Domain Model

Programming 2.2

Analysis

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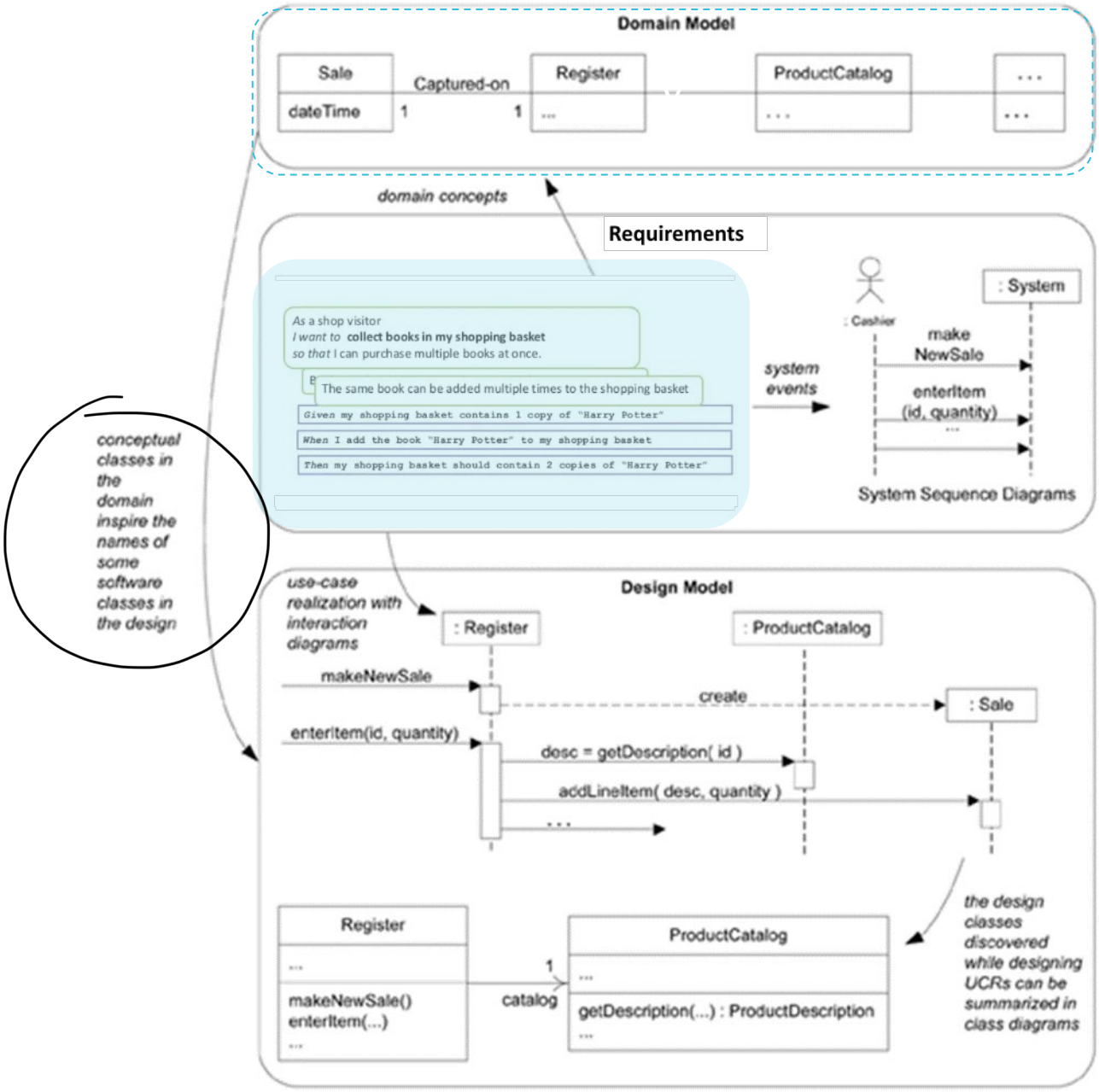
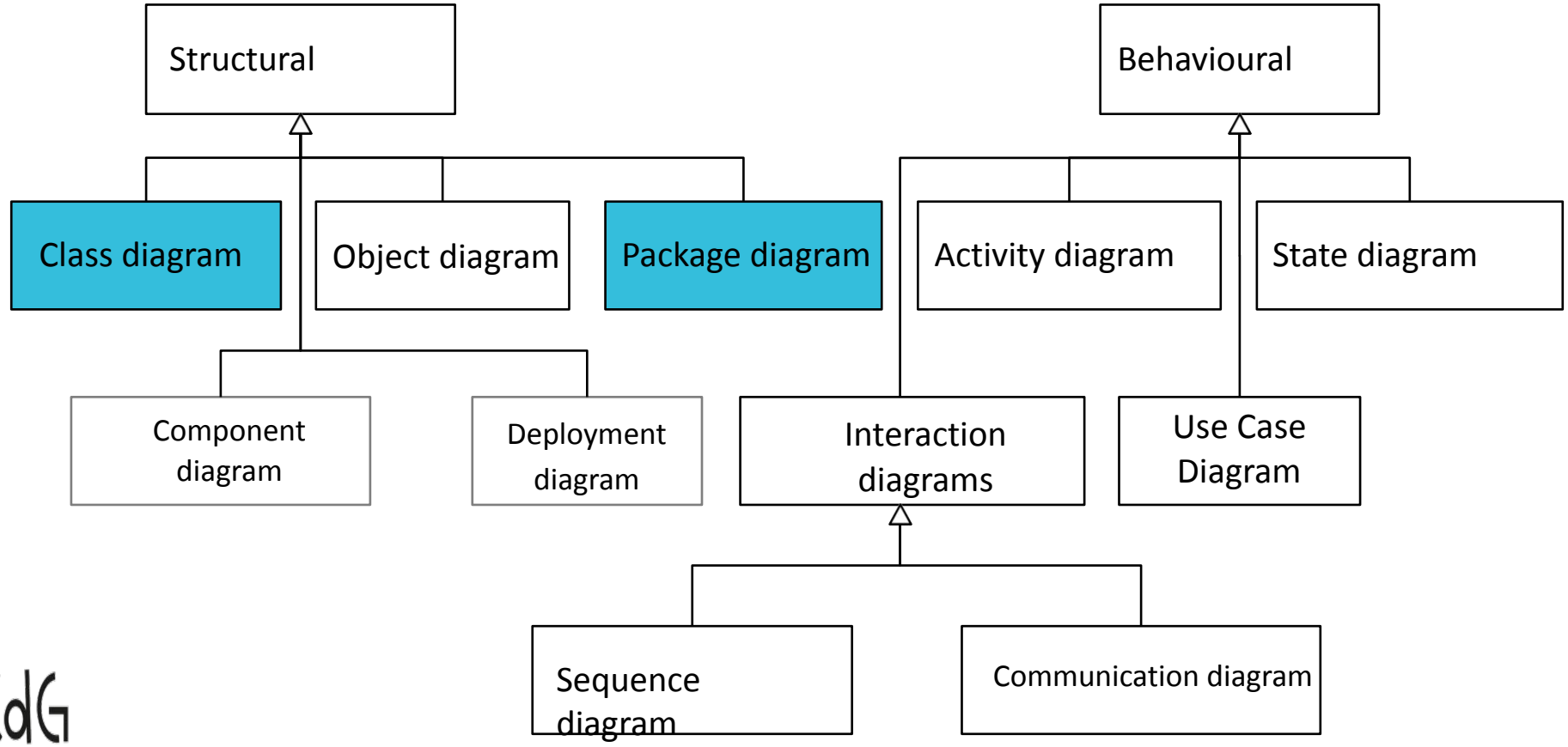
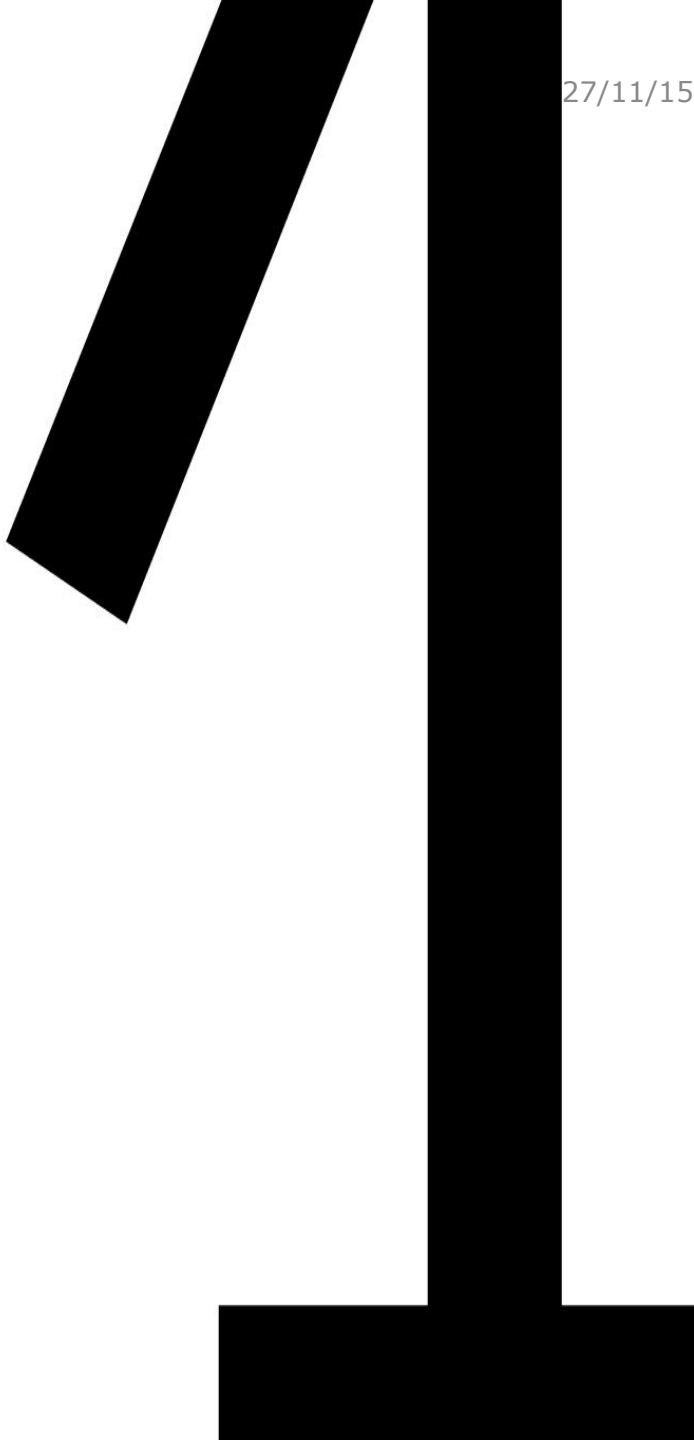
Agenda

1. Extending UML
2. Domain model (class diagram)
   - Entities and associations
   - Data types
   - inheritance
   - datastructures overview
   - guidelines
3. DDD: strategic design


