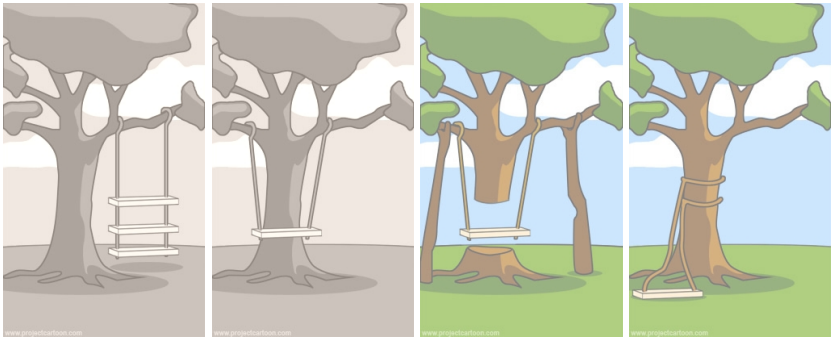
Software Engineering

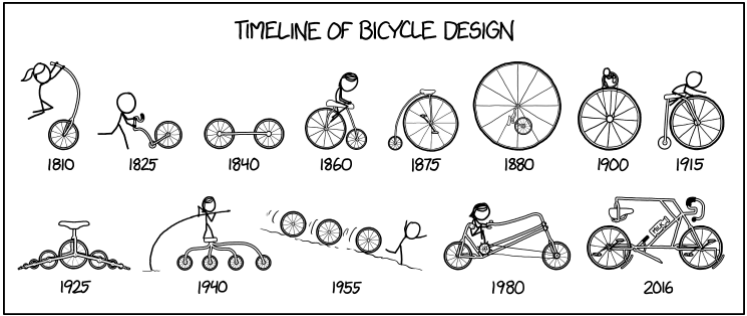
7. Design Patterns | Thomas Thüm | December 13, 2021

Design Patterns (Entwurfsmuster)



how the customer explained it | how the project leader understood it | how the analyst designed it | how the programmer implemented it

Tired of Swings? What about Bikes?

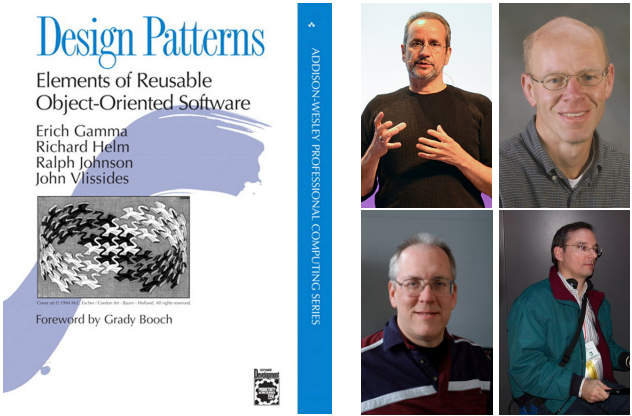


Lecture Overview

1. Structural Patterns
2. Creational Patterns
3. Behavioral Patterns

Lecture Contents

Gang of Four [Gang of Four (GoF)]



Design Patterns [Gang of Four]

Motivation

"Designing object-oriented software is hard, and designing **reusable** object-oriented software is even harder. [...] It takes a long time for novices to learn what good object-oriented design is all about. Experienced designers evidently know something inexperienced ones don't. What is it?"

