) {
    this.value = value;
  }

  public Money add(Money money){
    return new Money(value.add(money.getValue()));
  }

  public Money subtract(Money money){
    return new Money(value.subtract(money.getValue()));
  }

  public BigDecimal getValue() {
    return value;
  }
}
```

Combine 2 Money instances

Self-validating

- Value objects should never be in an invalid state

```
public class Money {
   private BigDecimal value;

   public Money(BigDecimal value) {
     validate(value);
     this.value = value;
   }

   private void validate(BigDecimal value){
     if (value.doubleValue() < 0)
       throw new MoneyCannotBeANegativeValueException();
   }

   public Money add(Money money){
     return new Money(value.add(money.getValue()));
   }

   public BigDecimal getValue() {
     return value;
   }
}
```

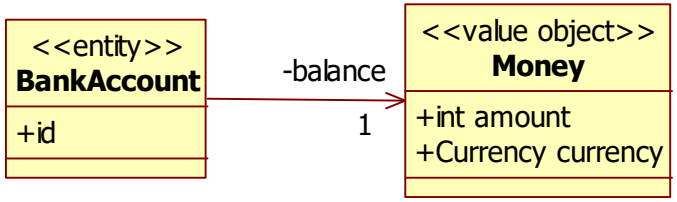
Self-validation

Testable

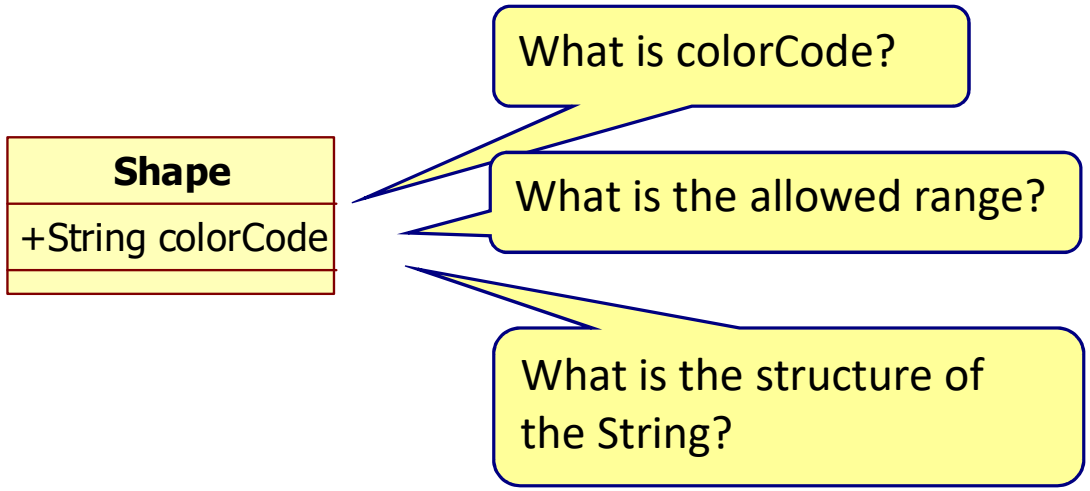
- Value objects are easy to test because of these qualities
  - Immutable
    - We don’t need mocks to verify side effects
  - Cohesion
    - We can test the concept in isolation
  - Combinability
    - Allows to express the relationship between 2 value objects

When to use value objects?

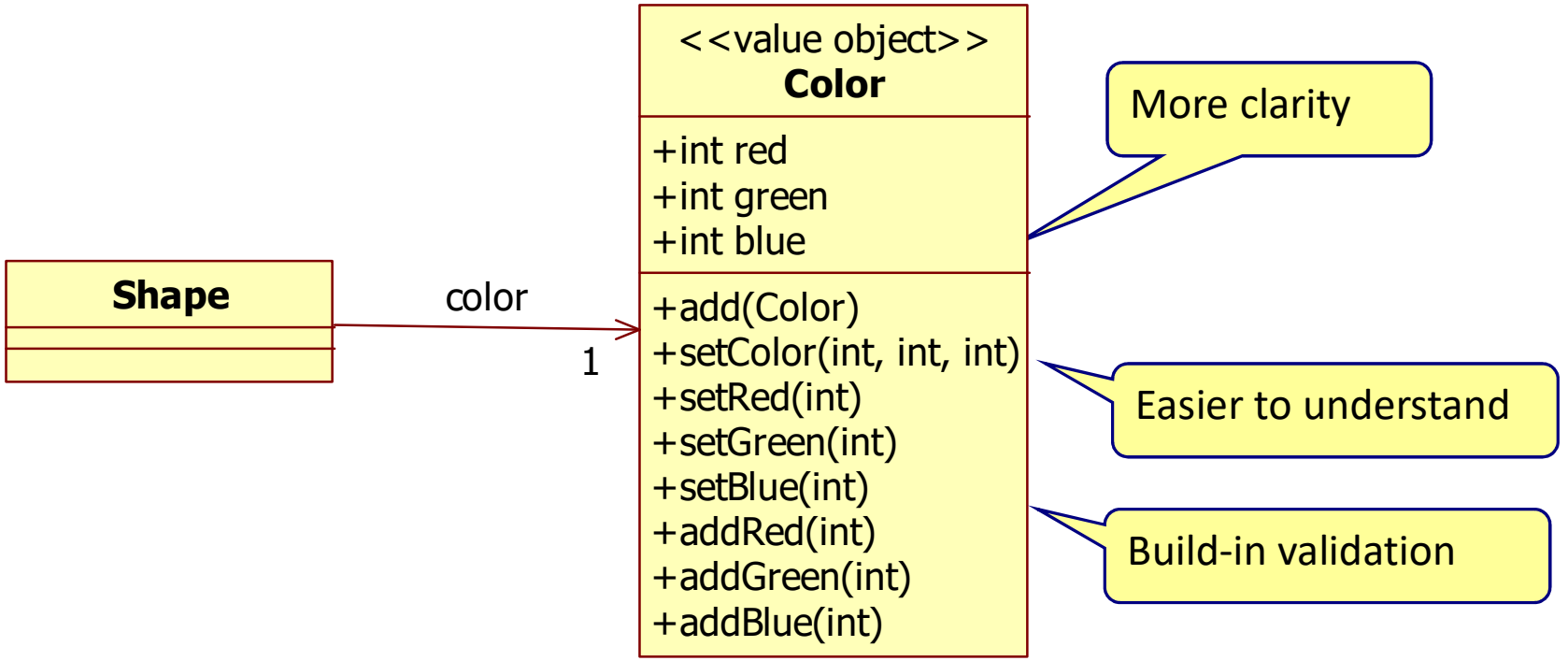
1. Representing a descriptive identity-less concept



2. Enhancing explicitness



Enhancing explicitness



Static factory methods

```
public class Heigth {
  private enum MeasureUnit {
    METER,
    FEET,
    YARD;
  }

  private int value;
  private MeasureUnit unit;

  public Heigth(int value, MeasureUnit unit) {
    this.value = value;
    this.unit = unit;
  }

  public static Heigth fromFeet(int value) {
    return new Heigth(value, MeasureUnit.FEET);
  }