Domain Model
Sale
dateTime
Captured-on
1
1
Register
...
ProductCatalog
...
...
...
domain concepts
Requirements
As a shop visitor
I want to collect books in my shopping basket
so that I can purchase multiple books at once.
The same book can be added multiple times to the shopping basket
Given my shopping basket contains 1 copy of "Harry Potter"
When I add the book "Harry Potter" to my shopping basket
Then my shopping basket should contain 2 copies of "Harry Potter"
system events
: Cashier
: System
make NewSale
enterItem (id, quantity)
...
System Sequence Diagrams
conceptual classes in the domain inspire the names of some software classes in the design
use-case realization with interaction diagrams
Design Model
: Register
: ProductCatalog
: Sale
makeNewSale
create
enterItem(id, quantity)
desc = getDescription(id)
addLineItem(desc, quantity)
...
Register
...
makeNewSale()
enterItem(...)
...
1
catalog
ProductCatalog
...
getDescription(...) : ProductDescription
...
the design classes discovered while designing UCRs can be summarized in class diagrams

UML diagrams





Extending UML: constraints and stereotypes

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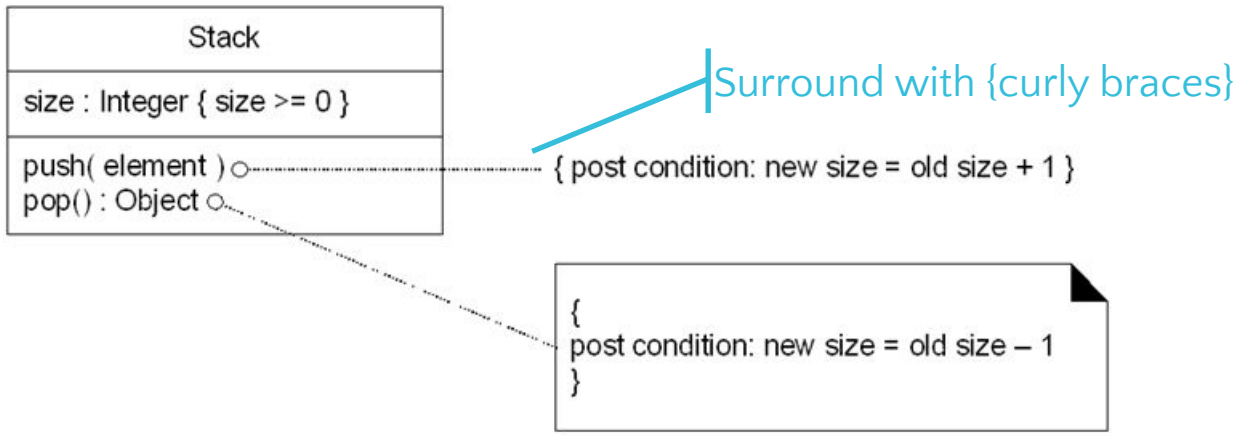
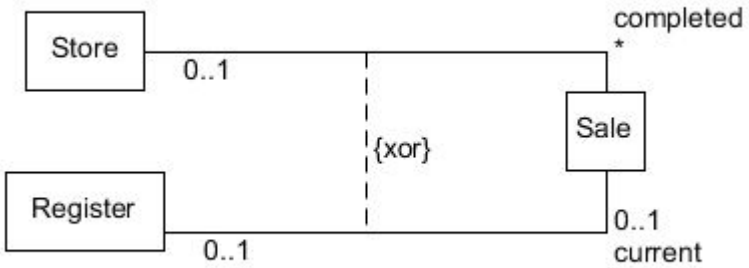
{constraint}: restriction on a UML element

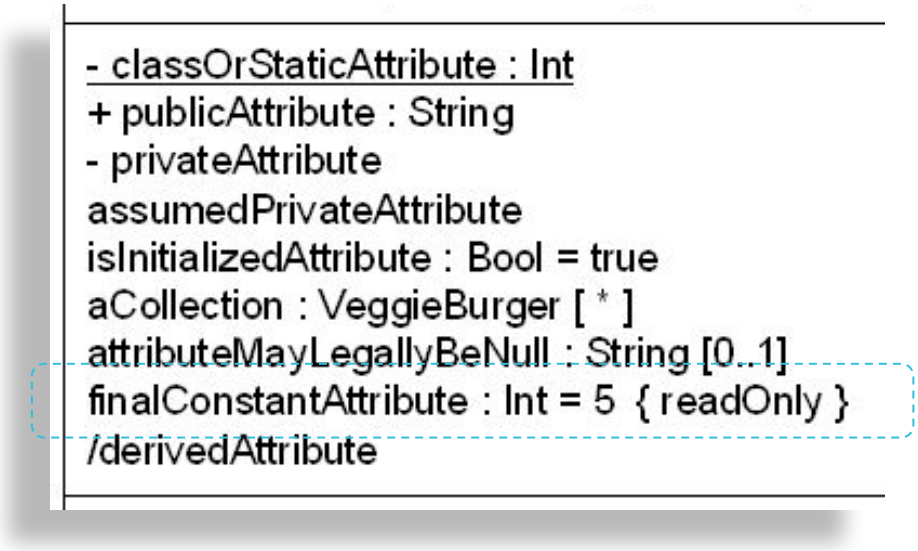
- Constraints indicate an additional restriction on a UML element by specifying a locgial condition, property or a restricted set of values





xor: exclusive or.
A sale is either linked with a Store OR a register

{constraint}


- classOrStaticAttribute : Int
+ publicAttribute : String
- privateAttribute
assumedPrivateAttribute
isInitializedAttribute : Bool = true
aCollection : VeggieBurger [*]
attributeMayLegallyBeNull : String [0..1]
finalConstantAttribute : Int = 5 { readOnly }
/derivedAttribute


Money
amount:double
valuta {DOLLAR,EURO}

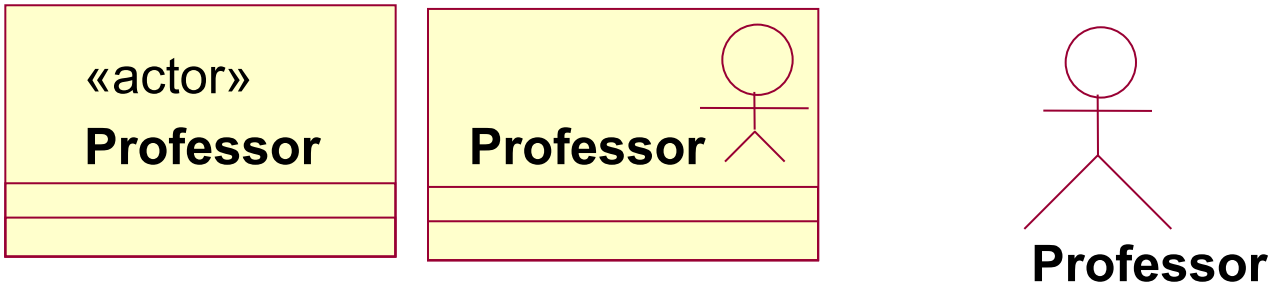
Stereotypes

- You can add new elements to the UML language by adding stereotypes: add a name between «guillemets» on an existing UML element
- Stereotypes can contain
  - extra constraints
  - extra attributes (name/value pairs)
- Some stereotypes are predefined as UML keywords: «enumeration», «actor», «include», «dataType» …

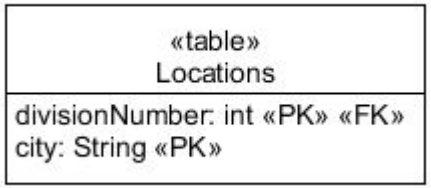
Stereotypes

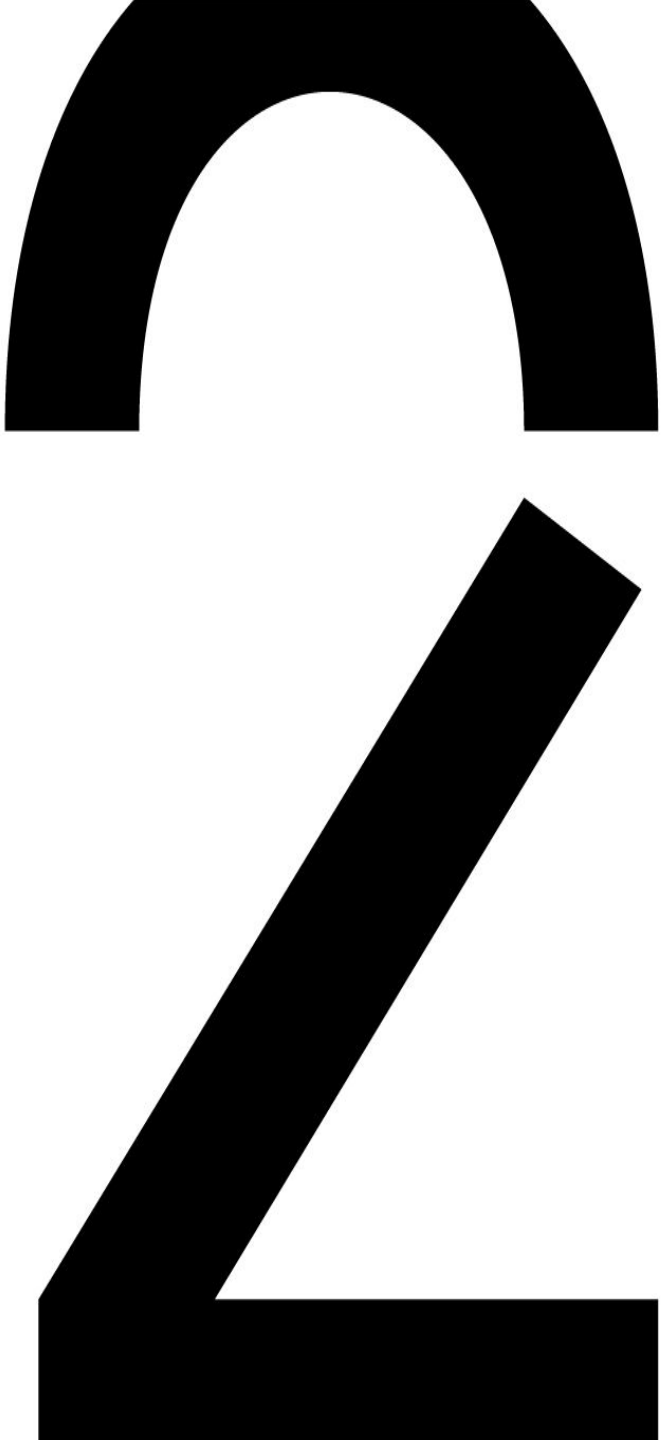
- Stereotypes can have their own graphical representation (icon)
- 3 options for showing stereotypes

«name» decoration icon



- You can add your own stereotypes (just add the «name»)





Domain model

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Entities and associations

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Domain

- Conceptual perspective of objects in the real world
  - Business concepts in the problem domain
  - no IT concepts (cloud, scanner…)
  - Technology neutral (independent of programming language, database…)
- Guideline: work like a mapmaker
  - Use existing names in the territory
  - Exclude what is not relevant
  - Work at the level of detail needed
  - Do not add things that are not there
- Domain Driven Design (DDD) designs software based on your domain model
  - The domain model evolves as your design advances