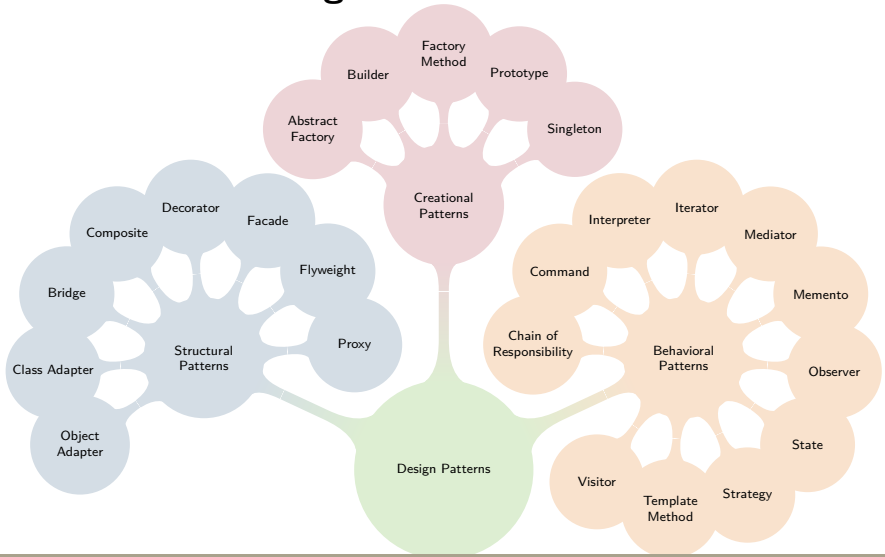
Design Patterns (Entwurfsmuster)

pattern name	for communication and high-level abstraction
problem	when to apply the pattern
solution	template on how to arrange classes and objects
consequences	trade-offs of applying the pattern

Kinds of Patterns

"Creational patterns (Erzeugungsmuster) concern the process of object creation. Structural patterns (Strukturmuster) deal with the composition of classes or objects. Behavioral patterns (Verhaltensmuster) characterize the ways in which classes or objects interact and distribute responsibility."

Overview on Design Patterns [Gang of Four (GoF)]



Object Adapter Pattern

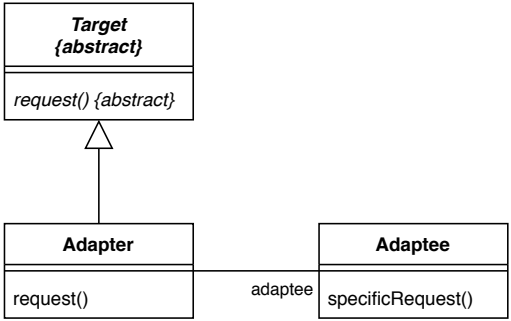
Object Adapter [Gang of Four]

intent "Convert the interface of a class into another interface clients expect. Adapter lets classes work together that couldn't otherwise because of incompatible interfaces."

aka. wrapper

motivation enable reuse of classes even though incompatible interfaces cannot be made compatible

idea create a new class with a compatible interface that forwards all requests



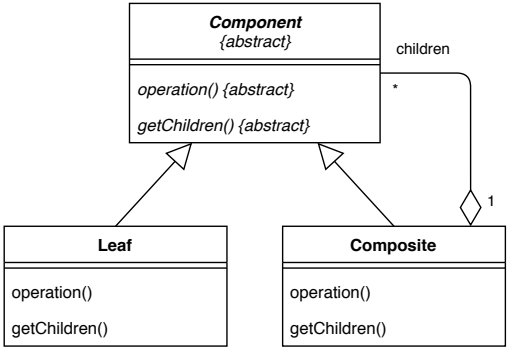
Composite Pattern

Composite [Gang of Four]

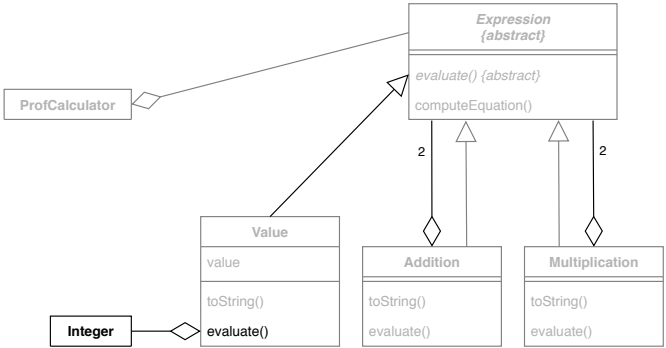
intent "Compose objects into tree structures to represent part-whole hierarchies. Composite lets clients treat individual objects and compositions of objects uniformly."