  public static Heigth fromMeters(int value) {
    return new Heigth(value, MeasureUnit.METER);
  }
}
```

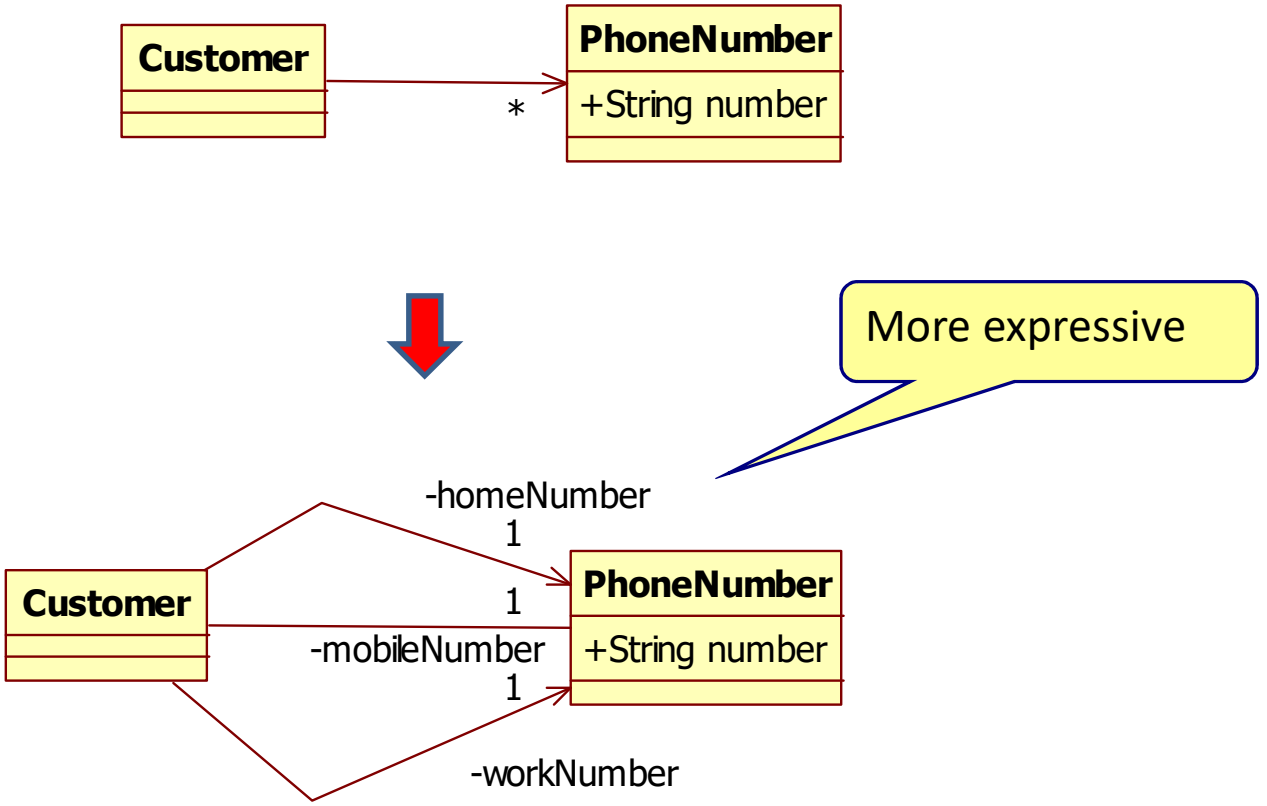
More expressive

Easier for clients to call

Decouple clients from MeasureUnit

Collection avoidance

- Be careful with collections of value objects

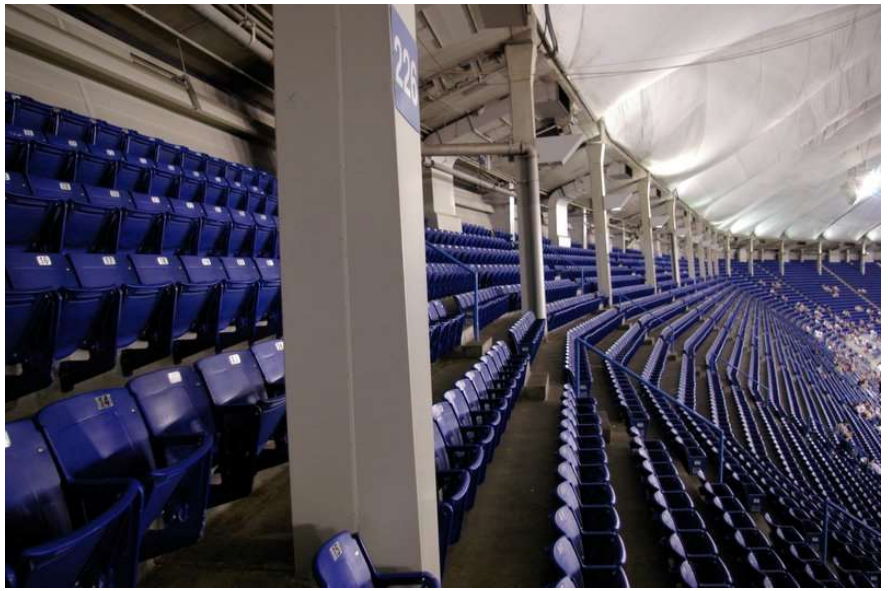


Persisting value objects

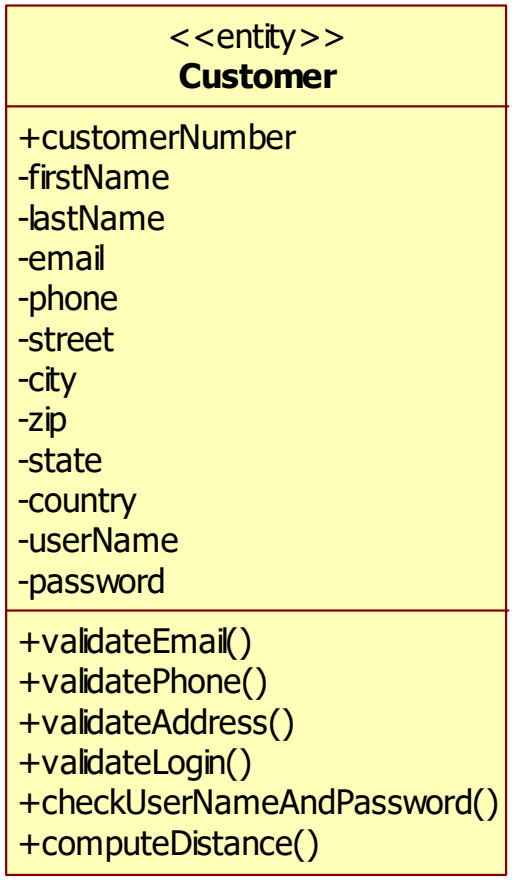
- Persist them into a denormalized form
  - Relational
    - Save them as String (using toString())
  - NoSQL
    - Embed them into the entity document
- Persist them into a separate relational table
  - Give the value object an id.

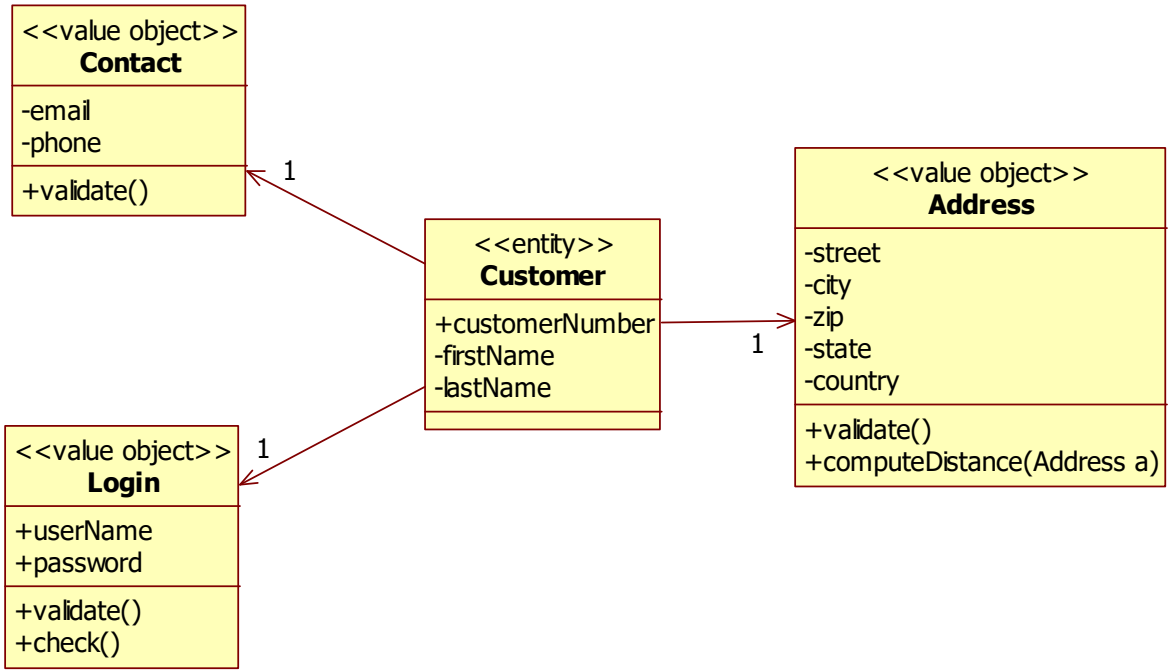
Entity versus value objects

- If visitors can sit wherever they find an empty seat then seat is a...
- If visitors buy a ticket with a seat number on it, then seat is a...



Pushing behavior into value objects





Entities versus Value objects

- Entities have their own intrinsic identity, value objects don't.
- The notion of identity equality refers to entities
  - Two entities are the same if their id's are the same
- The notion of structural equality refers to value objects
  - Two value objects are the same if their data is the same