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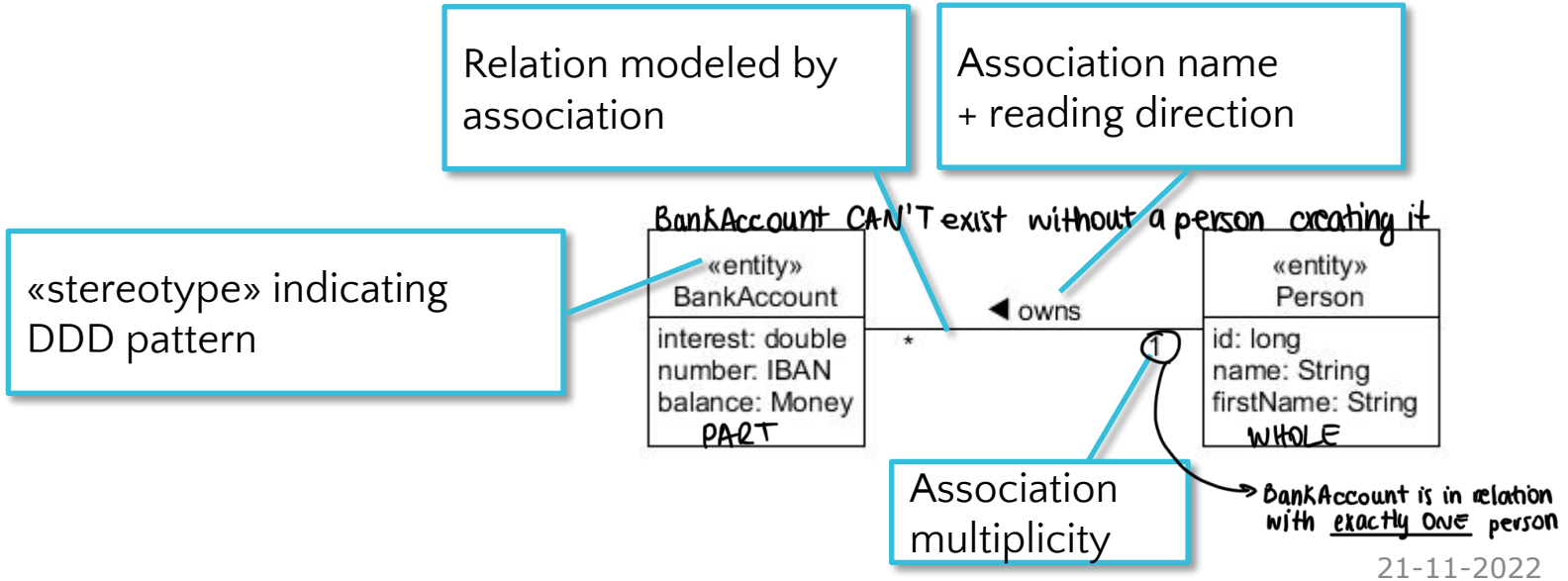
Entities

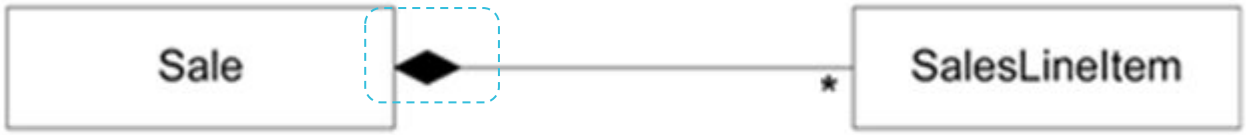
- In DDD, domain concepts are called entities.
- Implemented as Classes
  - Instances are reference Objects
- Have an explicit identity
  - Often one attribute or a subset of attributes
    - Example: BankAccount has an IBAN number
    - In Java equals() and hashcode() are based on identifying attributes
- Have a lifecycle in which the state (data in some attributes) can change. Changing the state does not change the identity.
    - Example: even if you change the balance, you are still handling the same Bankaccount

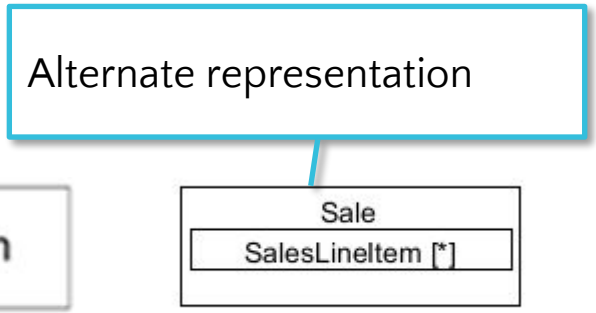
Associations

- Relations between entities are modelled as UML associations
  - implemented as attributes (Person will typically be an attribute of BankAccount)
  - Attributes contain the **state** of an object
- Entities are typically stored by the system and can be referred to by multiple other entities
  - It often makes sense to search for a stored entity

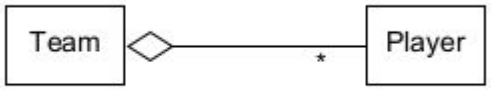


Composite (DDD:aggregate)



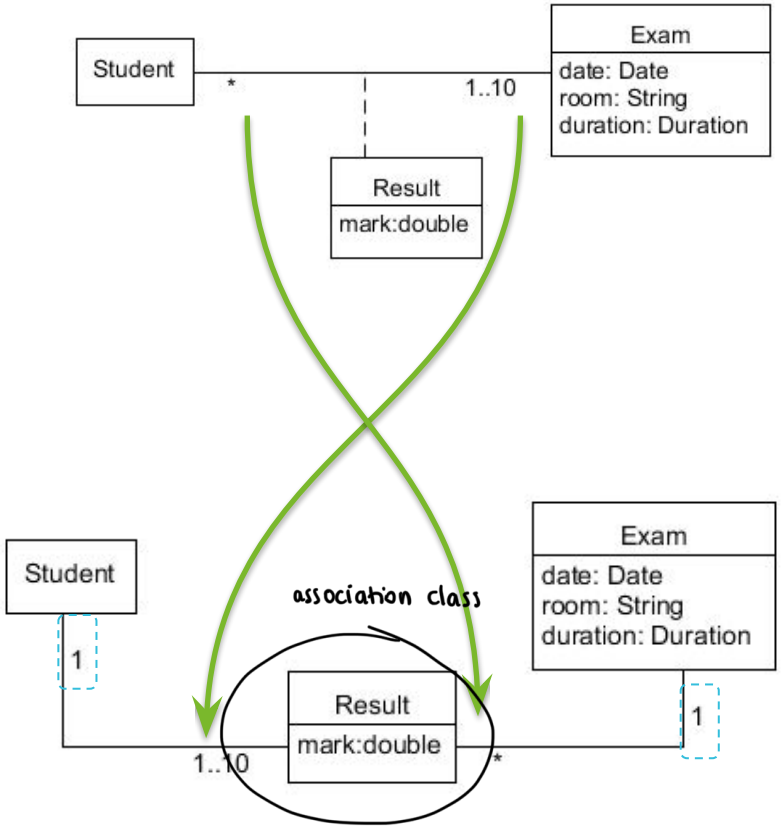


- Strong form of association: "owns or contains" relation
- whole (Sale) / part (SalesLineItem) relationship
- The whole is responsible for creating the parts
  - Parts cannot exist without the whole
  - Part object is member of exactly one whole object
- In DDD this is called an aggregate
  - All operations on the aggregate are always performed through the whole (in DDD called aggregate root)
  - Unfortunatly UML uses the term aggregate (open diamond <>) for a weaker form of composition, but this UML notation is not often used



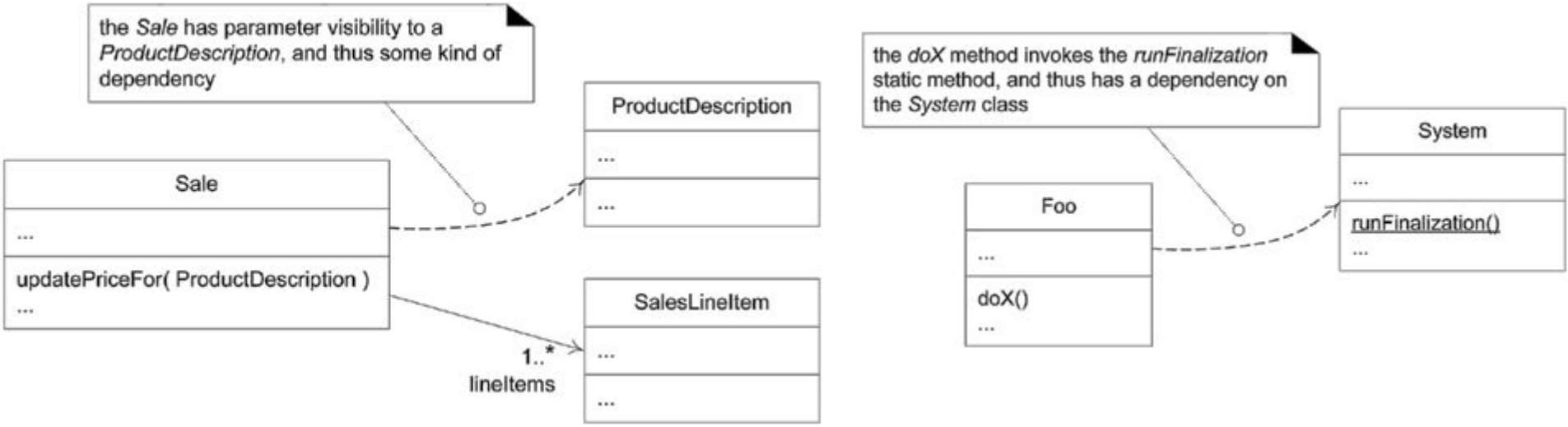
Association class

- If an association has attributes, you can put them in an association class
  - The association class contains data on a relation between 1 instance at each side (there can be a Result for each student-exam combination)
  - Often implemented as
    - Is this exactly the same?



Dependencies

- A dashed arrow (with open head -->) indicates that one UML element depends on another
  - If the other element changes this impacts the first
  - Can be used in all UML diagrams
- An association implies a dependency (no need to draw one explicitly)