motivation avoid case distinctions for primitive and compound objects

idea create a common abstract super class enabling a unified access



Excursion: Show Complete Formula



Decorator Pattern

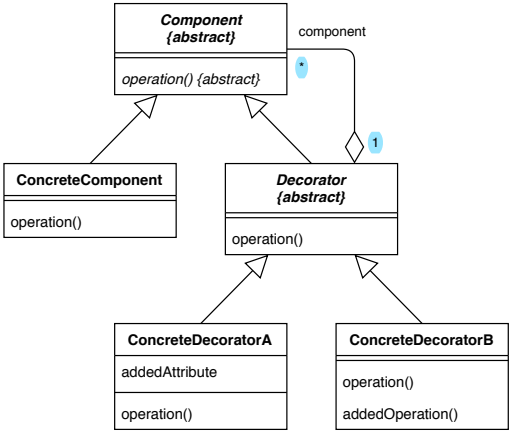
Decorator [Gang of Four]

intent "Attach additional responsibilities to an object dynamically. Decorators provide a flexible alternative to subclassing for extending functionality."

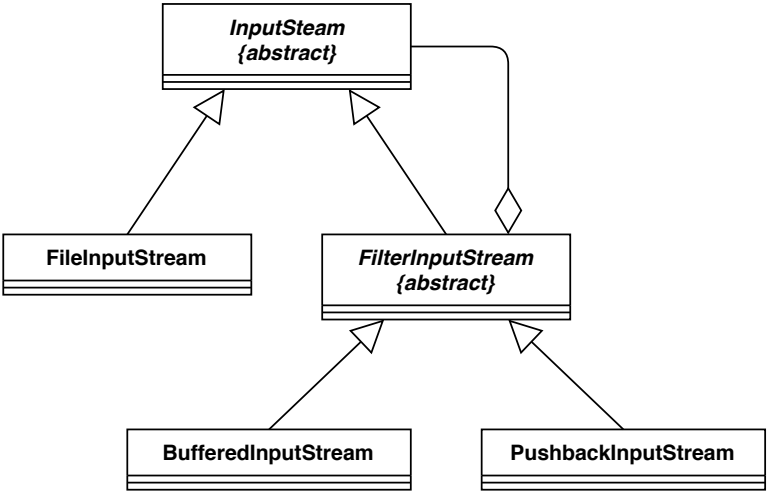
aka. wrapper (again)

motivation avoid explosion of static classes when combining all additional behaviors with all applicable classes

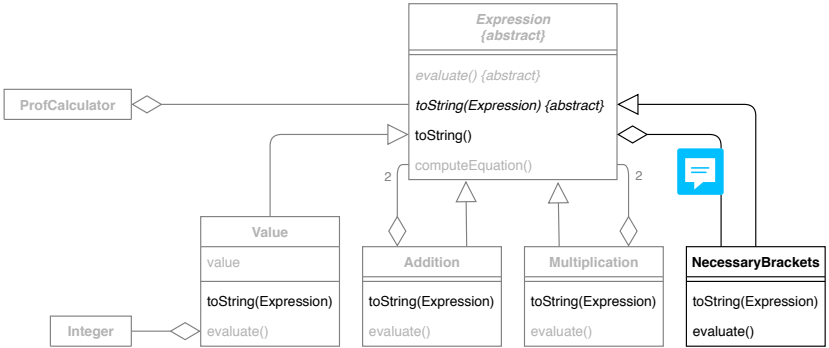
idea create decorators and components with the same interface, whereas decorators forward behavior whenever feasible



