

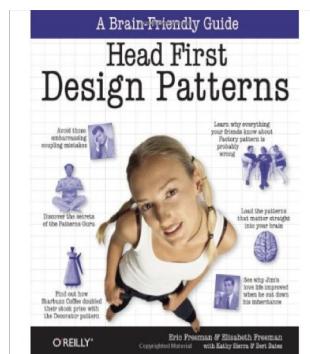
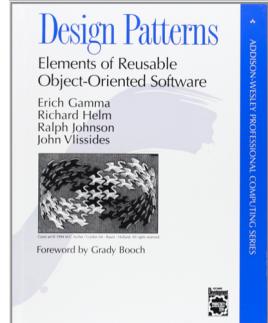
Design Patterns

General concepts

UA.DETI.PDS

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Resources



- ❖ *Design patterns: elements of reusable object oriented software.* E. Gamma, R. Helm, R. Johnson, J. Vlissides. Addison Wesley, 1994.
- ❖ *Head first design patterns.* E. Freeman, E. Freeman, K. Sierra, B. Bates. O'Reilly, 2004.
- ❖ Also based on:
 - Object-Oriented Software Engineering, Glenn D. Blank, <http://www.cse.lehigh.edu/~glennb/oose/oose.htm>
 - Software Design, Joan Serrat, <http://www.cvc.uab.es/shared/teach/a21291/web/>

What are patterns?

- ❖ Principles and solutions codified in a structured format describing a problem and a solution
- ❖ A named problem/solution pair that can be applied in new contexts
- ❖ It is advice from previous designers to help designers in new situations
- ❖ The idea behind design patterns is simple:
 - Write down and catalog common interactions between objects that programmers have frequently found useful.
- ❖ Result:
 - Facilitate reuse of object-oriented code between projects and between programmers.

Some definitions of design patterns

- ❖ “Design patterns constitute a set of rules describing how to accomplish certain tasks in the realm of software development.” (Pree, 1994)
- ❖ “Design patterns focus more on reuse of recurring architectural design themes, while frameworks focus on detailed design... and implementation.” (Coplien & Schmidt, 1995).
- ❖ “A pattern addresses a recurring design problem that arises in specific design situations and presents a solution to it” (Buschmann, et. al. 1996)
- ❖ “Patterns identify and specify abstractions that are above the level of single classes and instances, or of components.” (Gamma, et al., 1993)

Characteristics of Good patterns

- ❖ It solves a problem
- ❖ It is a proven concept
- ❖ The solution isn't obvious
- ❖ It describes a relationship
- ❖ The pattern has a significant human component

Types of patterns

❖ Architectural Patterns

- Expresses a fundamental structural organization or schema for software systems.

❖ Design Patterns

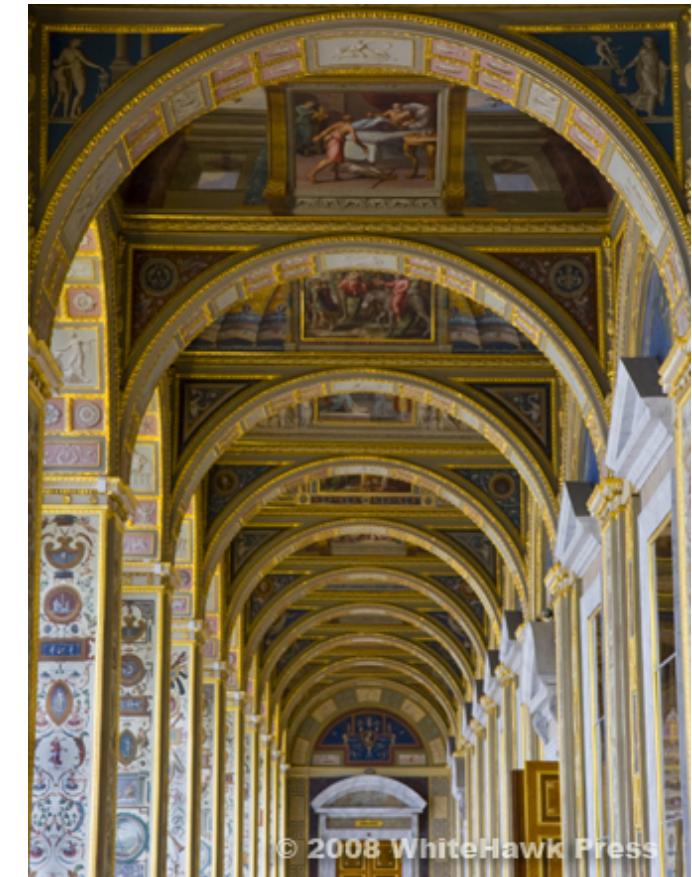
- Provides a scheme for refining the subsystems or components of a software system, or the relationships between them.