- Entities have a history; value objects have a zero lifespan.
- A value object should always belong to one or several entities.
  - It can't live by its own.
- Value objects should be immutable; entities are almost always mutable.
  - If you change the data in a value object, create a new object.
- If you can safely replace an instance of a class with another one which has the same set of attributes, that's a good sign this concept is a value object
- Value objects don't need their own tables in the database.
  - The data can be embedded into the entity table
- Always prefer value objects over entities in your domain model.

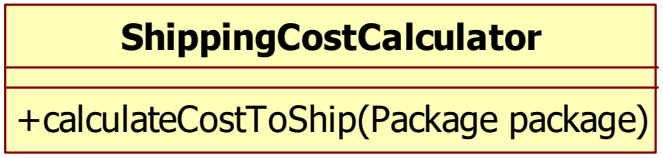
Main point

- Instead of a large entity class, we strive for a small and simple entity class with many value classes
- The Unified Field contains all knowledge in its simplest and most abstract form.

DOMAIN SERVICES

Domain service

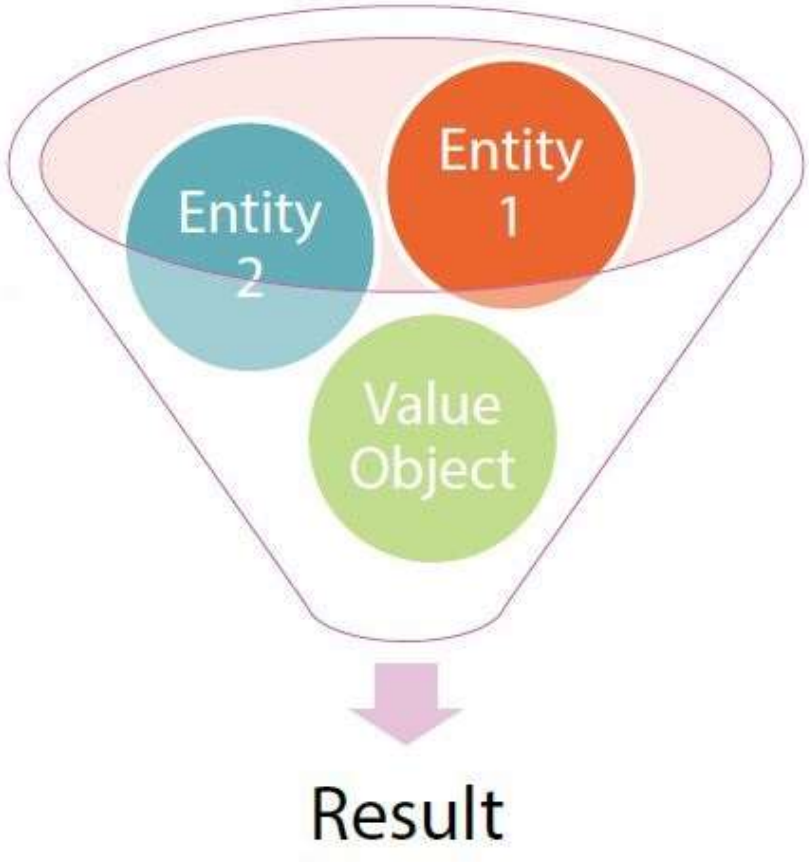
- Sometimes behavior does not belong to an entity or value object
  - But it is still an important domain concept
- Use a domain service.



Domain service

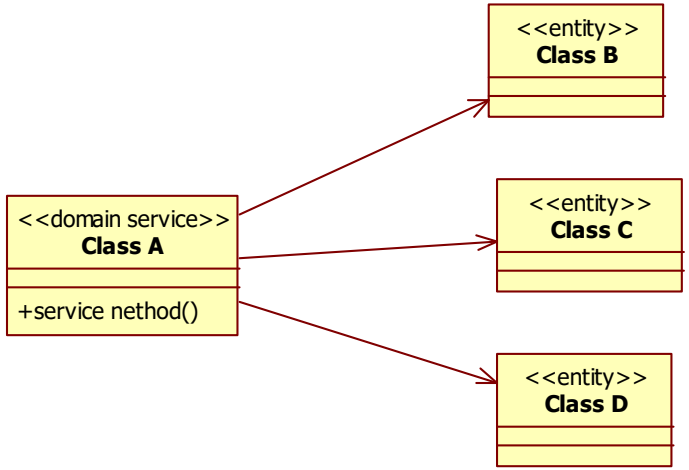