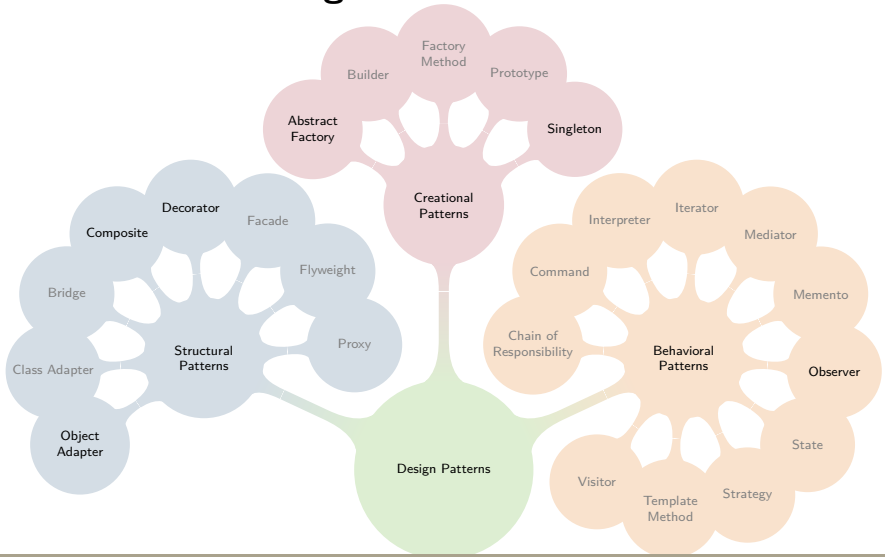
Example of the Decorator Pattern



Excursion: Introduce Necessary Brackets



Overview on Design Patterns [Gang of Four (GoF)]



Structural Patterns

Lessons Learned

- Design patterns by the Gang of Four
- Object adapter, composite pattern, decorator pattern
- Further Reading: Gang of Four (GoF), Chapter 4

Practice

- See Moodle
- Inspect code on Github: `https://github.com/tthuem/2020WS-SWT-Calculator/tree/xmaslecturev1`
- Implement further operations or the ability to show formulas without brackets and by using evaluation if needed (and checkbox to switch between brackets and evaluation)
- Fork the project on Github, upload your changes, and send pull request to get feedback

Lecture Contents

1. Structural Patterns

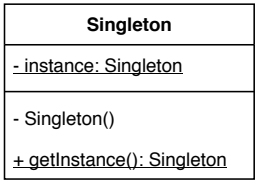
2. Creational Patterns
   - Singleton Pattern
   - Excursion: Add Logging for Debugging
   - Abstract Factory Pattern
   - Excursion: Create Styles for GUI
   - Overview on Design Patterns
   - Lessons Learned

3. Behavioral Patterns

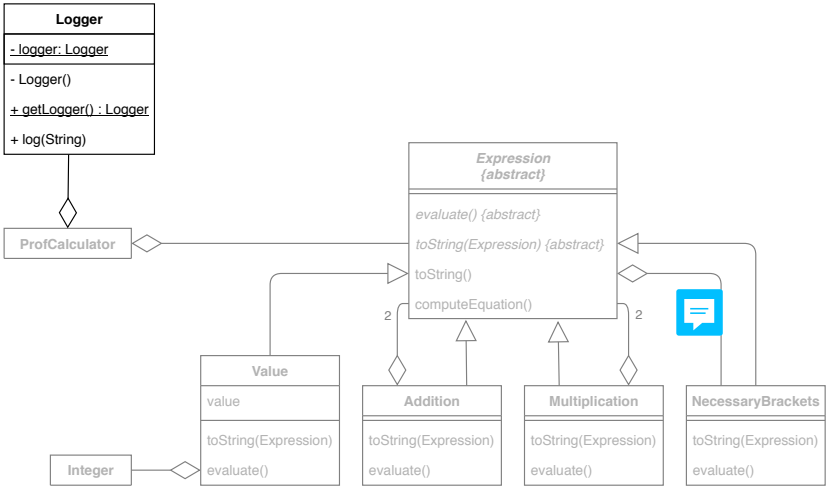
Singleton Pattern

Singleton [Gang of Four]

intent	"Ensure a class [has only] one instance, and provide a global point of access to it."
motivation	avoid the uncontrolled creation of multiple instances
idea	a private constructor is called on class initialization and a public static method is used for access to that single instance



Excursion: Add Logging for Debugging



Abstract Factory Pattern

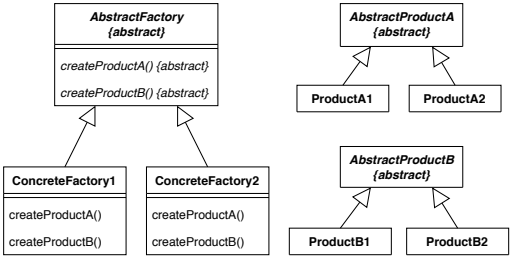
Abstract Factory [Gang of Four]

intent "Provide an interface for creating families of related or dependent objects without specifying their concrete classes."