❖ Idioms

- An idiom describes how to implement particular aspects of components or the relationships between them using the features of the given language.

Design patterns in architecture

- ❖ A pattern is a recurring solution to a standard problem, in a context.
- ❖ Christopher Alexander, professor of architecture...
 - Why is what a prof of architecture says relevant to software?
 - “A pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice.”



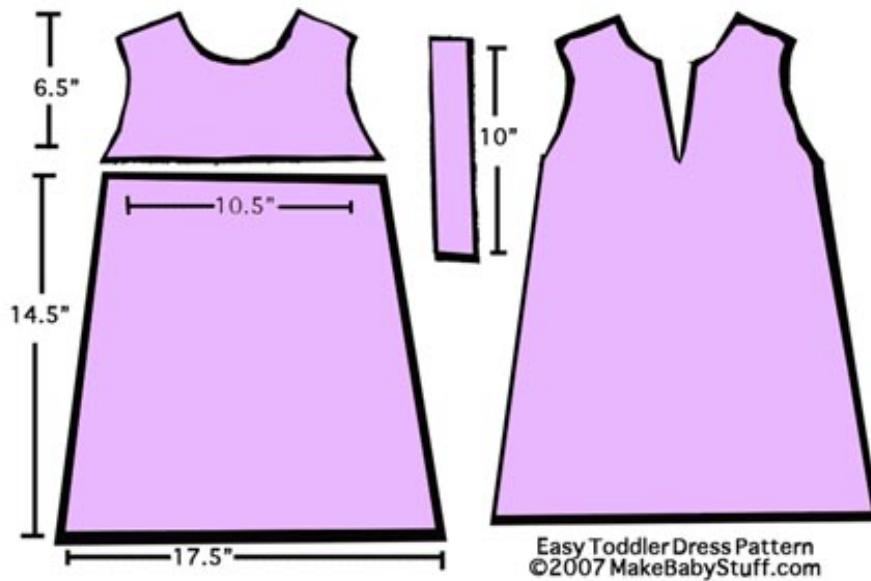
Design and dress patterns

- ❖ Jim Coplein, a software engineer:

- “I like to relate this definition to dress patterns ...

- I could tell you how to make a dress by specifying the route of a scissors through a piece of cloth in terms of angles and lengths of cut. Or, I could give you a pattern.

Reading the specification, you would have no idea what was being built or if you had built the right thing when you were finished. The pattern foreshadows the product: it is the rule for making the thing, but it is also, in many respects, the thing itself.”



Easy Toddler Dress Pattern
©2007 MakeBabyStuff.com

Patterns in engineering

- ❖ How do other engineers find and use patterns?
 - Mature engineering disciplines have handbooks describing successful solutions to known problems
 - Automobile designers don't design cars from scratch using the laws of physics
 - Instead, they reuse standard designs with successful track records, learning from experience
 - Should software engineers make use of patterns? Why?
- ❖ Developing software from scratch is also expensive
 - Patterns support reuse of software architecture design

Gang of Four (GoF) Patterns

- ❖ Eric Gamma and colleagues published in 1995 the influential book Design patterns: *Elements of Reusable Object-Oriented Software*.
- ❖ Has a catalogue of 23 patterns. For each one, a template is followed:
 - Name
 - Intent : what it does and advantages 1–2 sentences
 - Motivation : example
 - Structure : template class diagram
 - Applicability : when to use it
 - Consequences : advantages and shortcomings
 - Implementation discussion, C++ sample code

Naming Patterns – important!