- Interface is defined in terms of other domain objects

ShippingCostCalculator
+calculateCostToShip(Package package)

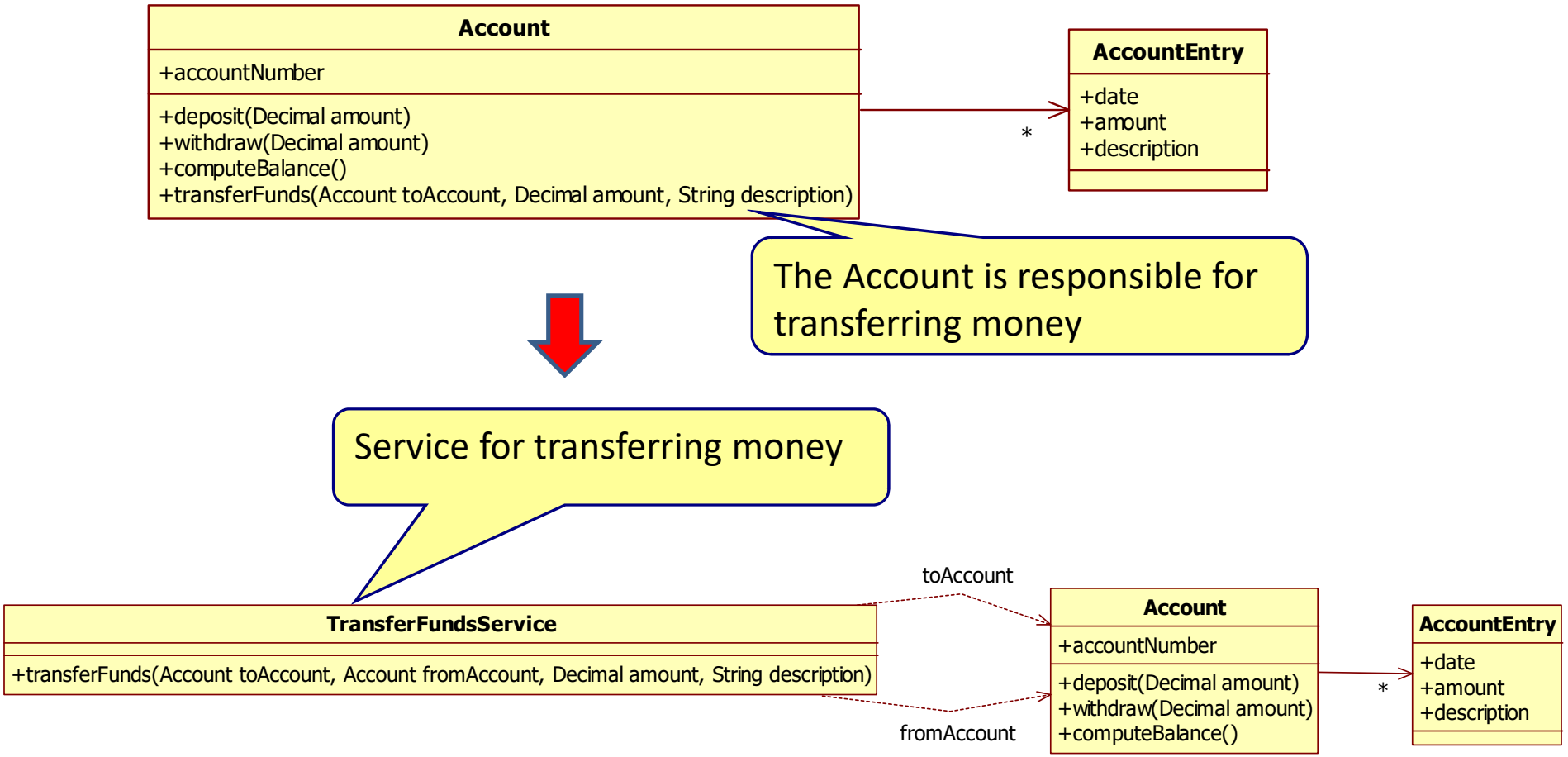


Domain service characteristics

- Stateless
  - Have no attributes
- Represent behavior
  - No identity
- Often orchestrate multiple domain objects



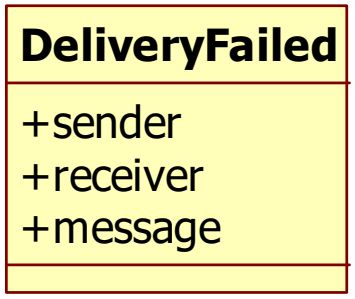
Service example

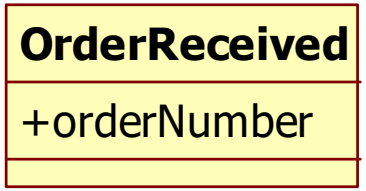


DOMAIN EVENTS

Domain event

- Classes that represent important events in the problem domain that have already happened
  - Immutable

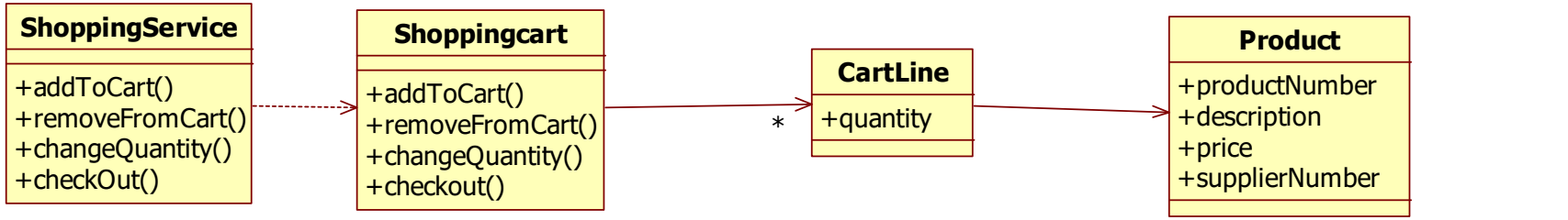


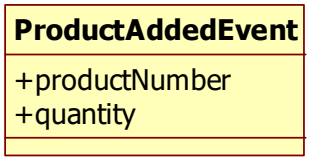


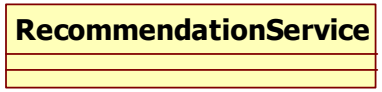
Domain event

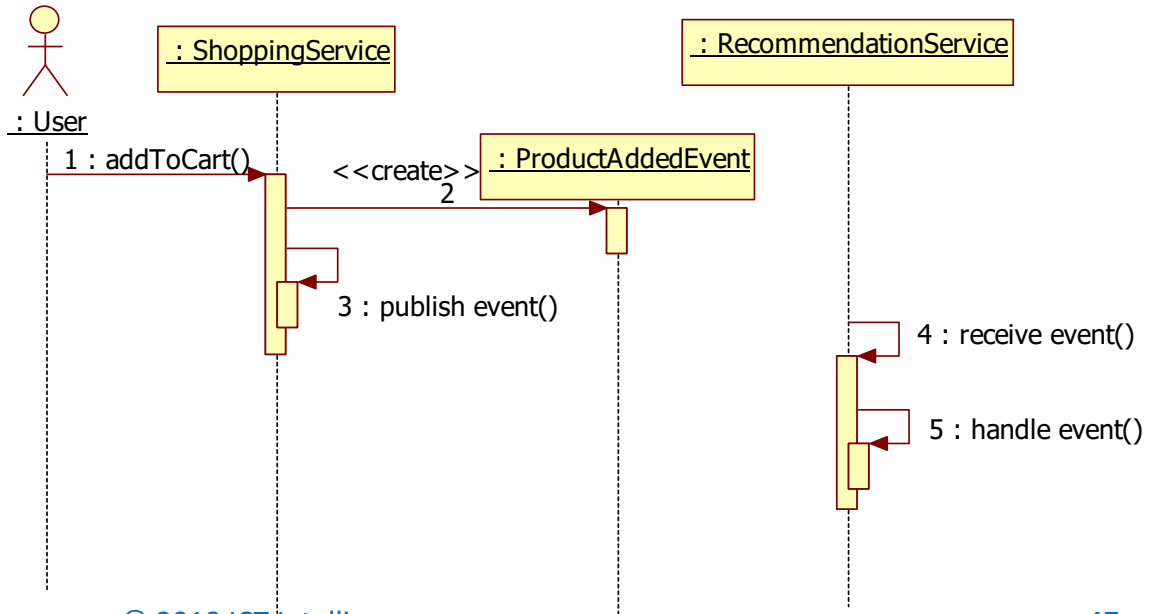
- Events are raised and event handlers handle them.
- Some handlers live in the domain, and some live in the service layer.

Domain event example





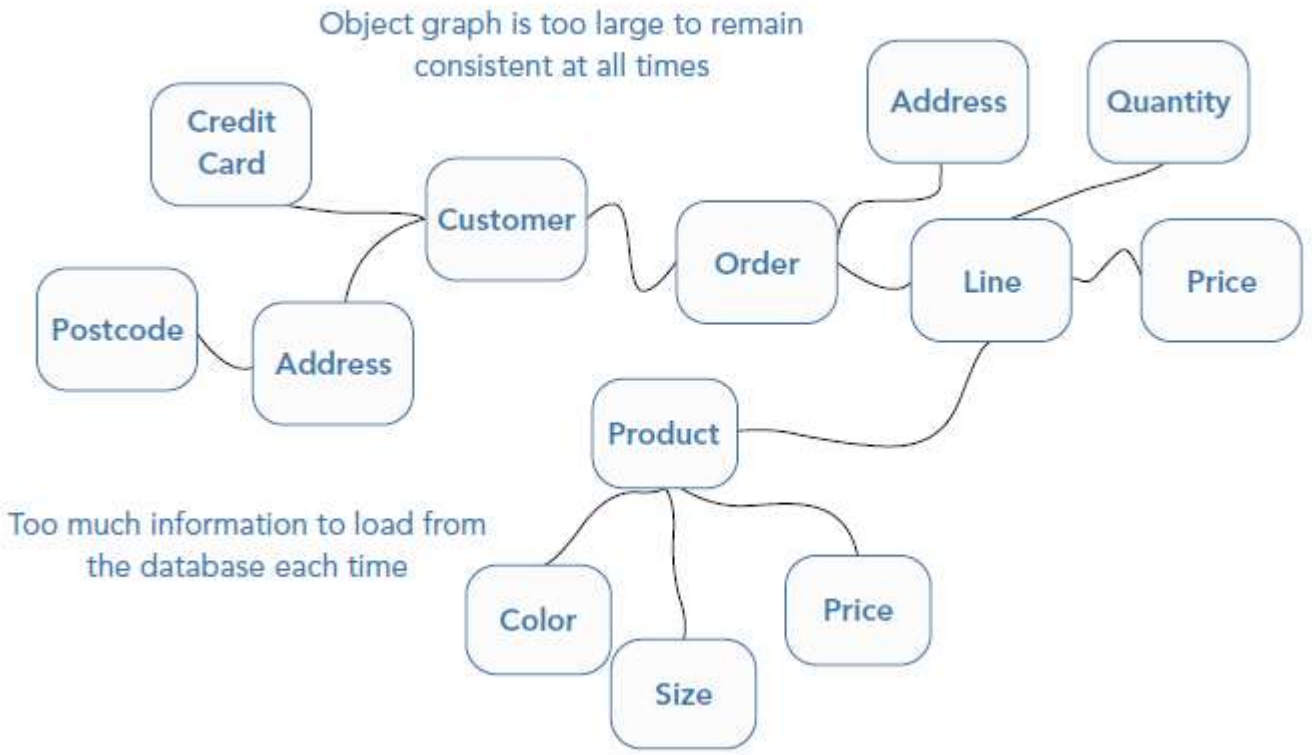




AGGREGATES

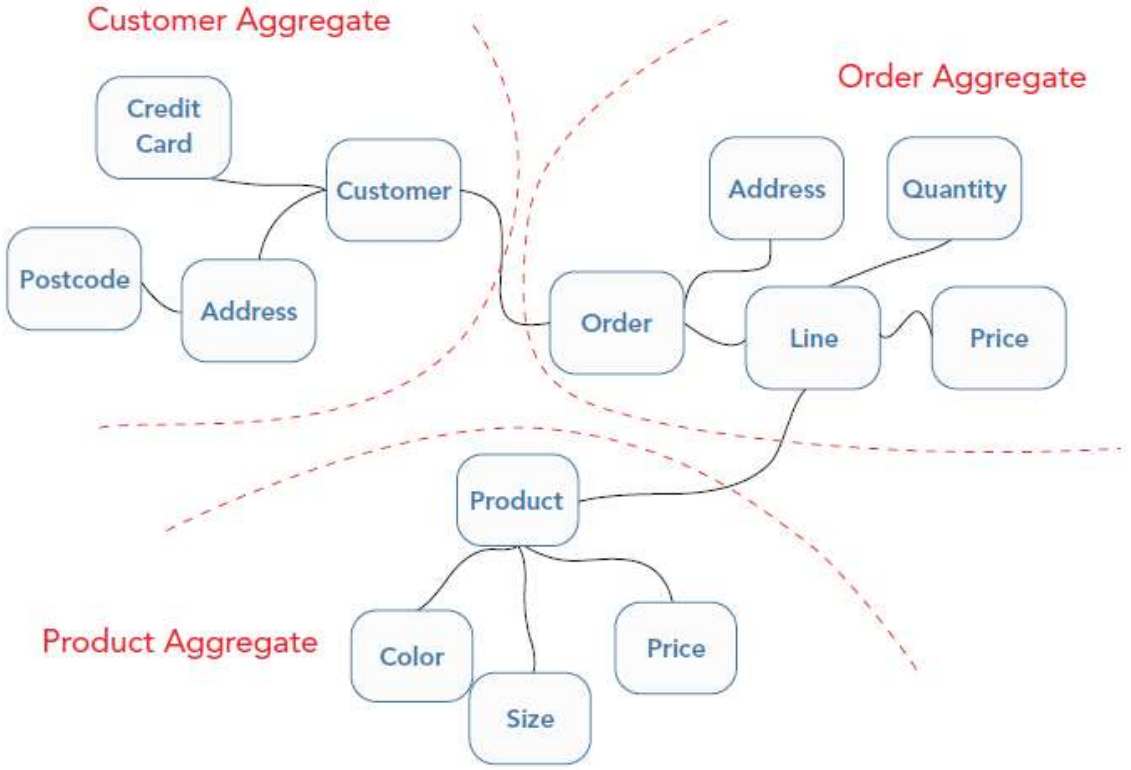
Aggregates

- Large object graphs are difficult to keep consistent



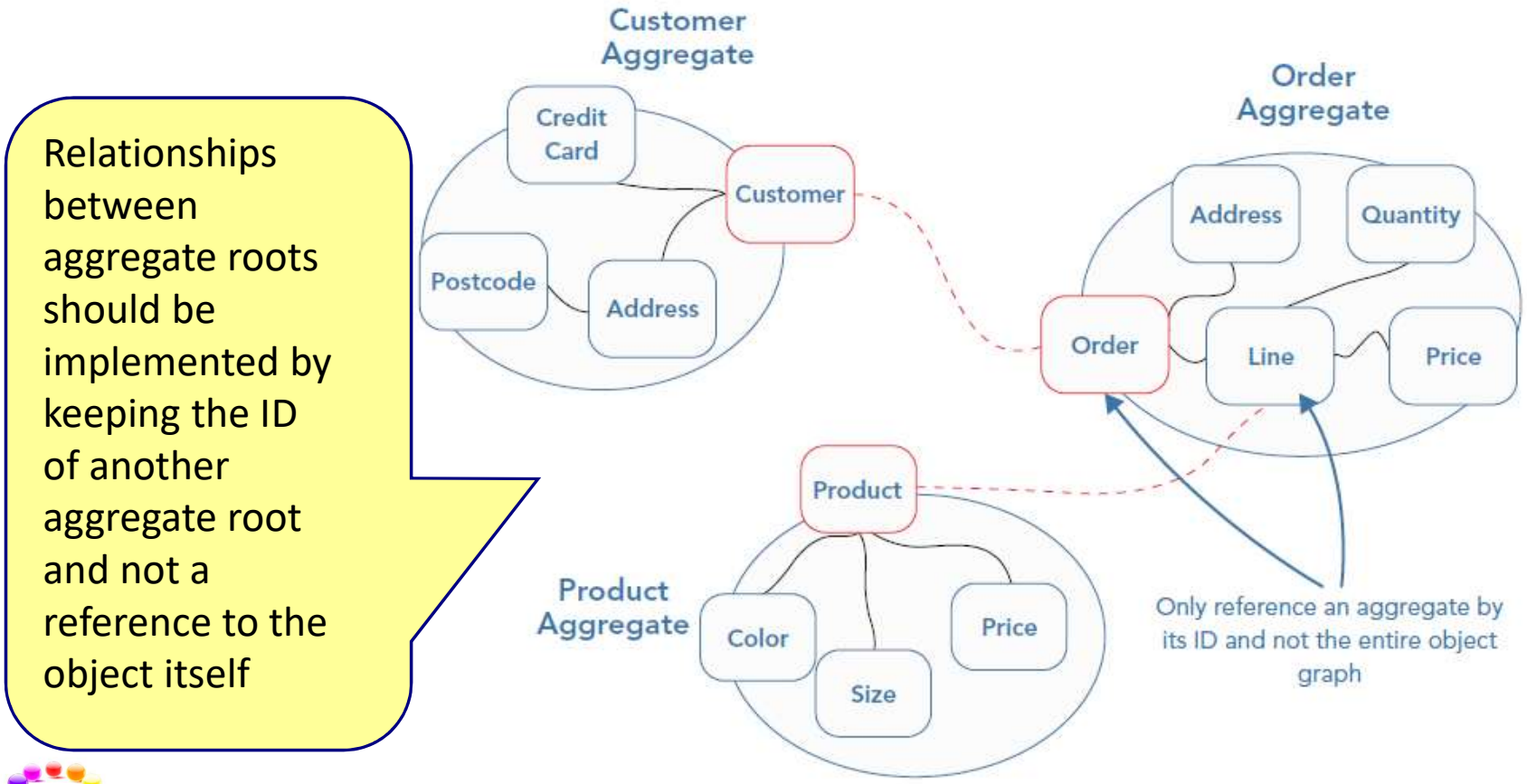
Aggregates

- Large models are split and grouped into aggregates of entities and value objects that are treated as a conceptual whole.