Data types

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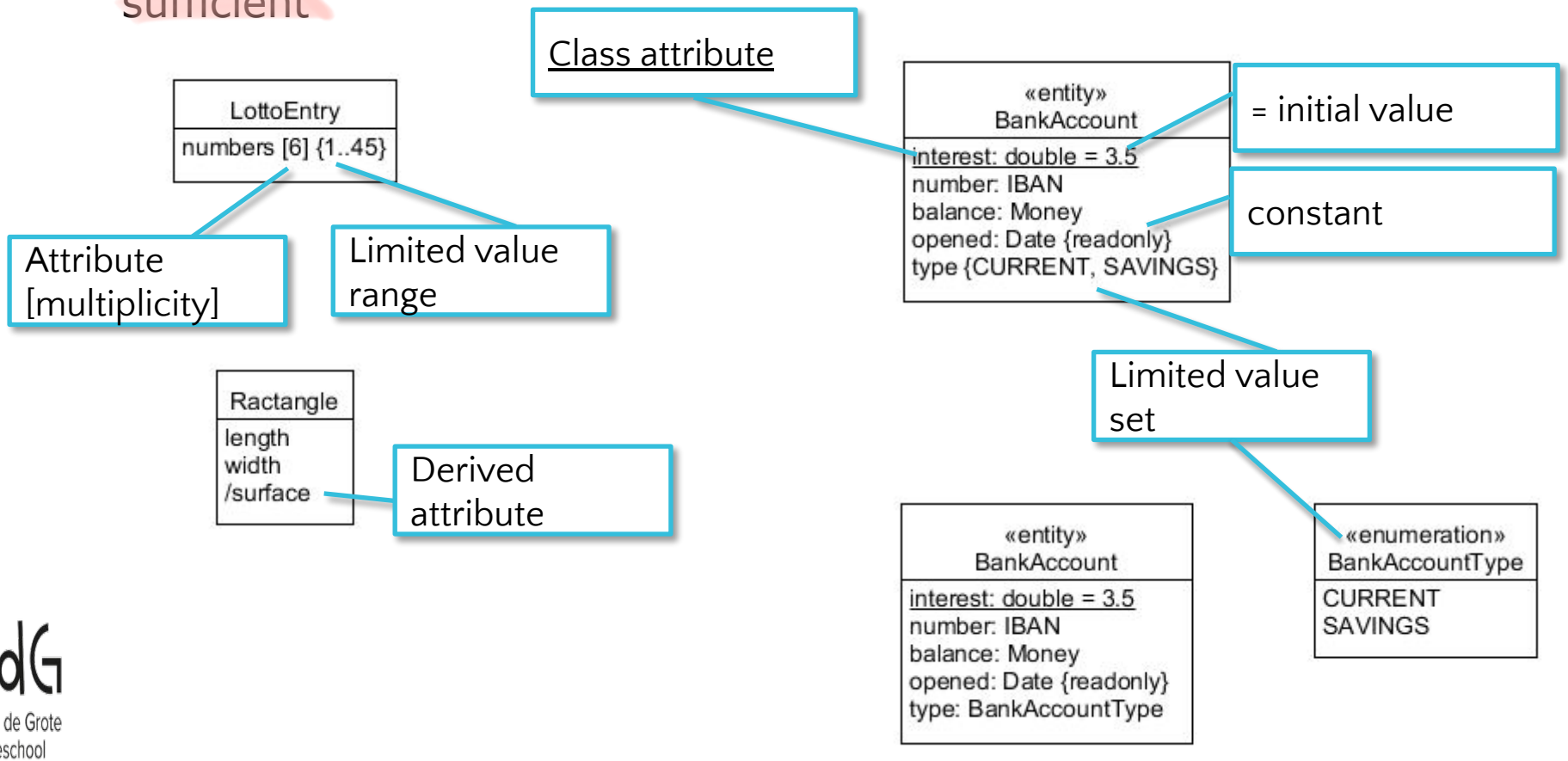
Primitive datatypes

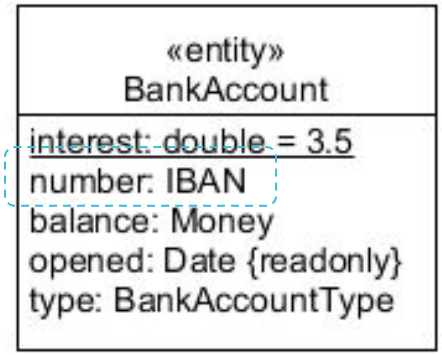
Refresher

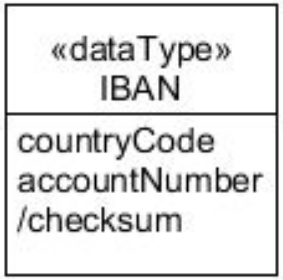
- Simple values like person name
- Modelled as UML attributes
  - During analysis, a semantic datatype (number, date, text) is sufficient



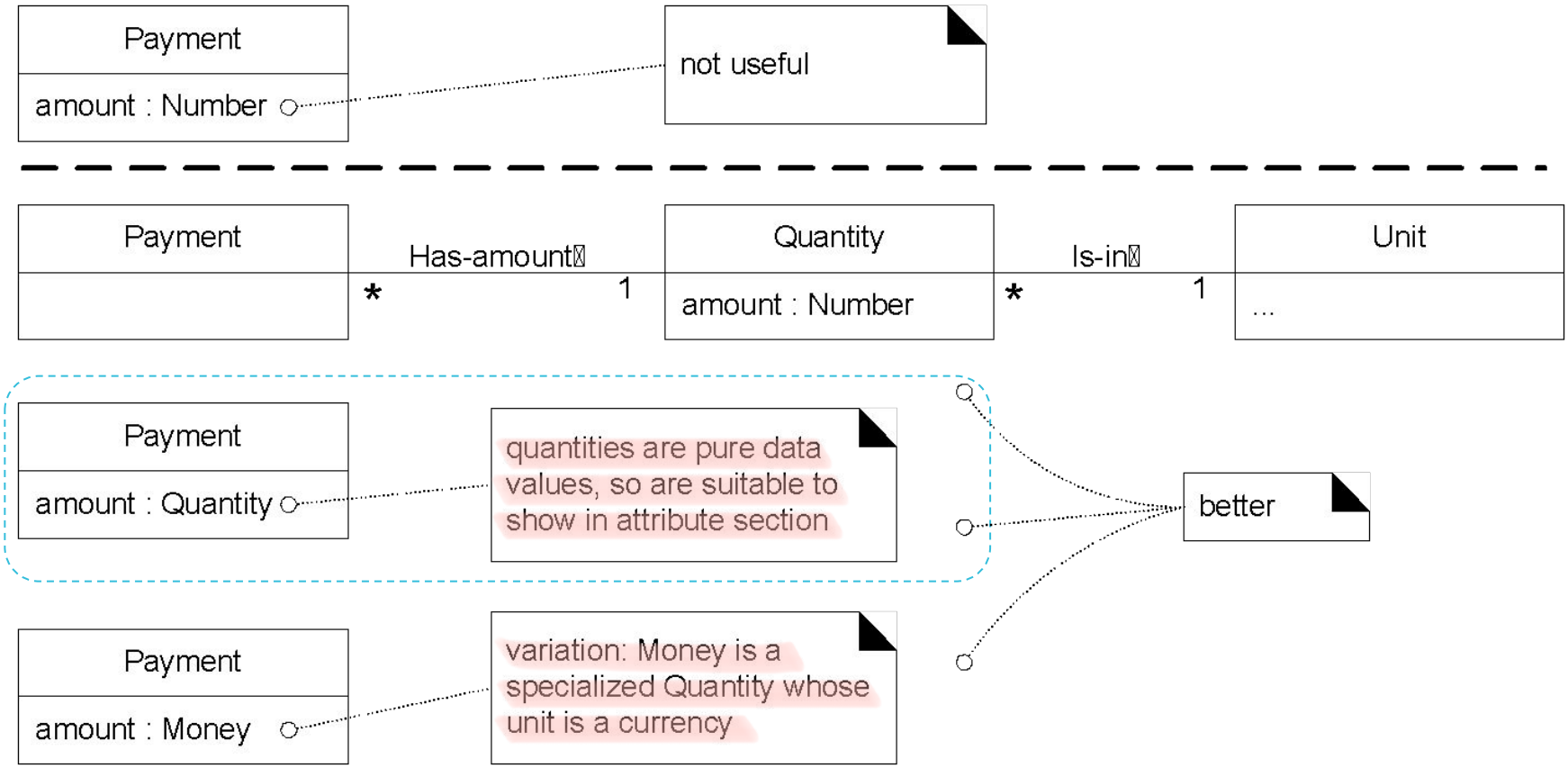
Value objects

- DDD Value objects are instances of complex datatypes (or datatype classes): values with multiple fields (example: Date)
  - «dataType» UML stereotype
- In UML classes refer to datatypes as attributes
  - Drawing an association to the Date class (like we would do for an entity) from every class that uses it, would mess up our diagrams
  - Classes also refer to enumerations as attributes (see previous slide)





Value Objects



Value Objects

- Are not entities, but rather describe entities.
  - Example: a Date is a characteristic of a Payment
- Do not have a unique ID
  - primitive (int) and complex (Date) datatypes do not have an identity
    - Are saved, together with their entity and not shared with others
      - You do search or reuse them (you just make a new Date)

Value Objects

- Completely defined by their values
  - Any attribute you change, results in another value (any field you change in a date, gives a different date)
  - A well designed datatype class is immutable.
    - All attributen are set by the constructor
      - attribute **{readonly}** // in Java: `private final`
    - No setter

Value Objects

Exercise

Java's Date class is not immutable

```
# calculate someone's birthday in 2022
Date dateOfBirth = person.getDateofBirth();
dateOfBirth.setYear(2020);
```

deprecated → replaced with LocalDate because it is IMUTABLE

Value Objects

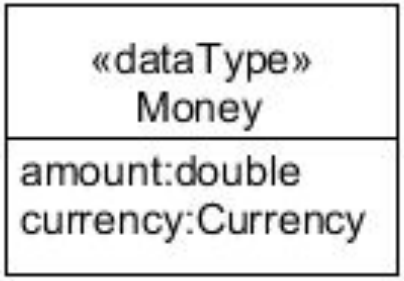
- Date methods like **void** setYear(…) have been deprecated
- Replaced by LocalDate with methods like

```
LocalDate          withYear(int year)
                   Returns a copy of this LocalDate with the year altered.
```

  - **LocalDate** is immutable. Changing something is accomplished by first making a new copy of the date.

Value Object: Write the Money class

Exercise



Value Object: Write the Money class

Exercise

```java
package be.kdg.se2e.immutable;

import java.util.Currency;
import java.util.Objects;

//final class so there can be no mutable subclasses
public final class Money { Complexity is 10 : OK
  //final attributes can only be set by constructor
  private final double amount;
  private final Currency currency;

  public Money(double amount, Currency currency) {
    this.amount = amount;
    this.currency = currency;
  }

  // no setters
  public double getAmount() {
    return amount;
  }

  public Currency getCurrency() {
    return currency;
  }

  @Override
  public boolean equals(Object o) { Complexity is 9 : OK
    if (this == o) return true;
    if (!(o instanceof Money)) return false;
    Money that = (Money) o;
    return Double.compare(that.amount, amount) == 0
      && currency.equals(that.currency);
  }

  @Override
  public int hashCode() {
    return Objects.hash(amount, currency);
  }
}
```

Value Object: Money record

Exercise

```
package be.kdg.se2e.record;

import java.util.Currency;

public record Money(double amount, Currency
currency) {}
```

- Java 16 `record`
  - immutable class with all boiler plate code implicitly present
  - Money record and money class are equivalent
    - Instead of `getAttibute()` use `atttibute()`

Syllabus

Jenkov Record tutorial

Example

https://gitlab.com/kdg-ti/acs-programming-2.2/m05_domain_money

modelling actors

Limit to what the system needs

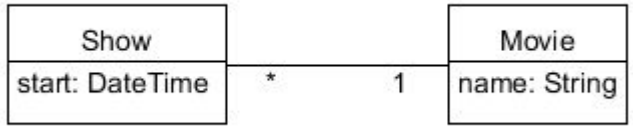
- Only model associations to an actor in a user story if your program needs to track this information. Example:

  As a planner

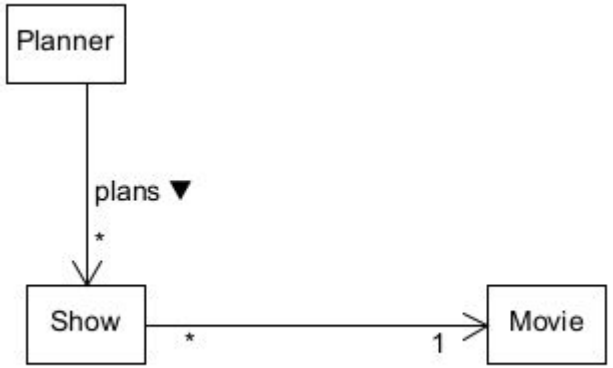
  I want to schedule movies

  So that I can align it with demand and best times for its audience

1. No need to track who managed a movie



2.System needs to know who manages each movie



Exercise 1-3

Inheritance

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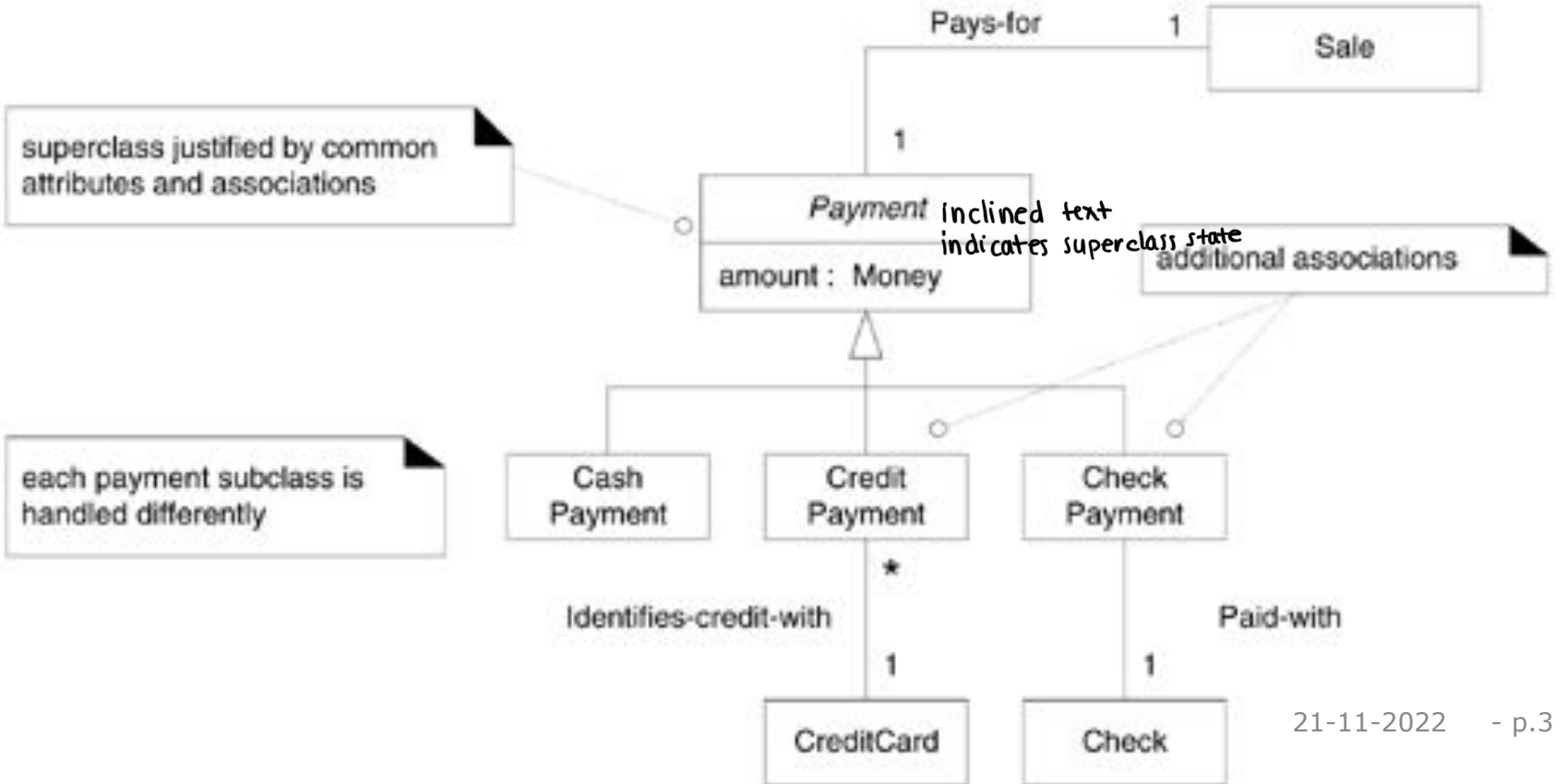
Specialisation/Generalisation

Refresher

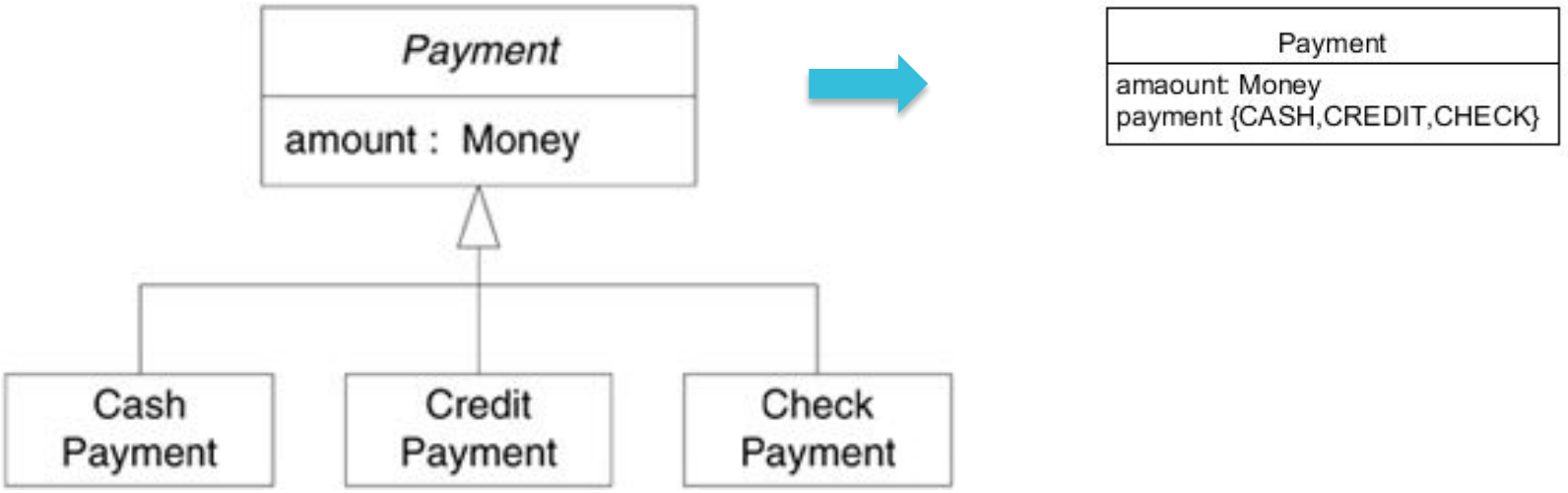
- Specialisation: subclass has all state (attributes and associations) and behaviour of the superclass + extra state/behaviour of its own: is a kind of relation
- Superclass is a generalisation of the subclass



Specialisation/Generalisation

Refresher

- Useful if subclasses have additional state and/or behaviour
  - If not modelling this with an enumeration is simpler



Datastructures overview

Domain model

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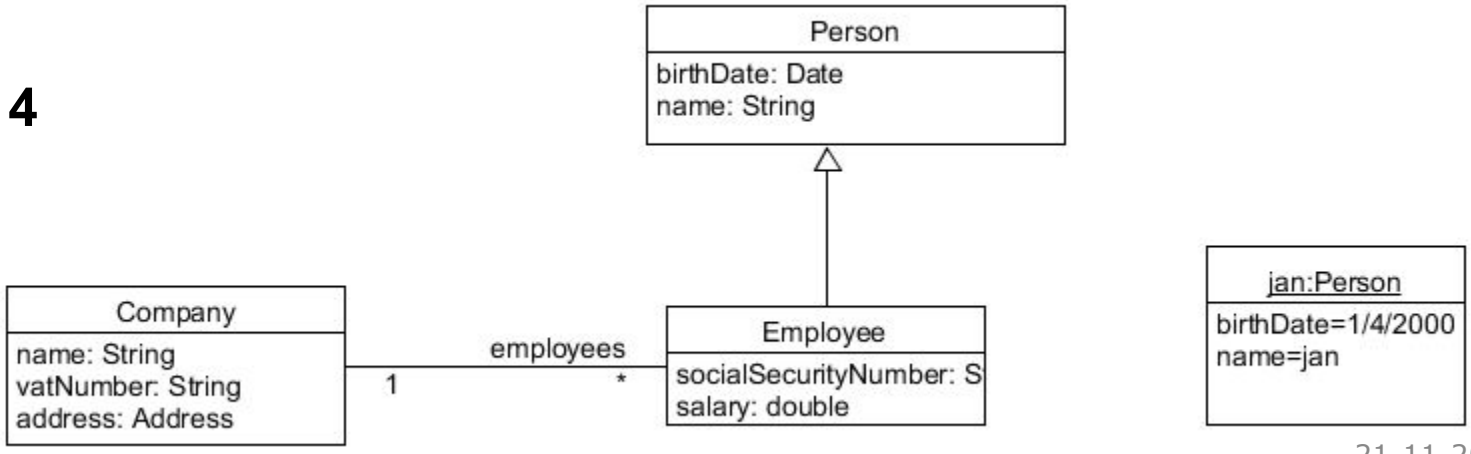
Overview data structures

structure	inverse	example
Object (instance)	Class	jan is an instance of Person
Record (Relation)	Attribute	Company • name • address • VAT number • employees
Verzameling (Collection)	Element	employees: Collection <Employee>
Generalisation	Specialisation	An Employee is a (kind of) Person