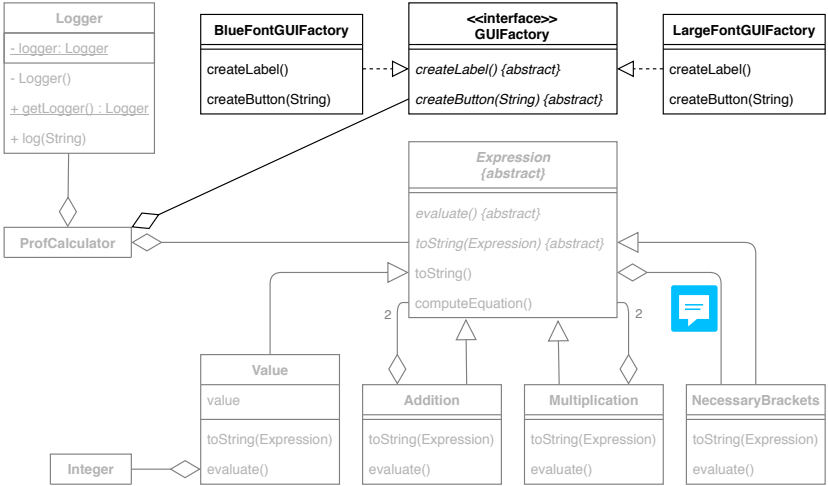
aka. kit

motivation avoid case distinctions when creating objects of certain kind, consistently create objects of a particular kind

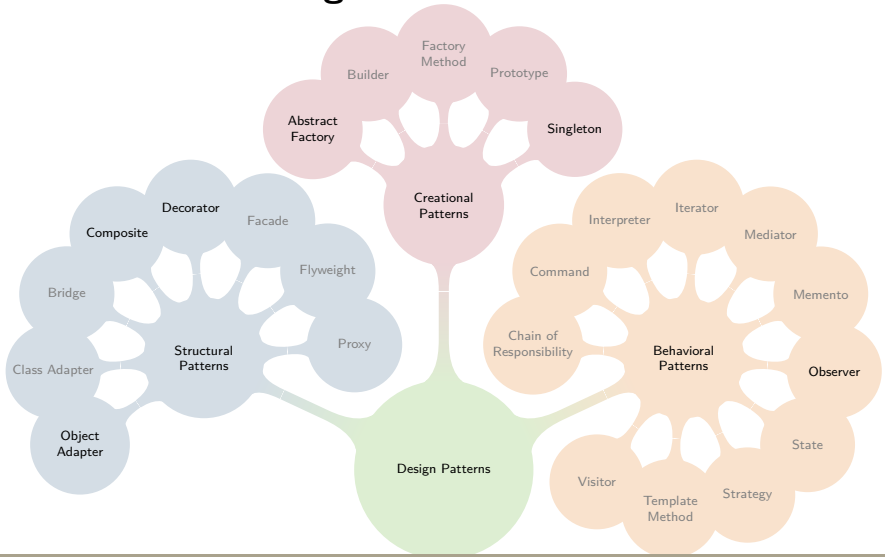
idea create classes for the consistent creation of objects



Excursion: Create Styles for GUI



Overview on Design Patterns [Gang of Four (GoF)]



Creational Patterns

Lessons Learned

- Singleton pattern, abstract factory pattern
- Further Reading: Gang of Four (GoF), Chapter 3

Practice

- See Moodle
- Inspect code on Github: `https://github.com/tthuem/2020WS-SWT-Calculator/tree/xmaslecturev2`
- Implement your own GUI factory **or** add the textbox to all factories
- Fork the project on Github, upload your changes, and send pull request to get feedback

Lecture Contents

1. Structural Patterns

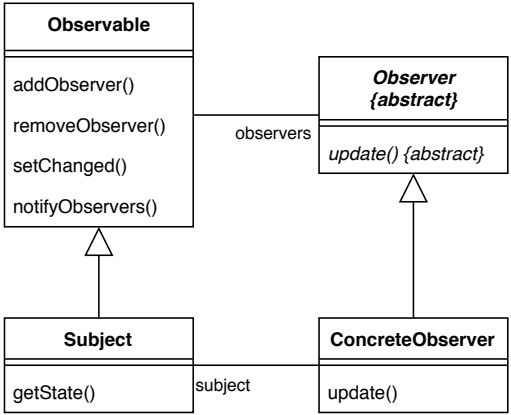
2. Creational Patterns

3. Behavioral Patterns
   - Observer Pattern
   - Excursion: Counter from 1 to 10
   - Overview on Design Patterns
   - Lessons Learned