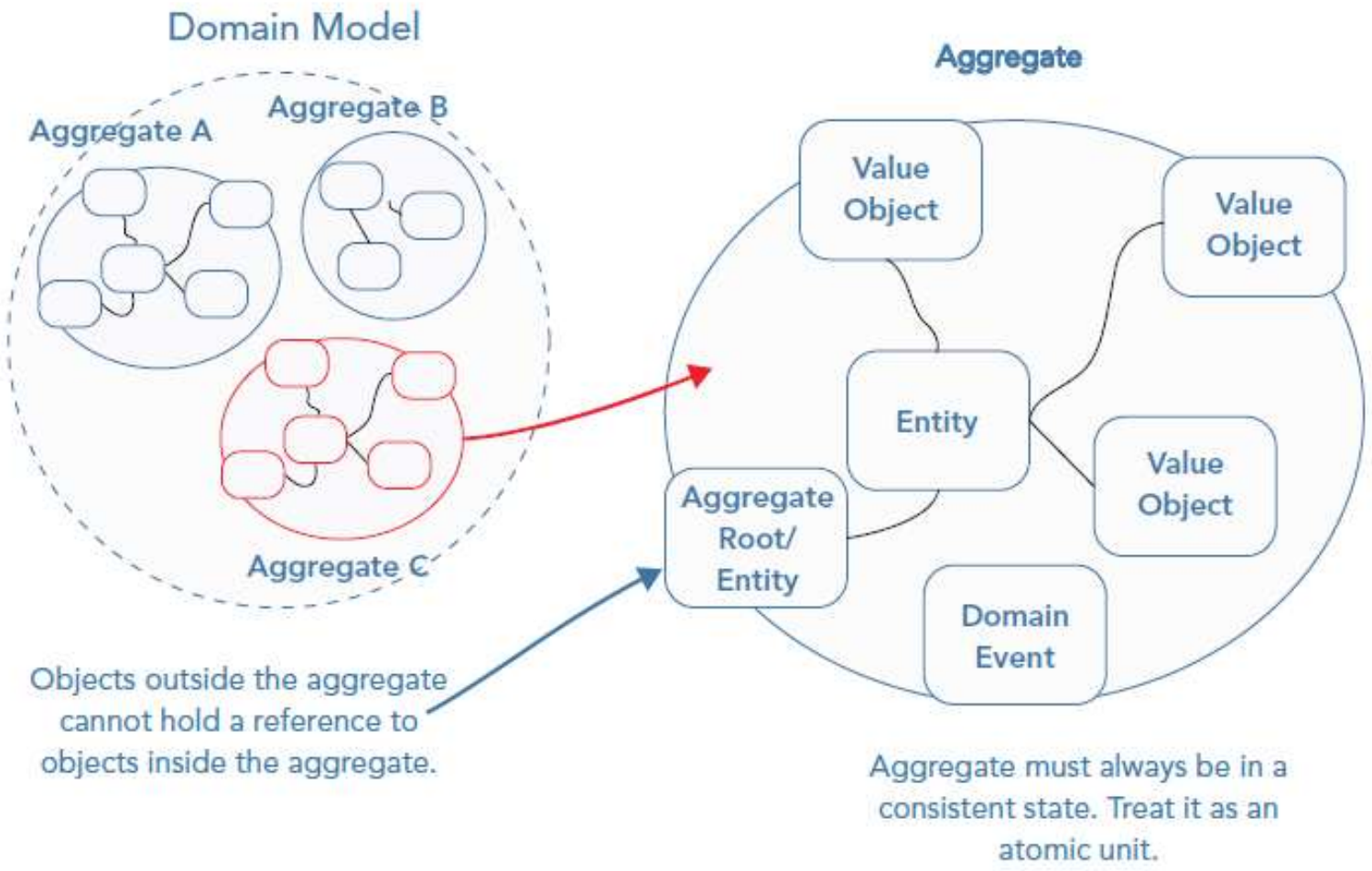


Aggregate root

- An aggregate root acts as the entry point to the aggregate.



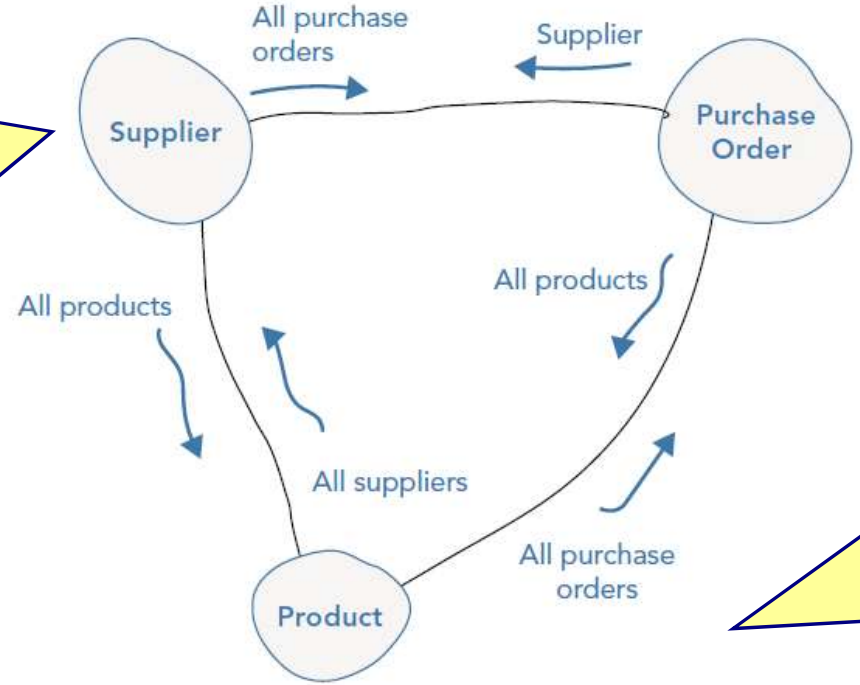
Aggregate root is entry point into the aggregate



Bi-directional relationship

- Many-to-many relationships can become overwhelmingly complex
- The model does not need to reflect the real world

When we change the contact details of the Supplier, do we need to load all Products?

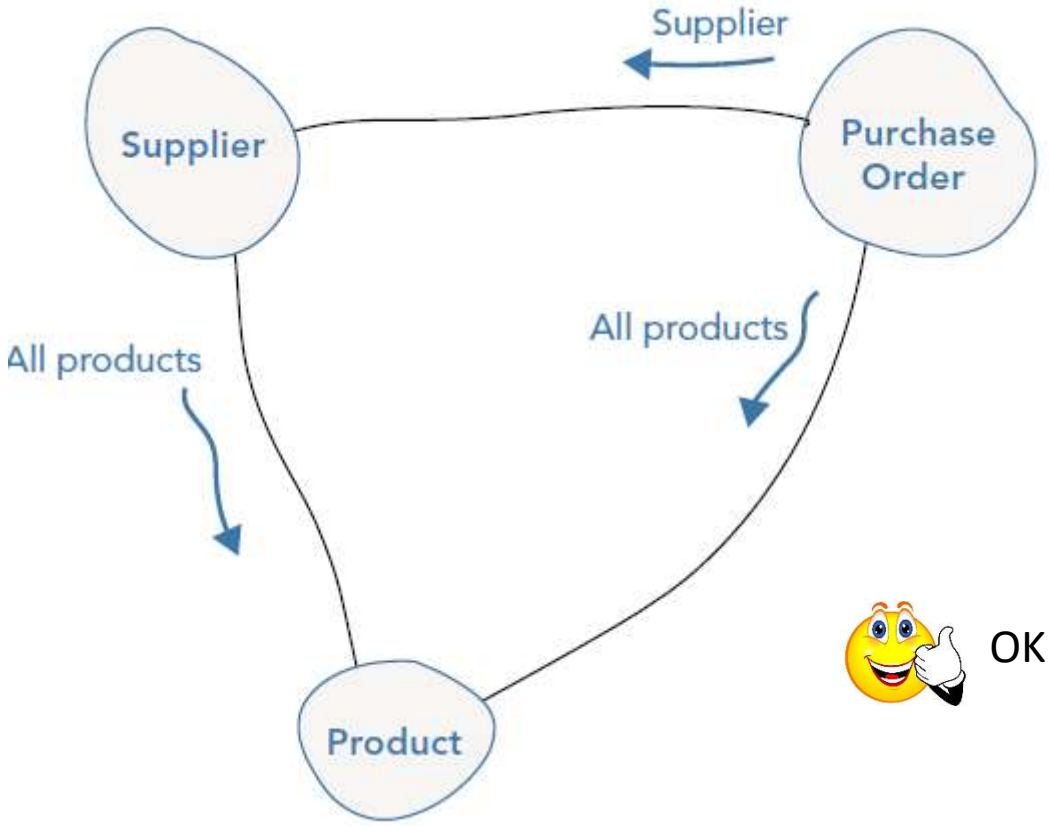


NOT OK

When we have a product, do we need to know all Purchase Orders that contain this Product?

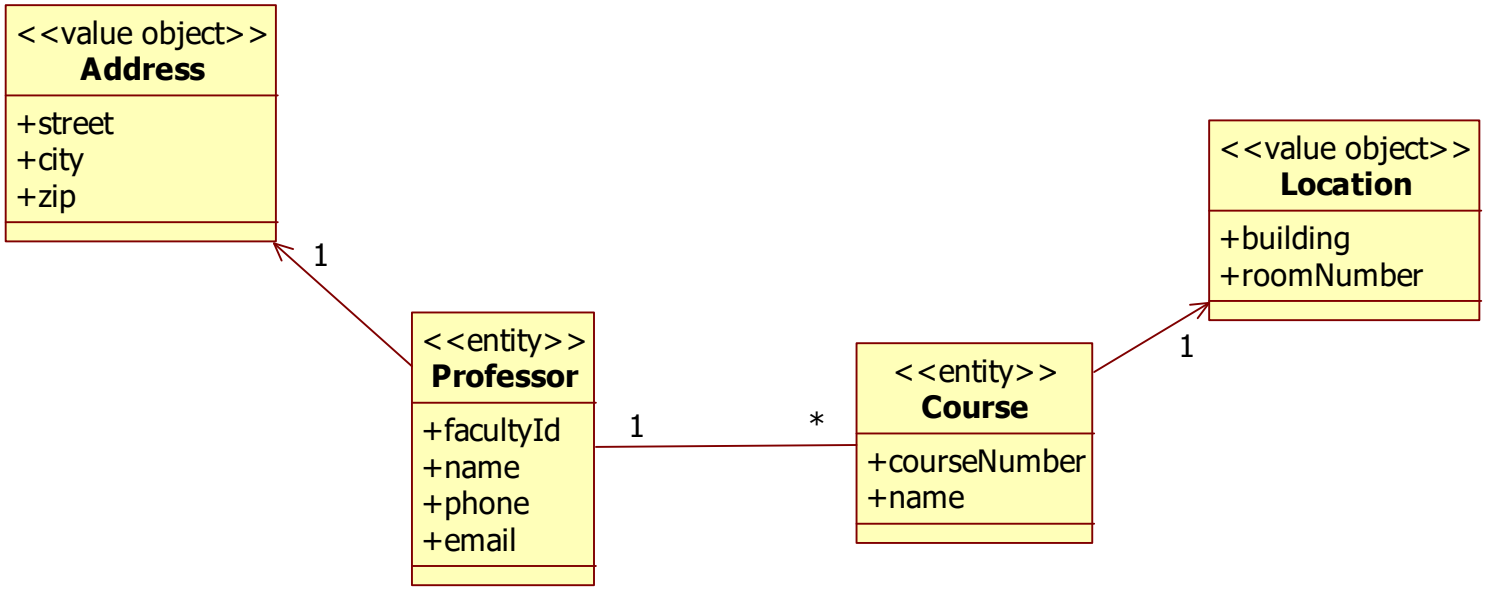
Favor single traversal directions

- Simplicity
- Shows who is the owner of a relation

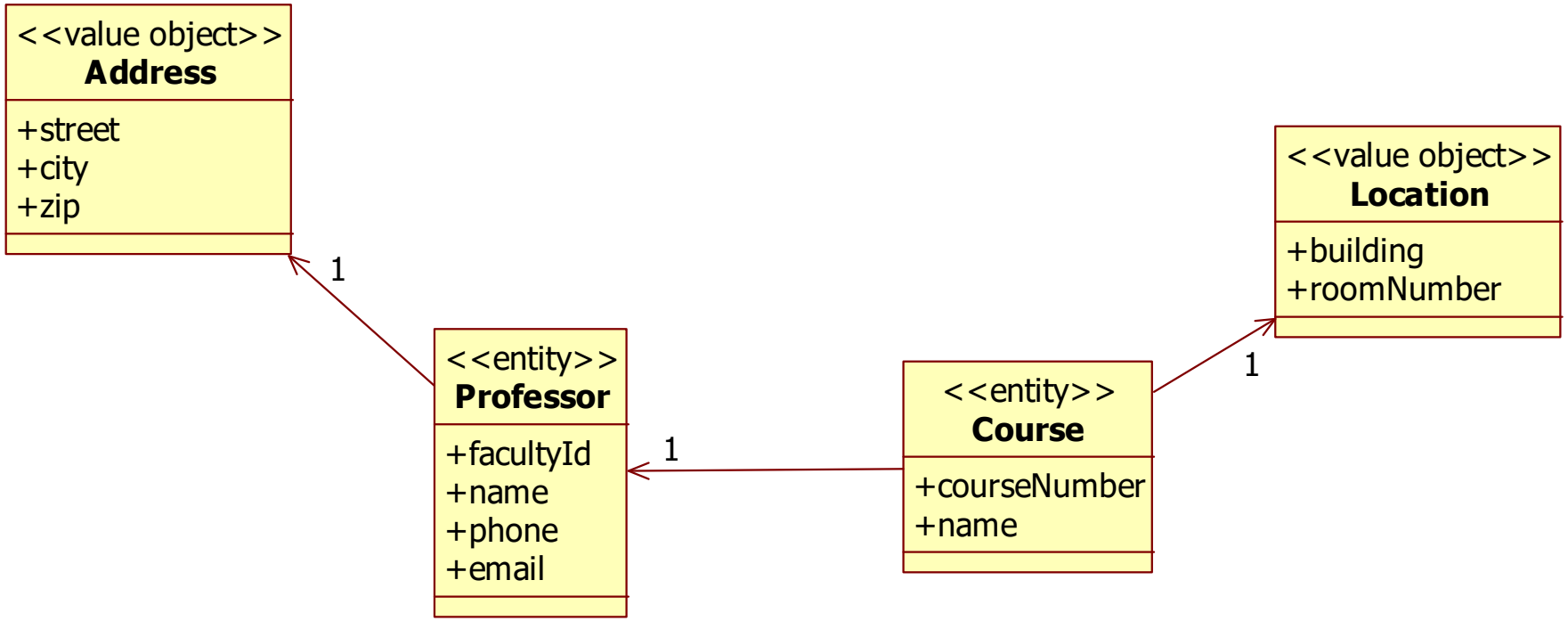


OK

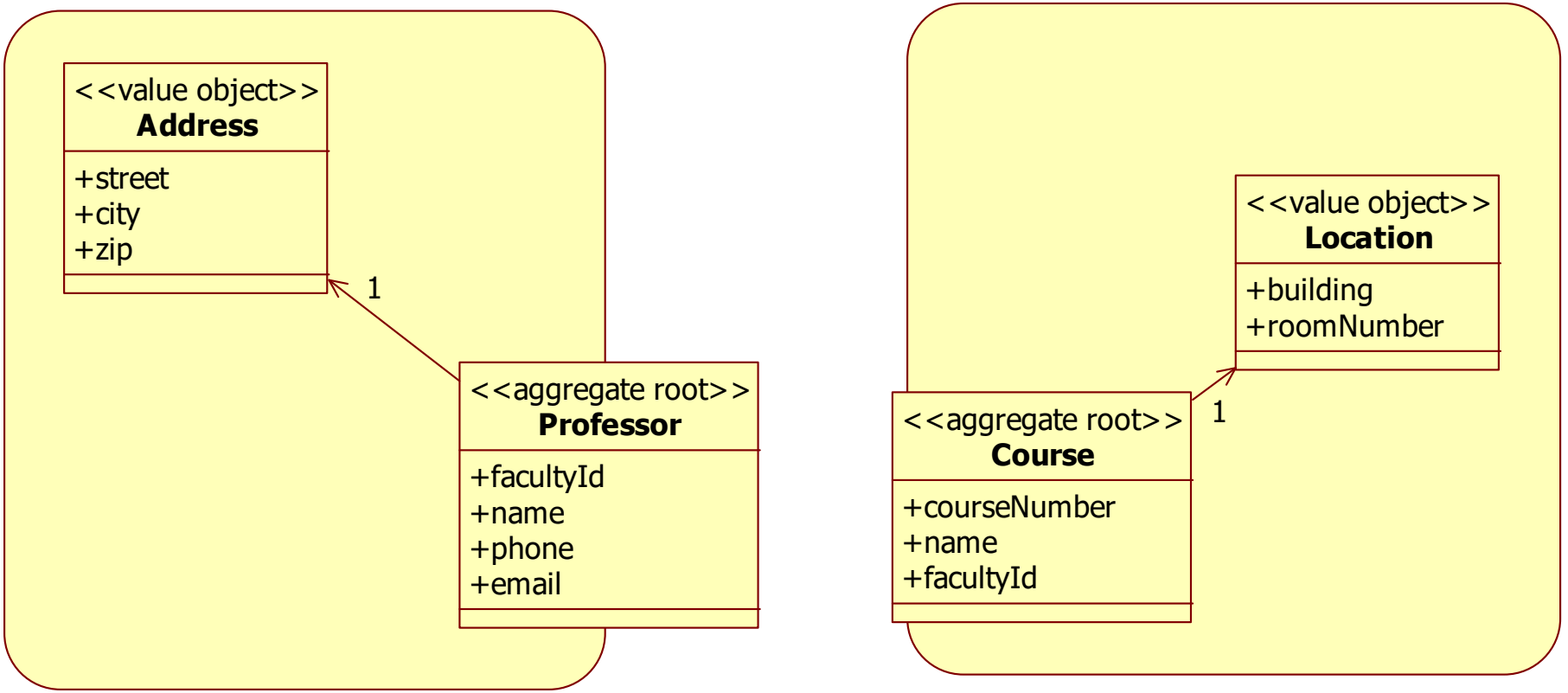
Bi-directional relation



Uni-directional relation

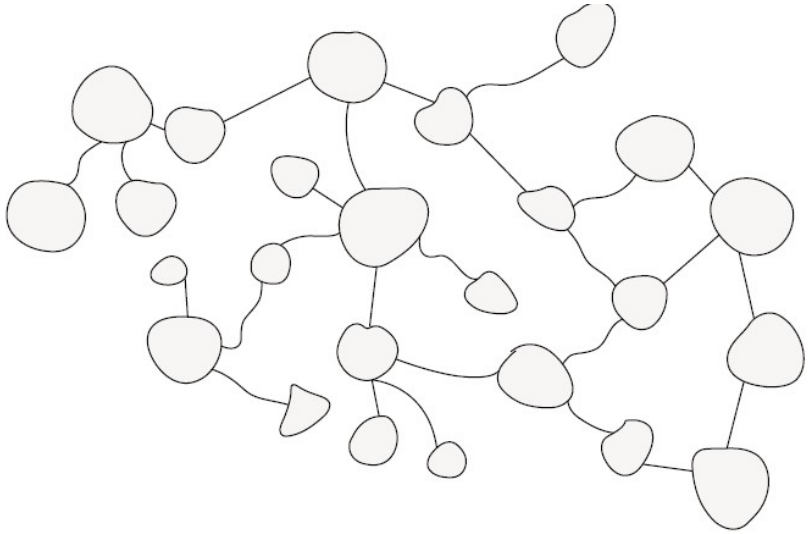


Using aggregates



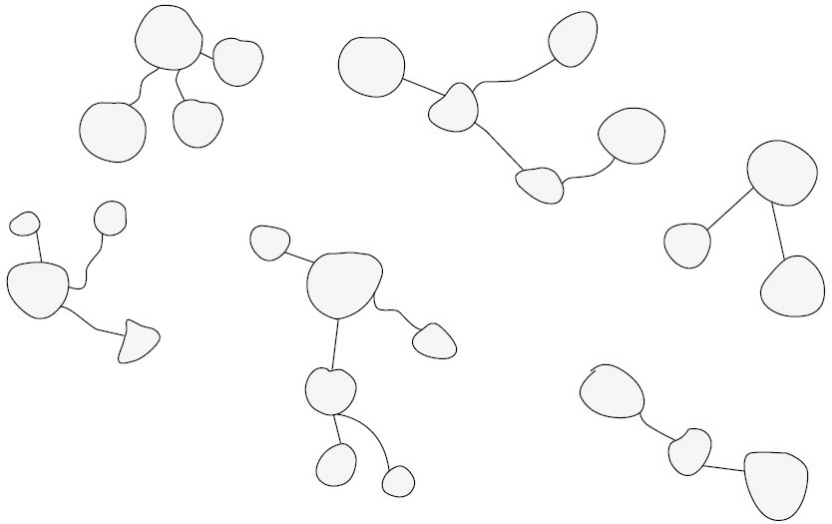
Simplicity of the domain model

NOT OK



Complex domain model with many unnecessary associations

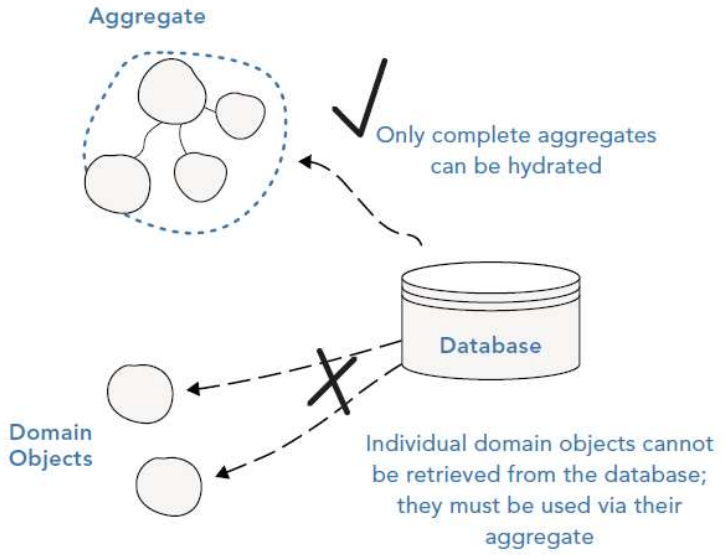
OK



Clearer domain model with only the essential associations

Aggregates and database actions