Exercise 4



Domain model guidelines

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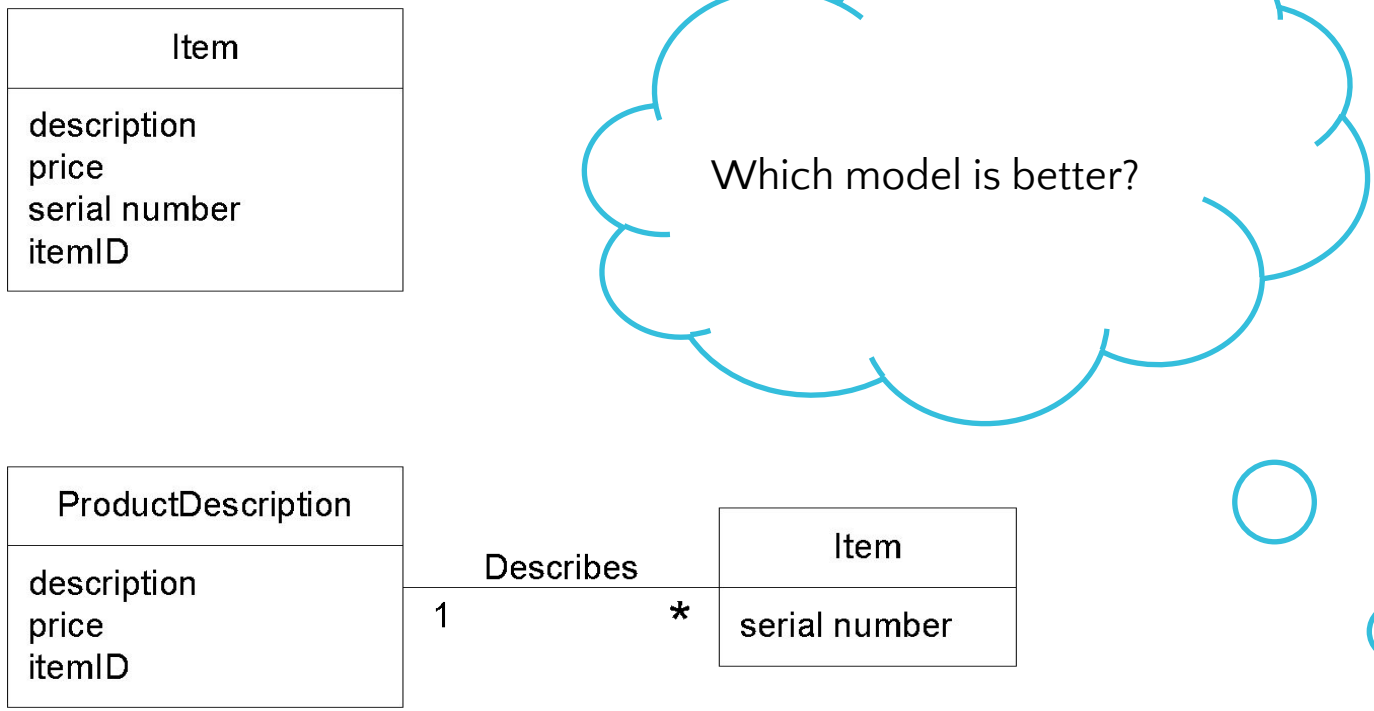
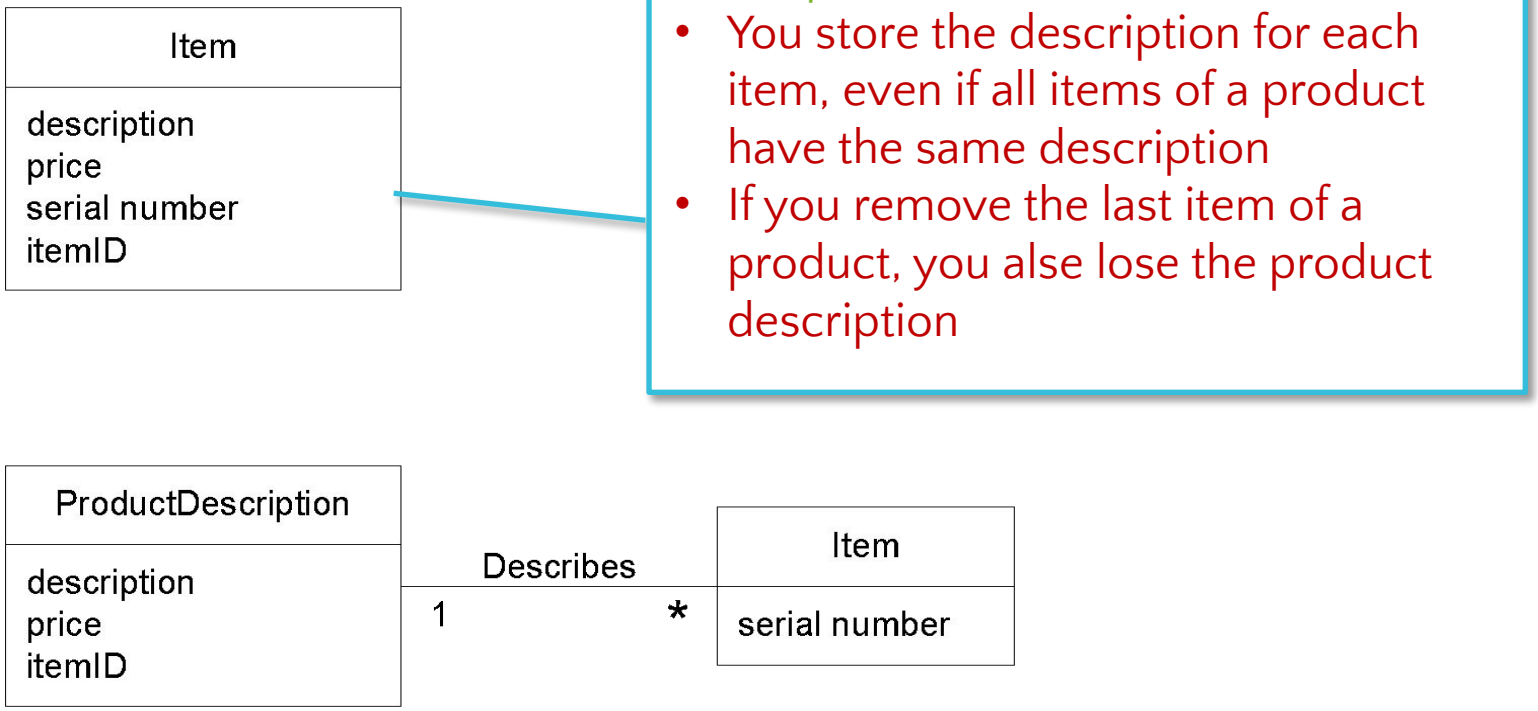
Item-Descriptor pattern

Refresher



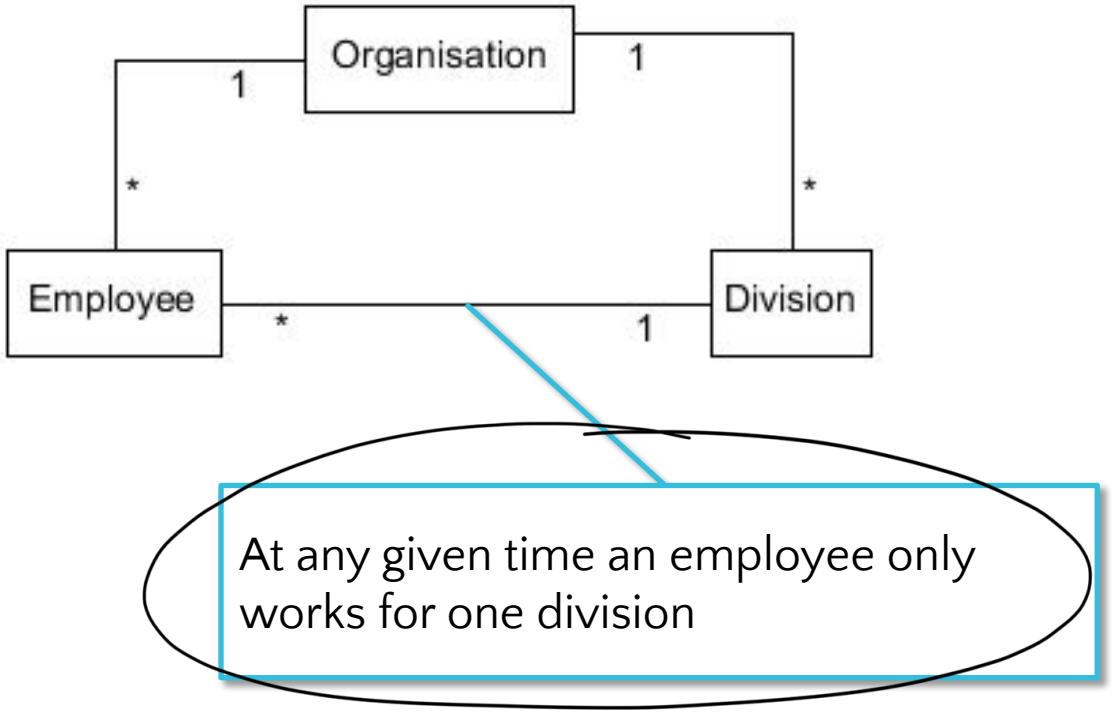
Description pattern

Refresher



modelling history

- Multiplicities normally show relations at one point in time
  - Not over a period of time

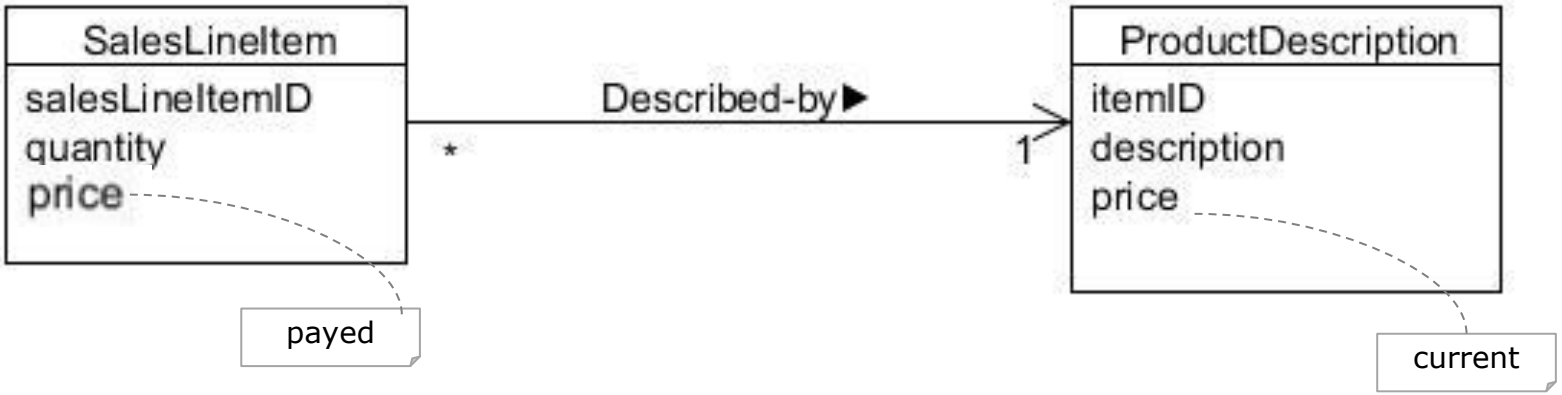


modelling history: price

Is this model OK?
Do you always know at which price a product is sold?

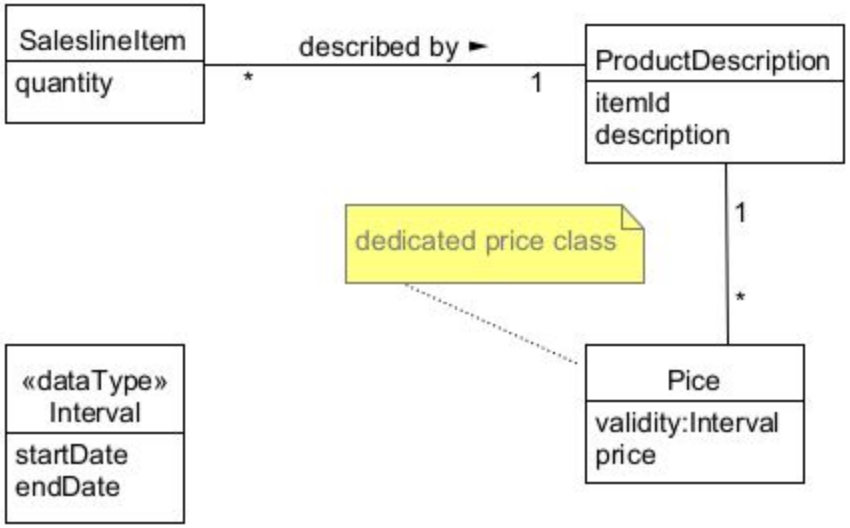
modelling history: price

- Solution 1: model history (duplicate current price)



modelling history: price

- Solution 2: model history (time interval)