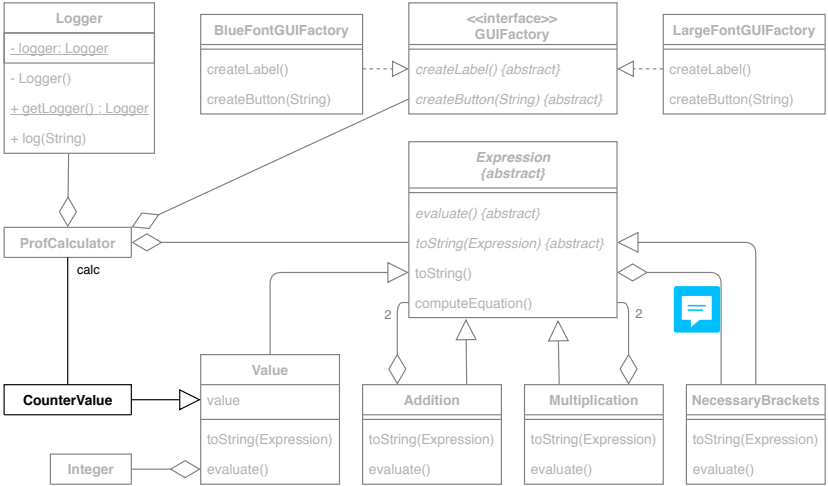
Observer Pattern

Observer [Gang of Four]

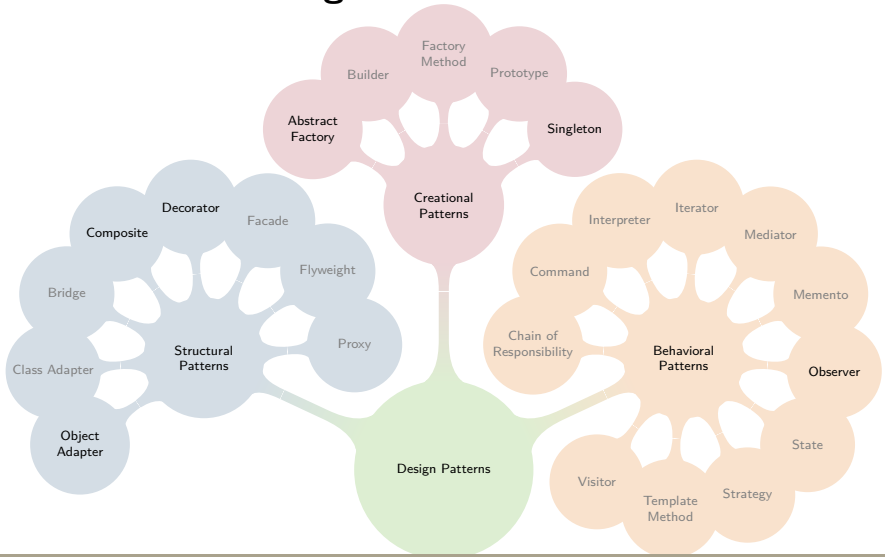
intent	"Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically."
aka.	dependents, publish-subscribe
motivation	avoid coupling of classes (i.e., explicit references such as imports)
example	no coupling between model and view in model-view-controller architectures
idea	data object (model) has a list of observers (views) that are notified about changes



Excursion: Counter from 1 to 10



Overview on Design Patterns [Gang of Four (GoF)]



Behavioral Patterns

Lessons Learned

- Observer pattern
- Further Reading: Gang of Four (GoF), Chapter 5

Practice

- See Moodle
- Inspect code on Github: `https://github.com/tthuem/2020WS-SWT-Calculator/tree/xmaslecturev3`
- Implement the observer pattern (to avoid explicit reference of the calculator in CounterValue) **or** one other behavioral pattern not discussed in the lecture
- Fork the project on Github, upload your changes, and send pull request to get feedback