- Aggregates are saved, updated and deleted as a whole
- Aggregates are loaded from the database as a whole
- One Data Access Object (DAO) per aggregate
- The whole aggregate is within one transactional boundary

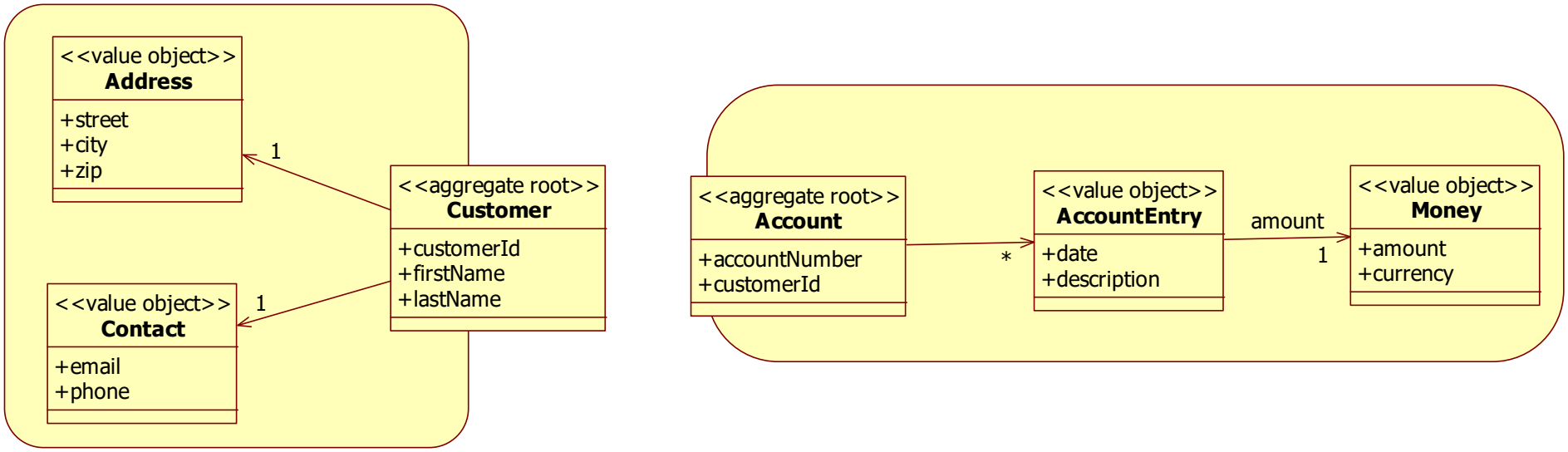


Referencing other aggregates

- Aggregate roots never holds a reference to another aggregate root
  - It should keep the ID of another aggregate root
  - Or we add a new class that it references

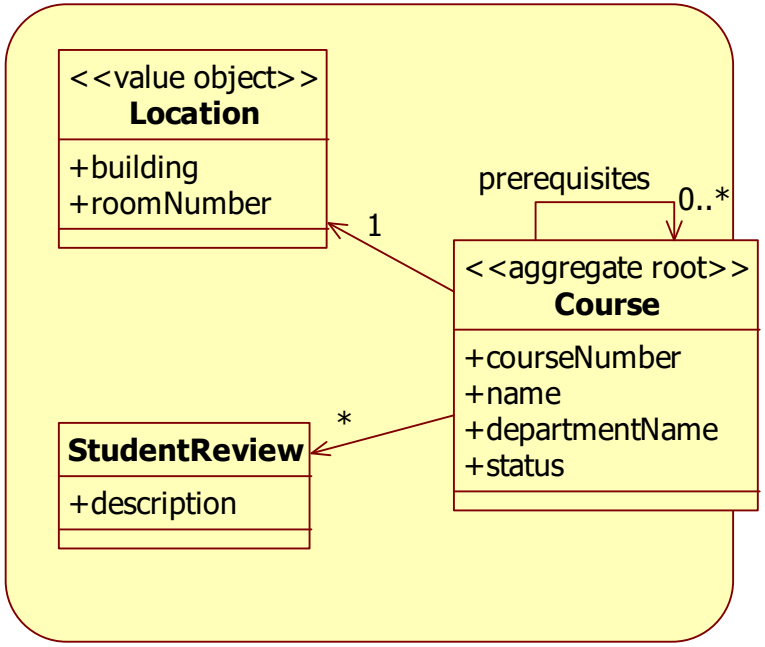
Referencing other aggregates

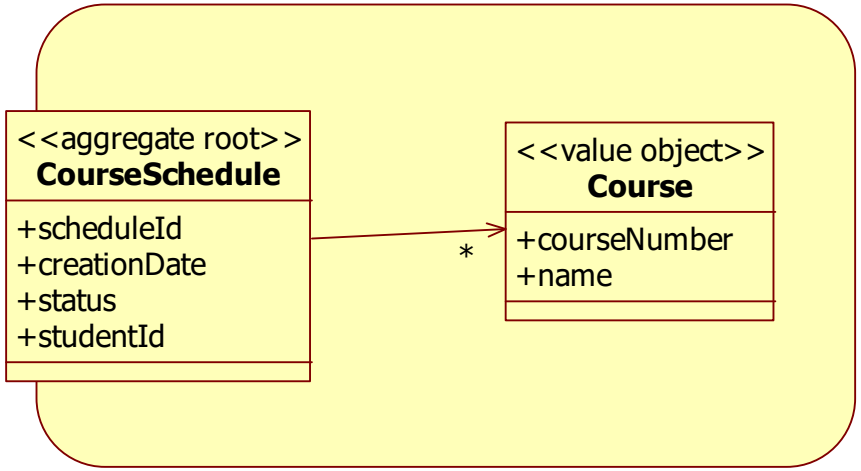
- Using an Id



Referencing other aggregates

- Add a new class



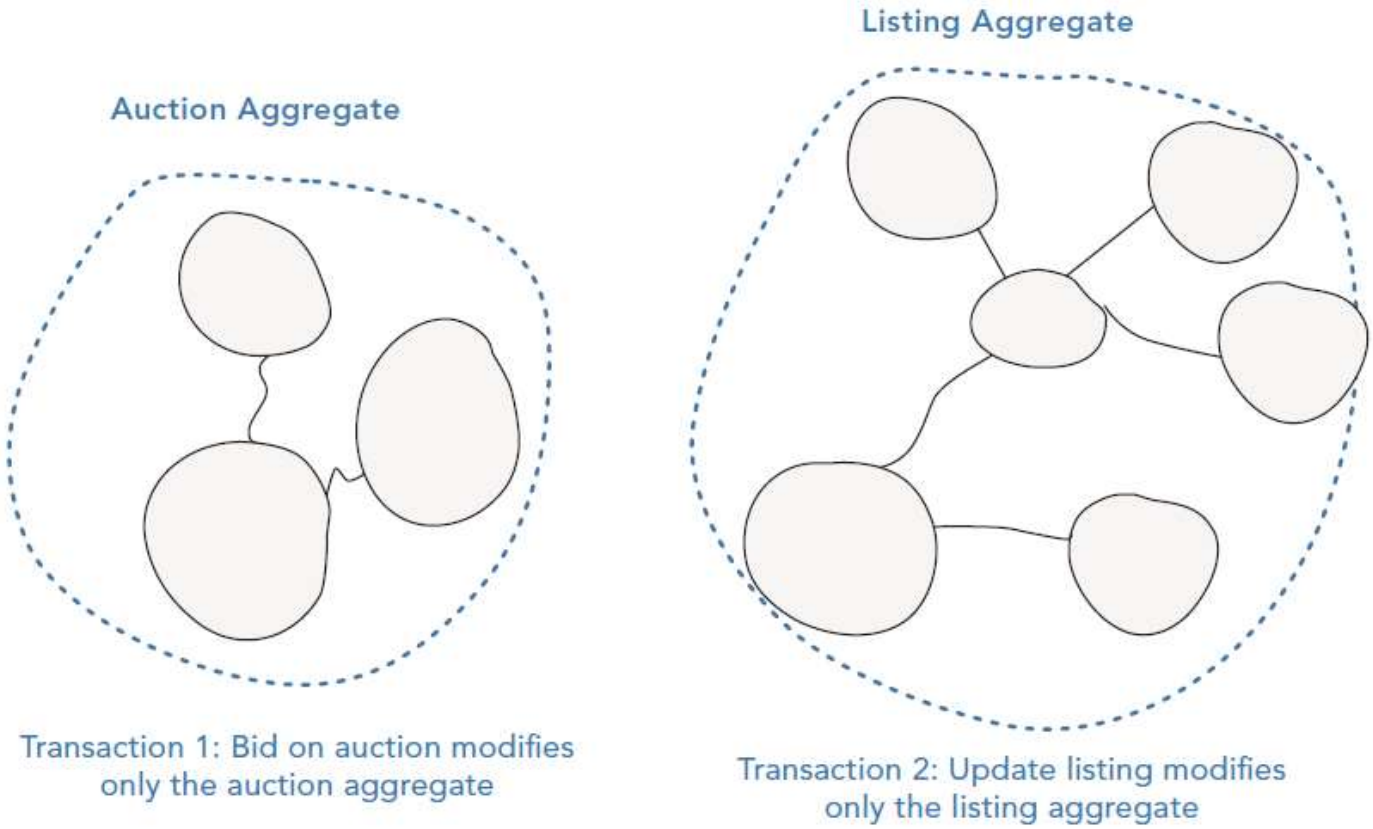


Size of the aggregate

- Favor smaller aggregates
  - Large aggregates can decrease performance
    - Many database calls with additional join queries
  - Large aggregates are often involved in multiple use cases
    - More concurrency conflicts
  - Large aggregates may not scale well
    - The whole aggregate needs to be placed in one database

Transactions and consistency

- Strive to modify a single aggregate per use case



Finding aggregates

- Which object are logically connected
  - High cohesion, low coupling

OK