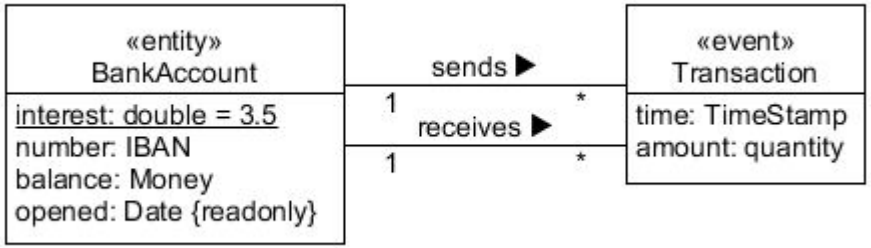


Exercise

Compare solutions (1) and (2) (pro/cons)

Modelling history

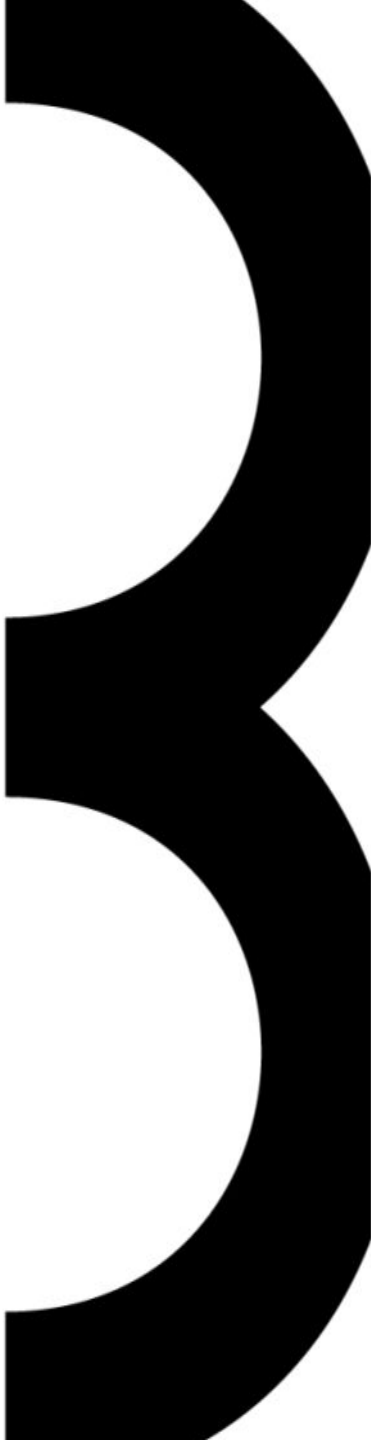
- Solution 3: DDD Domain events: log events triggering a change



- Similar to logging history
- information on changes (when, who, why, what…)
  - immutable
  - May have an identity (transactionNumber)
- Name can be past participle of the action, e.g. MoneyTranfered
- Can be used in design
  - Implement side effects in unrelated entity or external system (EventHandler, publish-subscribe, Event sourcing)

Compare solutions (2) and (3) (pro/cons)

DDD: Strategic design



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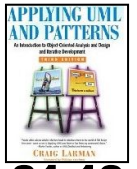
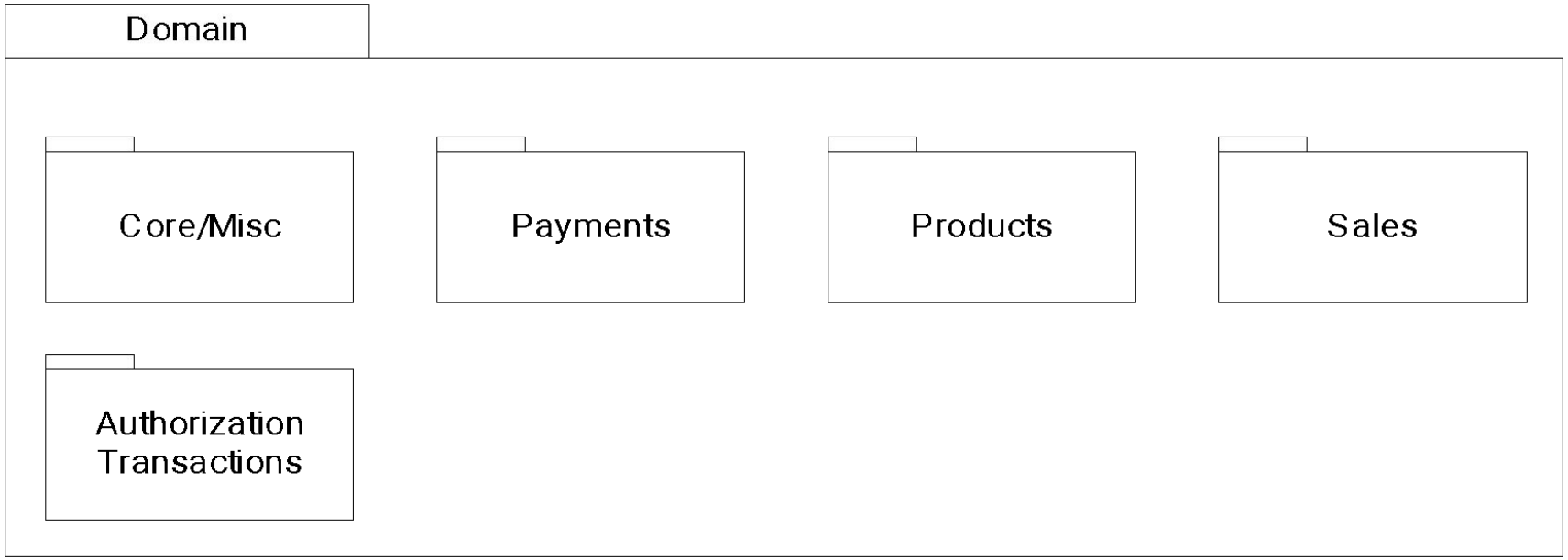
Packages (DDD: Modules)



- Structure a large domain in packages containing strongly related concepts
  - package names are part of the DDD ubiquitous language
- UML package diagram
  - Hierarchical tabbed folder representation



Strategic design

- Domain Driven Design aims to manage large business domains (and large projects)
  - DDD Strategic design groups patterns for high level design (business modelling)
- **DDD domain**: business processes we want to automate
- Is split up into **DDD subdomains**
  - Each subdomain is assigned to a project team
    - Team size is limited in agile processes
    - Small projects have a higher success rate

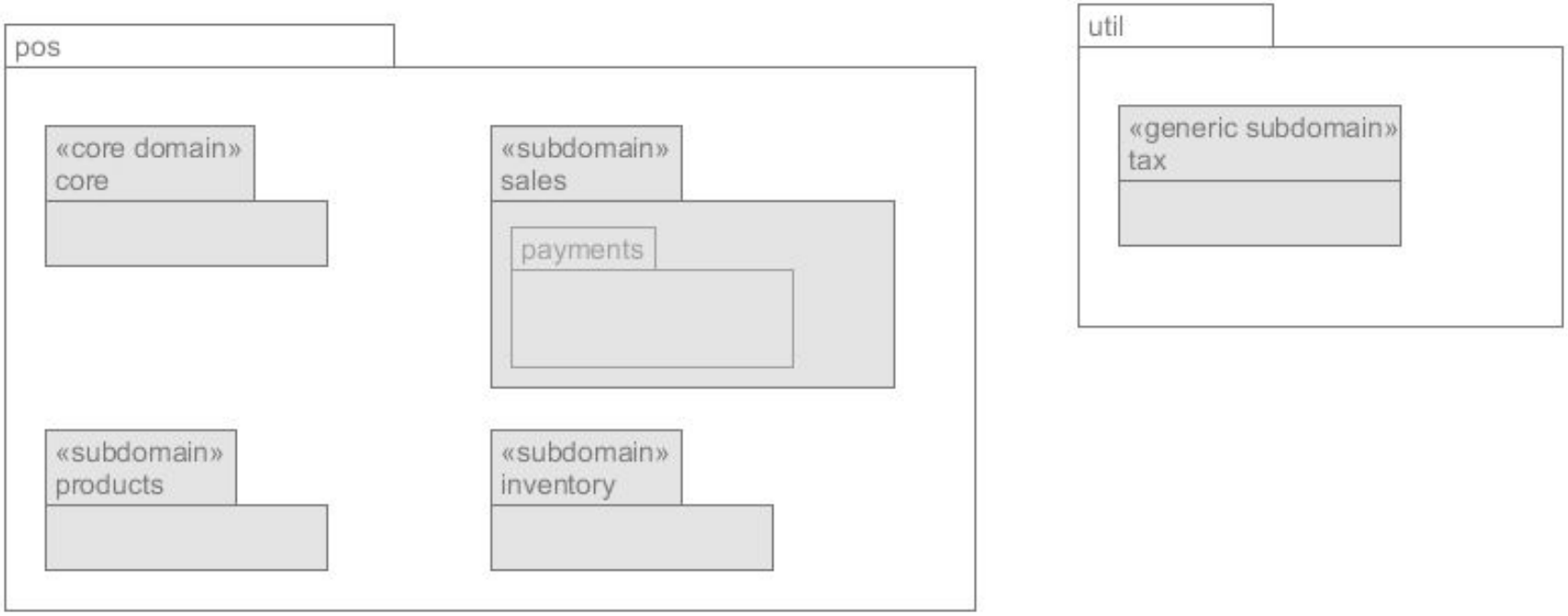
DDD Subdomain

- A domain is plit up in subdomains based on
  - Coupling and cohesion of packages
    - Cohesion: find one or more packages with a common purpose or subject
    - Coupling: put packages with hgh coupling in the same subdomain
  - Size: the subdomain must be small enough to be done by one team
  - onderlinge afhankelijkheden van packages
- Each subdomain is automated in a separte project
  - One subdomain cannot be handled by multiple projects (teams). Split up into smaller subdomains if needed
  - If subdomains are too small for a project, a team can get a project consisting of multiple subdomain

DDD antipattern: Big ball of mud

- Big Ball of mud: a domain that is NOT split up into manageable subdomains with high cohesion and low coupling
- Related to: spaghetti code