- ❖ Patterns have suggestive names:
 - Arched Columns Pattern, Easy Toddler Dress Pattern, etc.
- ❖ Why is naming a pattern or principle helpful?
 - It supports chunking and incorporating that concept into our understanding and memory
 - It facilitates communication



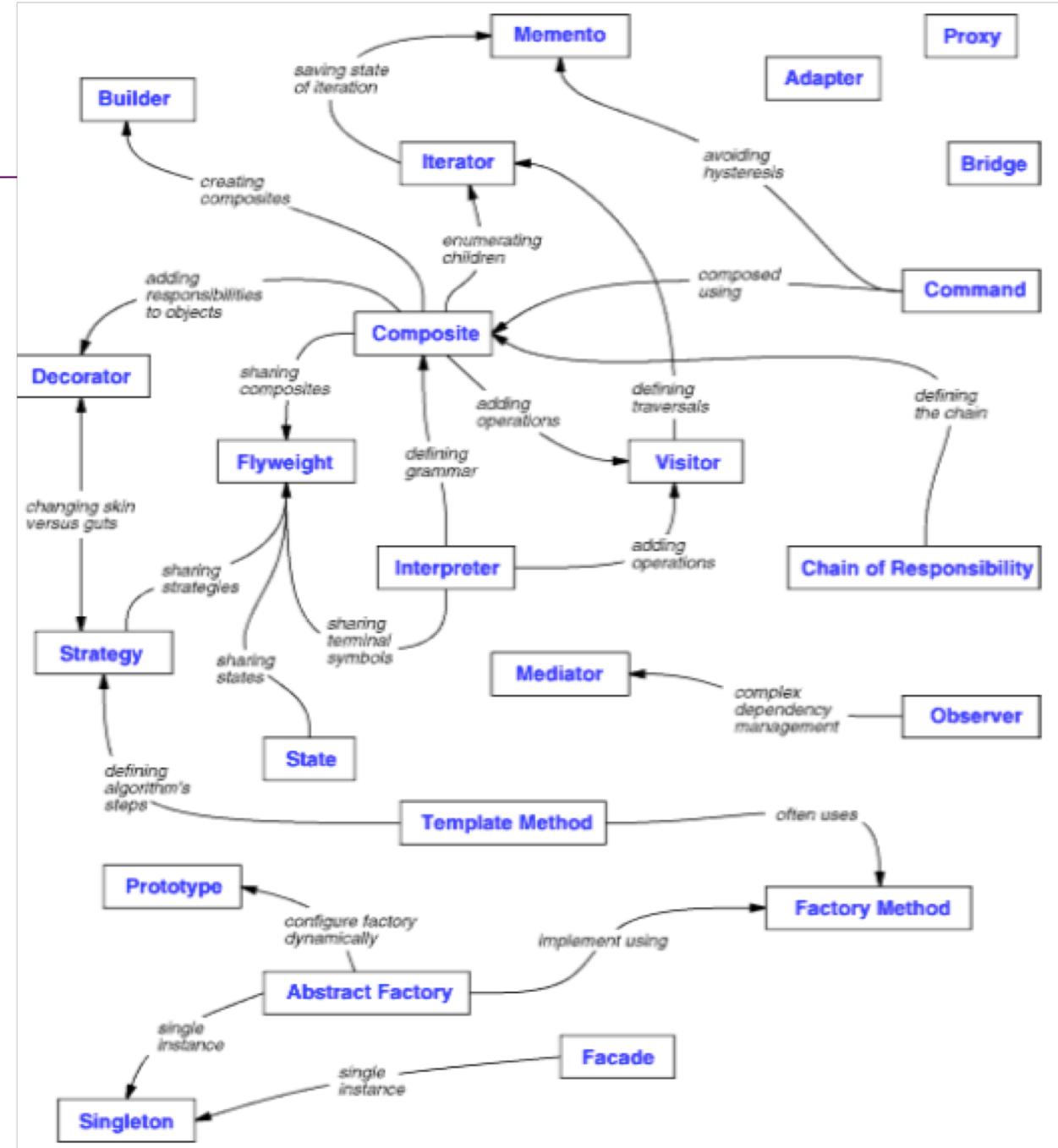
GoF Patterns

- ❖ Gamma et al. classify patterns into 3 groups:
- ❖ **Creational**
 - patterns concern the process of object creation
- ❖ **Structural**
 - patterns deal with the composition of classes or objects
- ❖ **Behavioral**
 - patterns characterize the ways in which classes or objects interact and distribute responsibilities