- Design aggregates around invariants/business rules
- Strive to modify a single aggregate per use case

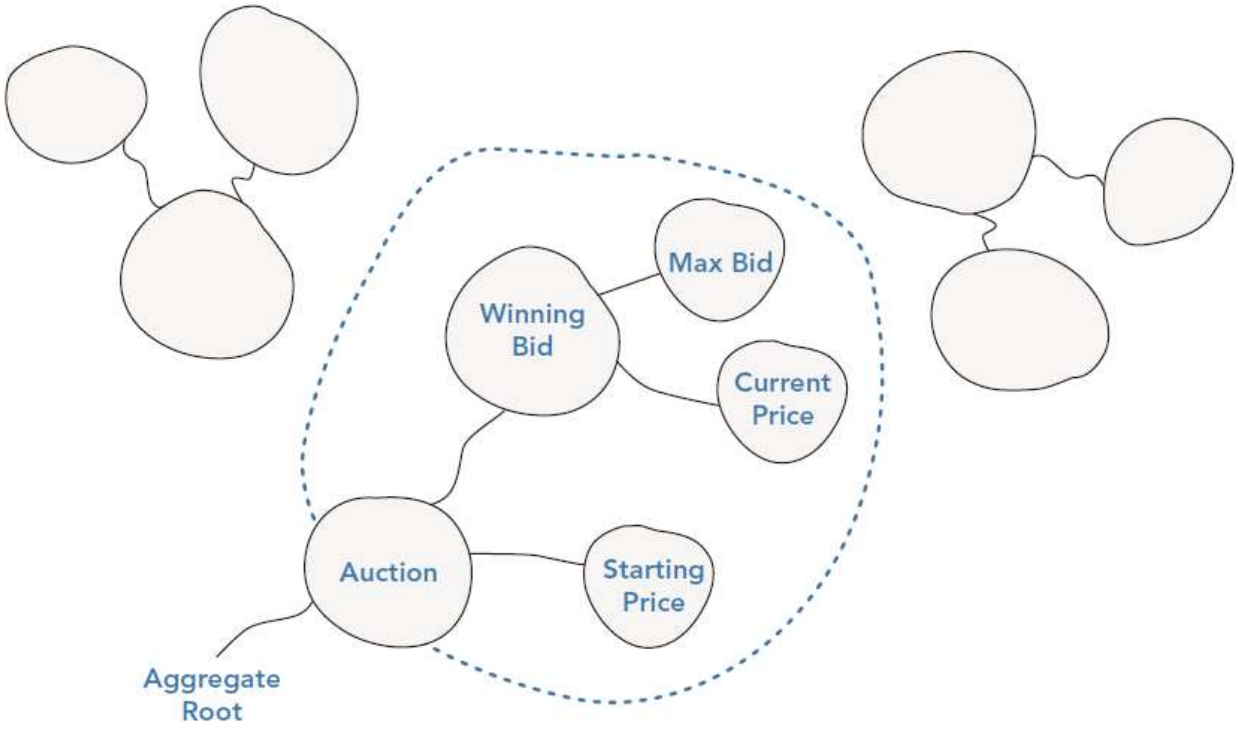
- Do not design aggregates around UIs

NOT OK

- Do not design aggregates around the data model
- Avoid dumb collections and containers
  - An aggregate is not a just a container for other objects

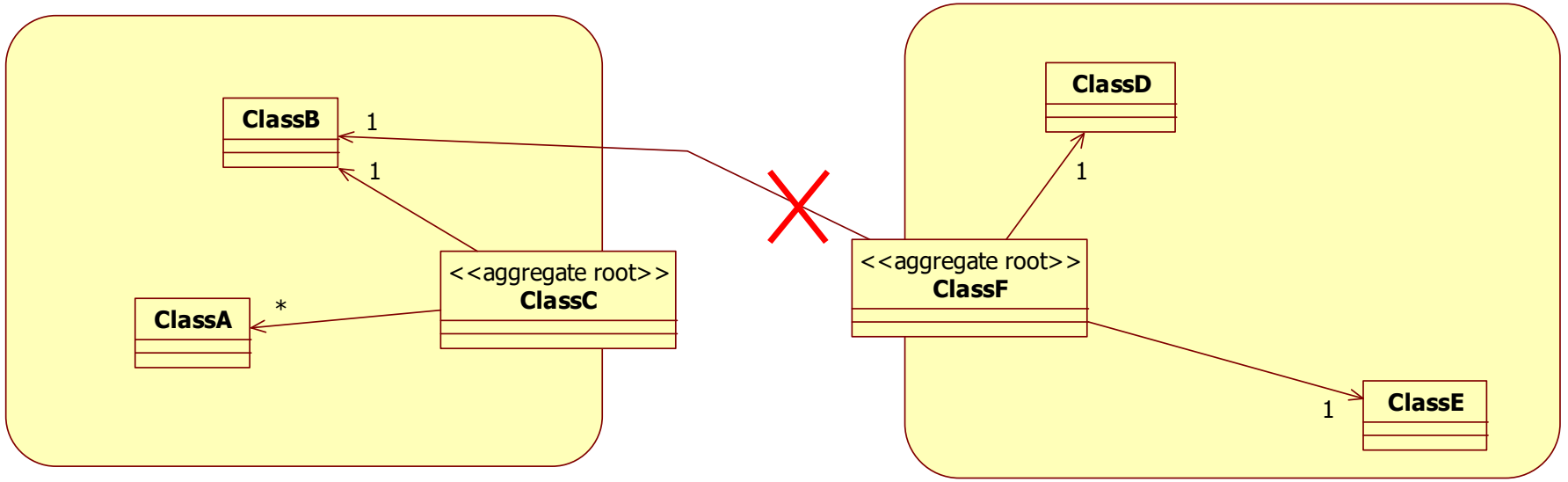
Aggregate Root

- All communication with an aggregate should go via its root



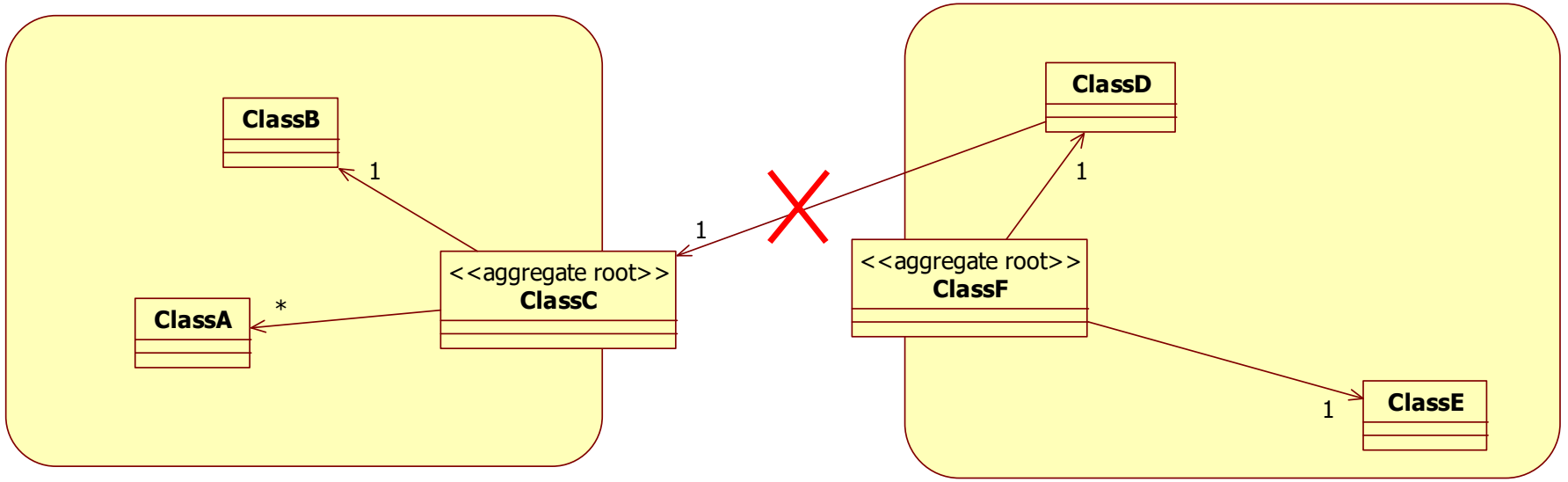
Encapsulation

- Nothing outside an aggregate should hold a reference to its inner members

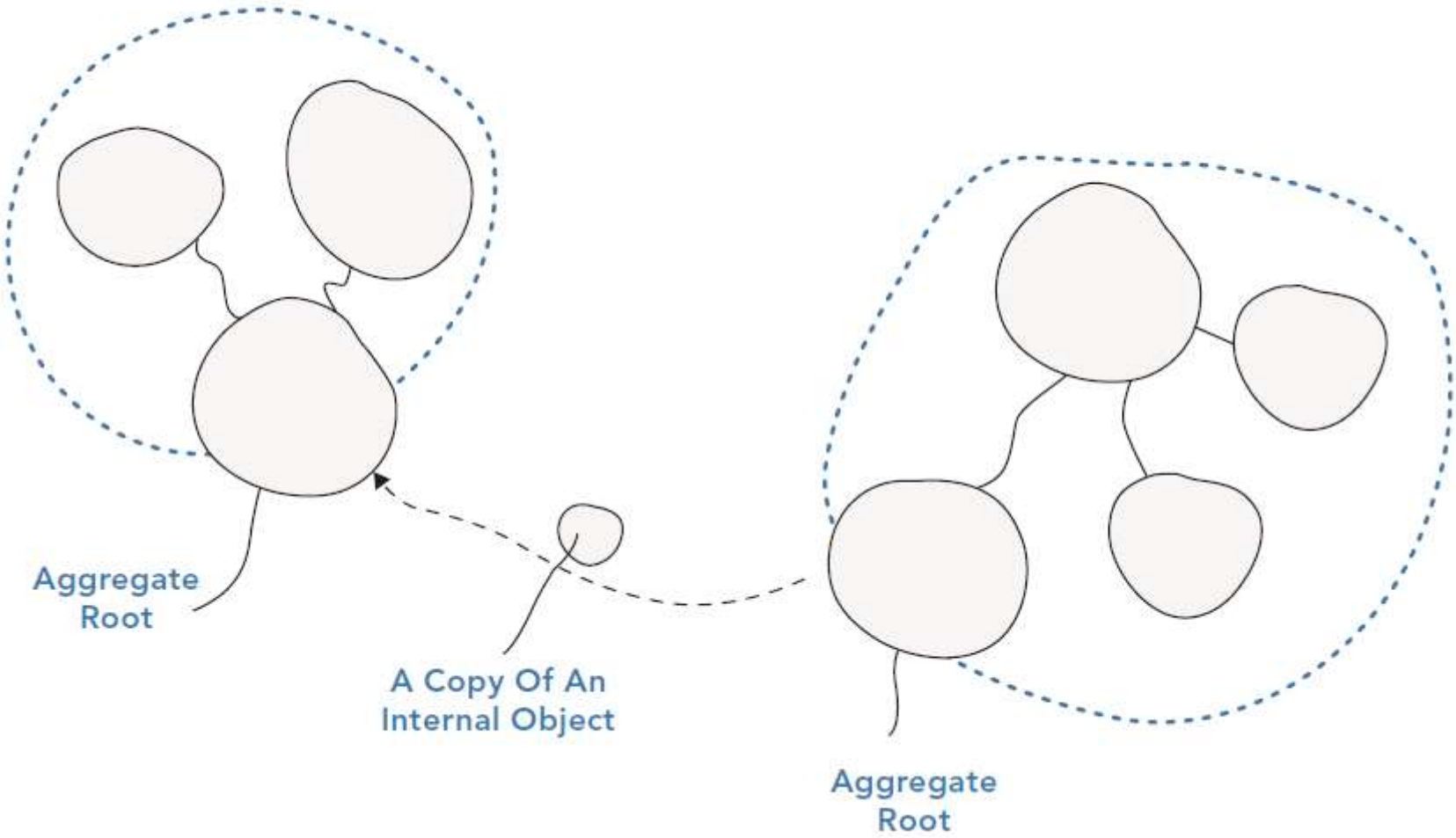


Internal reference to aggregate root

- Non aggregate roots can hold a reference to other aggregate roots



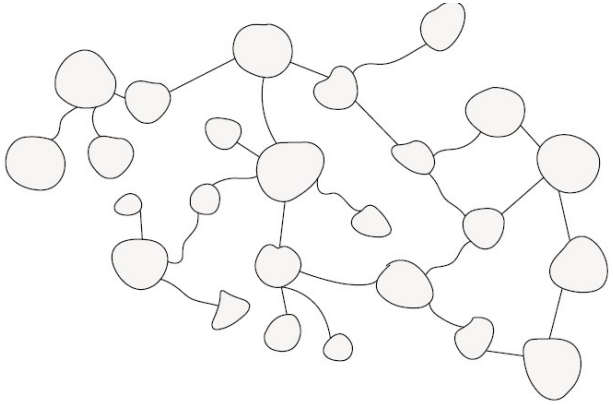
Sharing copies



Main point

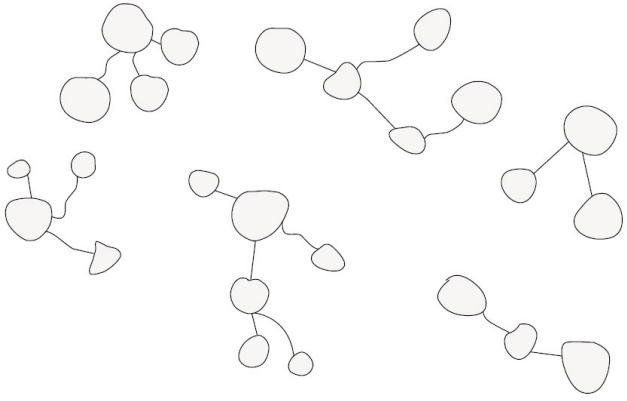
- A large complex class structures can be split up is smaller and simpler class structures using aggregates.

NOT OK



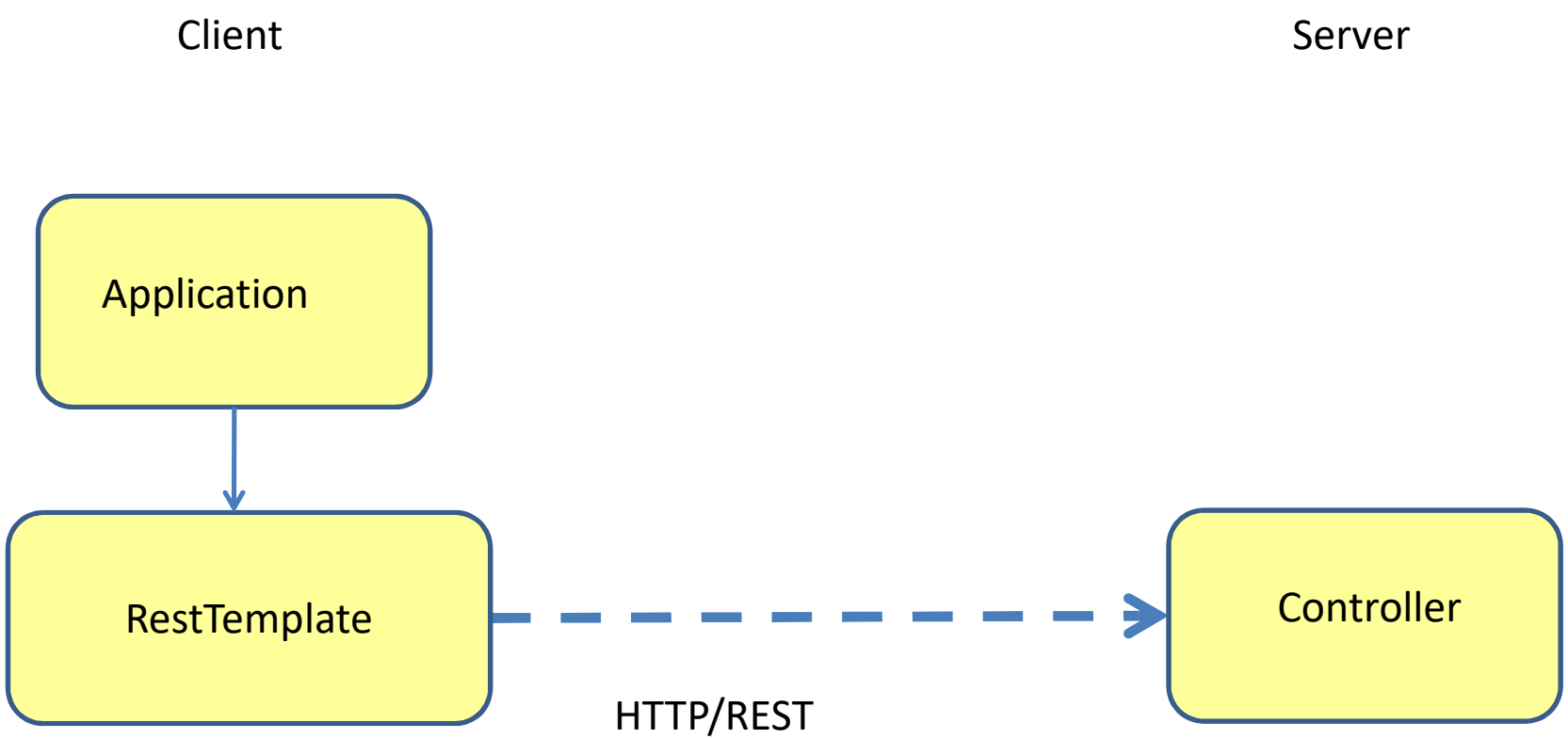
- By gaining full support of nature by tapping into pure consciousness, life gets simpler and more enjoyable.

OK



SPRING BOOT REST CLIENT

Creating a REST client



RestServer