Example: Pos subdomains



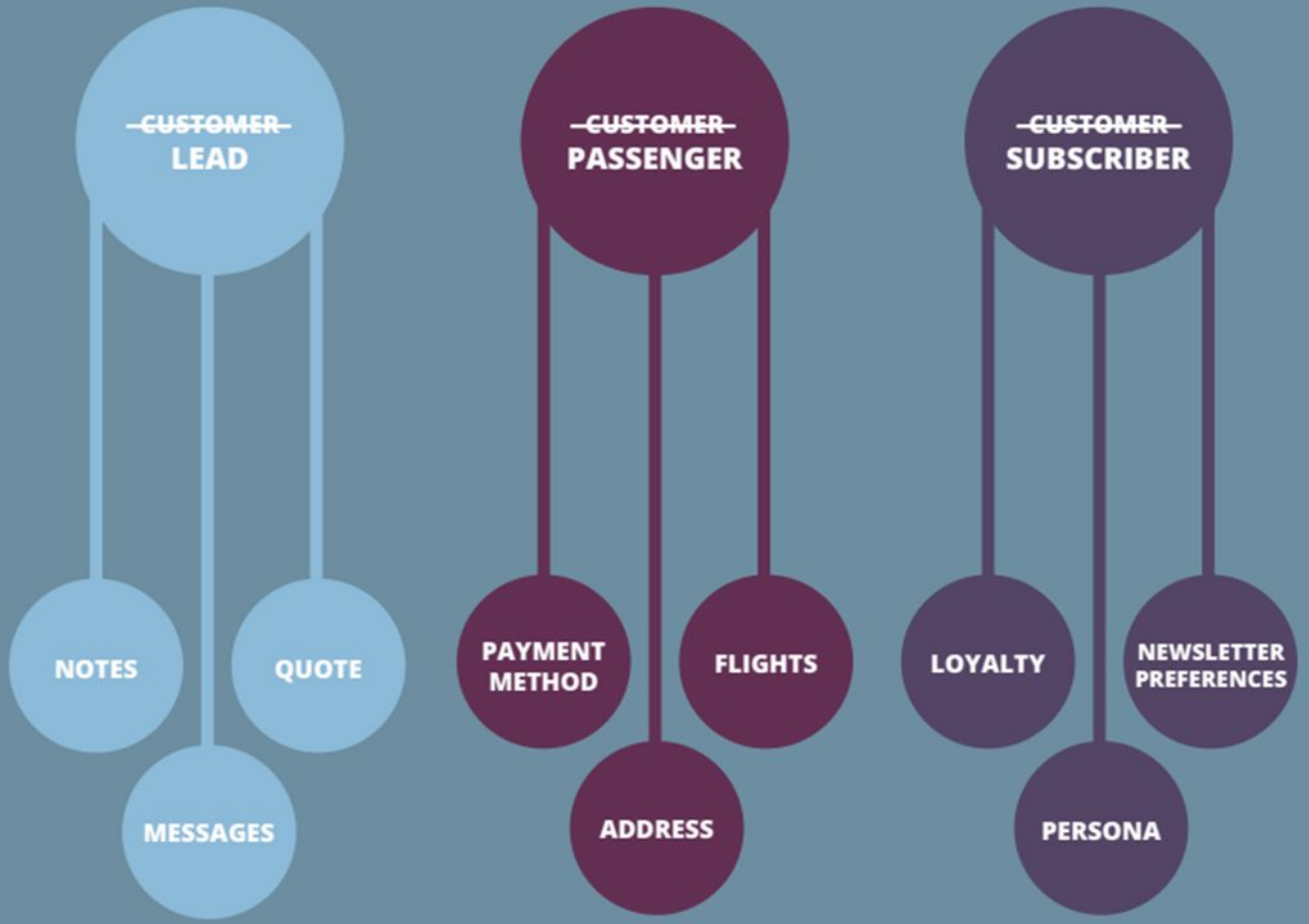
- POS is subdivided into (small) subdomains
  - core subdomain (shop management): contain core (most important) business logic
  - Each subdomain can be implemented in a different (microservices) project

DDD Bounded Context

- A project has a bounded context
  - Done by a separate team
  - Consists of one (or more) subdomains
  - Produces a system or subsystem
- Consequene:
  - **DDD ubiquitous language** is per project **team**

⇒ each **bounded context** has its own **ubiquitous language**

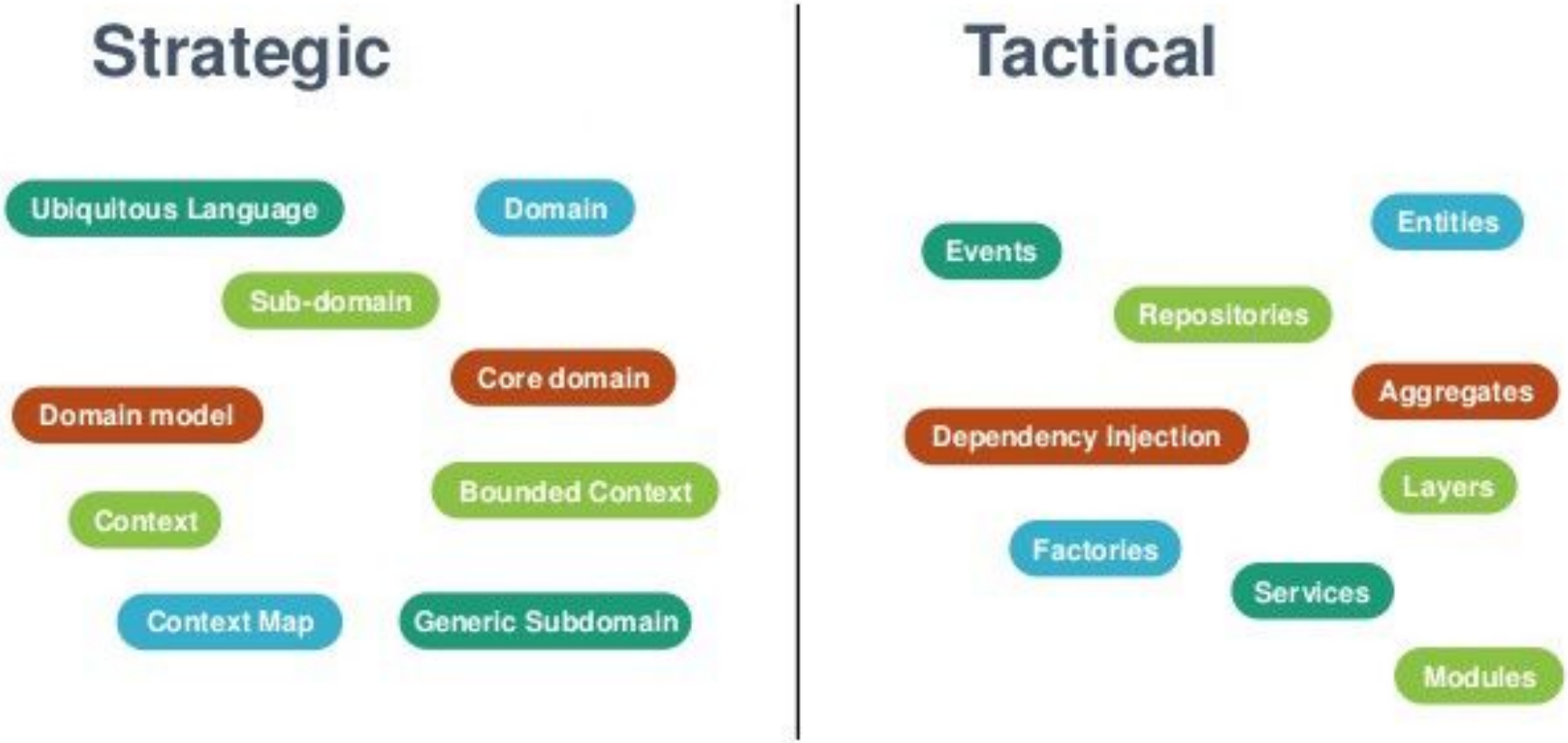
Use Specific Terminology In Each Bounded Context.



DDD: tactical design

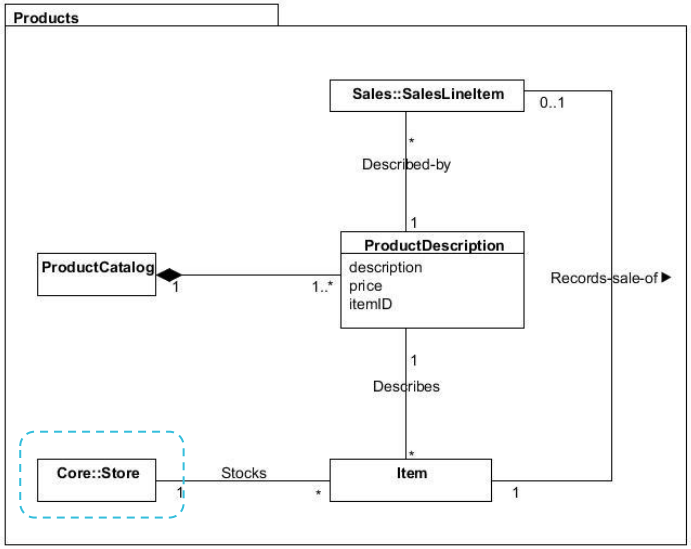
- DDD tactical design
  - applied within a bounded context
  - groups patterns for detailed design (software design)

DDD Strategic/tactical: some examples



Bounded Context: consequences

- Wat if we use concepts from another bounded context?
  - Example: we are using a Store from another bounded context
    - We can give the concept another name (e.g. Shop)
    - We may avaluate which attributes are important for us and adapt them



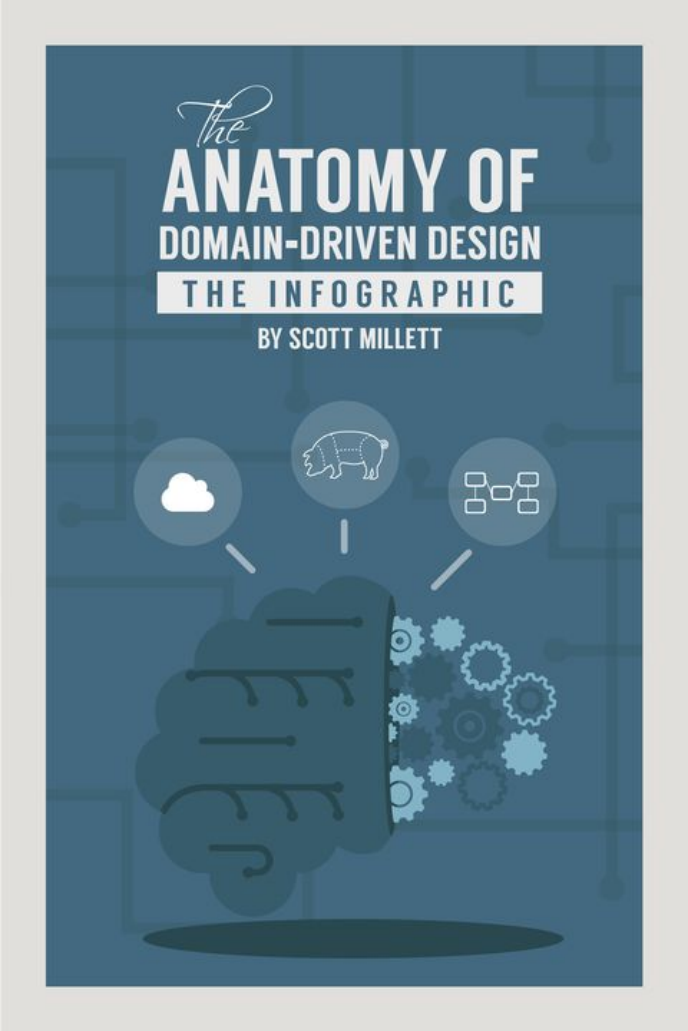
Bounded Context: consequences

- Within a bounded context: reuse code (DRY: Don't Repeat Yourself)
  - **DDD Continuous Integration:** share your work often and use the ubiquitous language
- We do **not** strive to reuse code from other subdomains
  - Exception: generic subdomains can be integrated in multiple projects (utility libraries…)

Bounded Context: consequences

- Even if the ubiquitous language can differ accross bounded contexts, you need to keep data consistent
  - example: Even is you use a store in the one context and a shop in the other one, their names and addresses must by kept in sync
    - Can be stored differently in both context (eg separte field for postbox or not)
- **DDD context mapping**: patterns to communicate between bounded contexts and keep data consistent

Intro DDD



https://leanpub.com/theanatomyofdomain-drivendesign

Summary

1. Extending UML
2. Domain model (class diagram)
   - Entities and associations
   - Data types
   - inheritance
   - datastructures overview
   - guidelines
3. DDD: strategic design