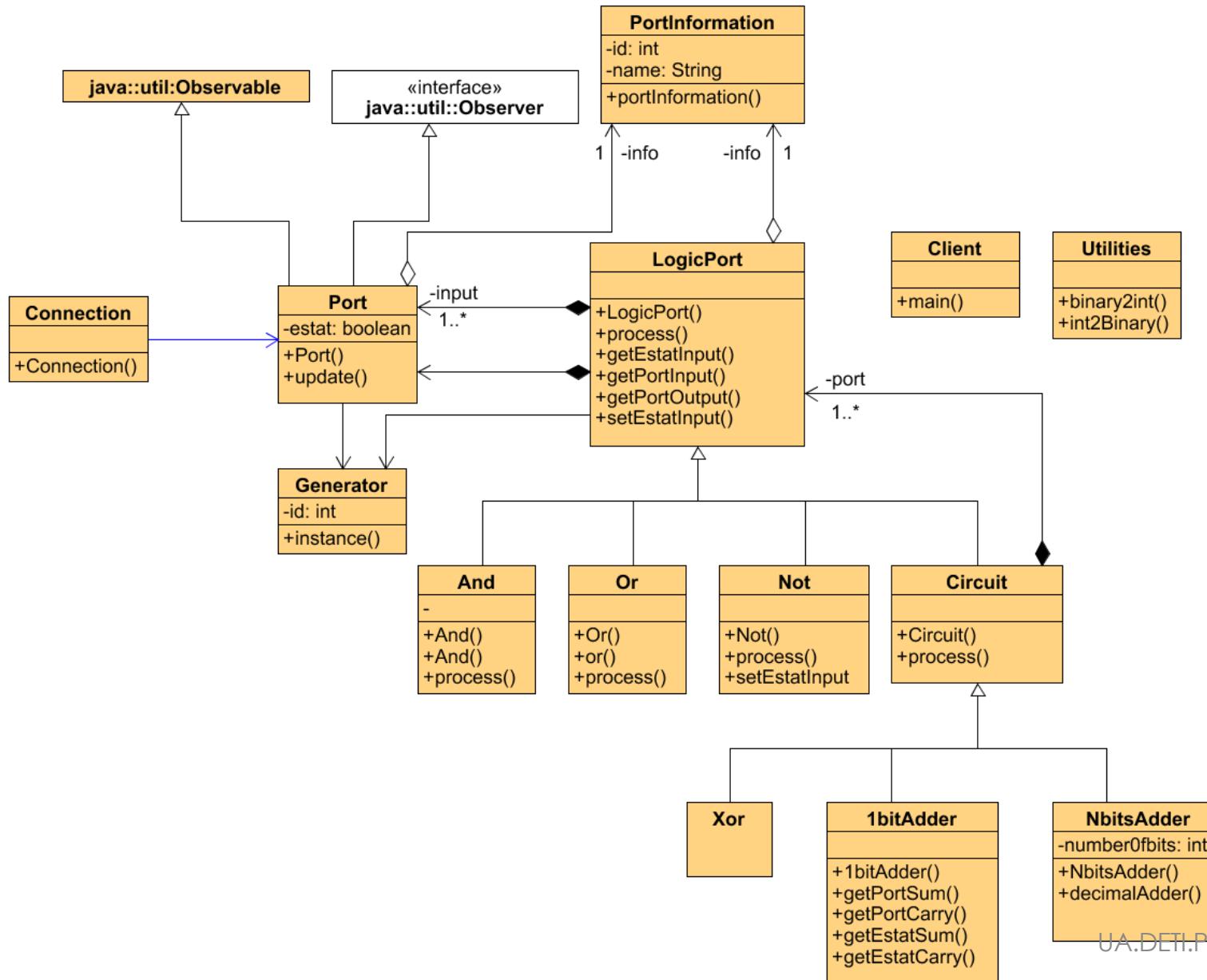
GoF Patterns

| By Purpose | | Creational | Structural | Behavioral |
|------------|--------|--|--|---|
| By Scope | Class | <ul style="list-style-type: none">• Factory Method | <ul style="list-style-type: none">• Adapter (class) | <ul style="list-style-type: none">• Interpreter• Template Method |
| | Object | <ul style="list-style-type: none">• Abstract Factory• Builder• Prototype• Singleton | <ul style="list-style-type: none">• Adapter (object)• Bridge• Composite• Decorator• Façade• Flyweight• Proxy | <ul style="list-style-type: none">• Chain of Responsibility• Command• Iterator• Mediator• Memento• Observer• State• Strategy• Visitor |