```java
@RestController
public class GreetingController {

    @RequestMapping("/greeting")
    public Greeting greeting() {
        return new Greeting("Hello World");
    }
}
```

```java
public class Greeting {
  private String content="";

  public Greeting() {}

  public Greeting(String content) {
    this.content = content;
  }

  public String getContent() {
    return content;
  }
}
```

RestClient

server.port=8081

```
@SpringBootApplication
public class RestClientApplication implements CommandLineRunner {
  @Autowired
  private RestOperations  restTemplate;

  public static void main(String[] args) {
    SpringApplication.run(RestClientApplication.class, args);
  }

  @Bean
  RestTemplate restTemplate() {
    RestTemplate restTemplate = new RestTemplate();
    restTemplate.getMessageConverters().add(new MappingJackson2HttpMessageConverter());
    restTemplate.getMessageConverters().add(new StringHttpMessageConverter());
    return restTemplate;
  }

  @Override
  public void run(String... args) throws Exception {
    Greeting greeting = restTemplate.getForObject("http://localhost:8080/greeting",
                        Greeting.class);
    System.out.println("Receiving message:" + greeting.getContent());
  }
}
```

Connecting the parts of knowledge with the wholeness of knowledge

1. A rich domain model contains all domain knowledge.
2. An aggregate is a small group of classes that belong together

3. **Transcendental consciousness** is the source of all activity.
4. **Wholeness moving within itself:** In Unity Consciousness, one realizes that all activity in the universe are expressions from and within one's own silent pure consciousness.