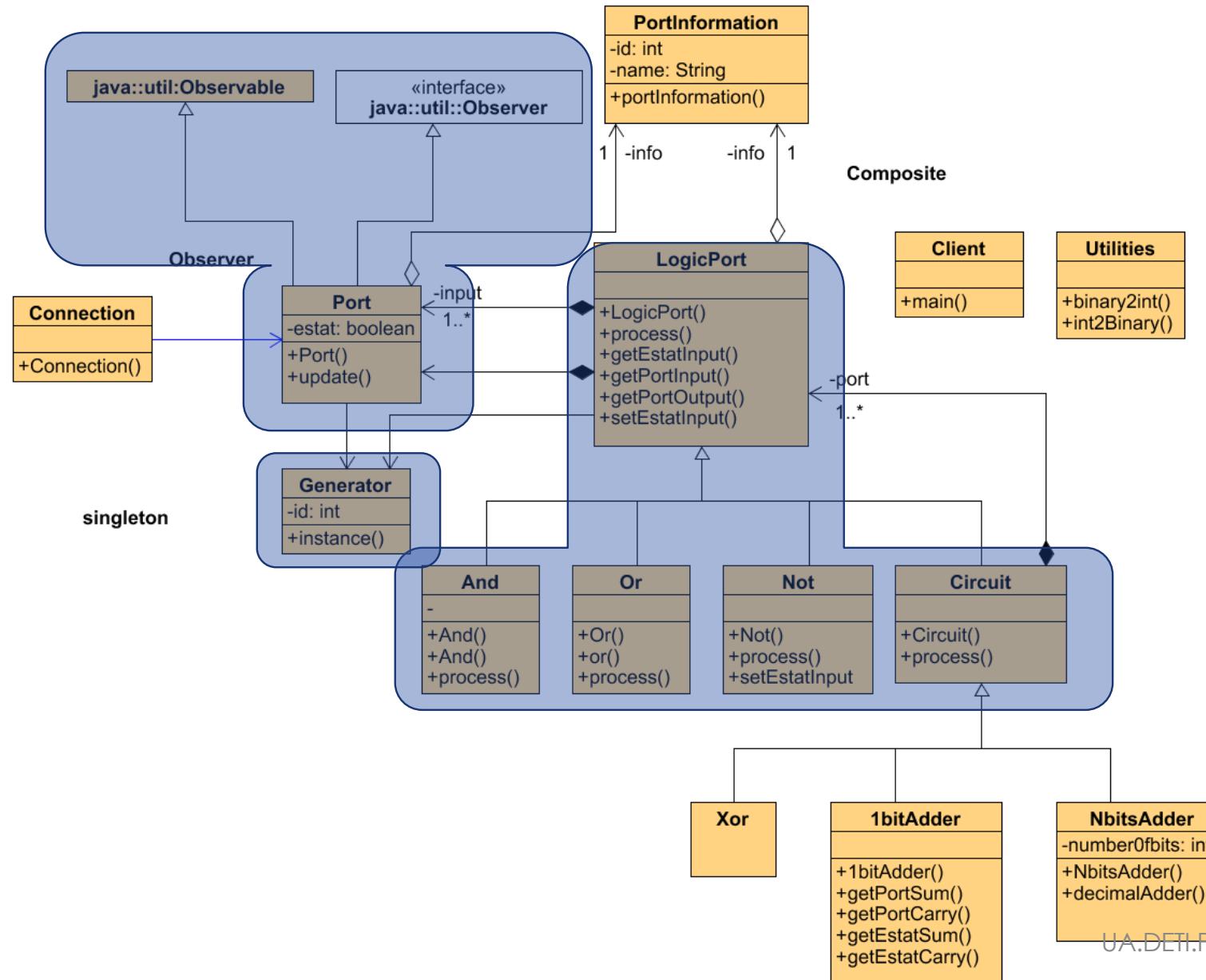
Relationships



Why patterns?



Why patterns?



Why patterns?

- ❖ A novice chess player knows
 - the game rules
 - the value of all pieces
- ❖ A novice OO designer must know
 - inheritance, encapsulation, data abstraction ...
 - UML notation
- ❖ A good chess player knows
 - tactics: occupy central cells, ...
 - strategies: immobilize, win with two bishops, ...
 - apertures, famous matches
- ❖ An expert designer knows
 - object oriented principles
 - examples of good designs
 - design patterns

More on this in the next weeks...

