Design Patterns

MSc in Computer Science

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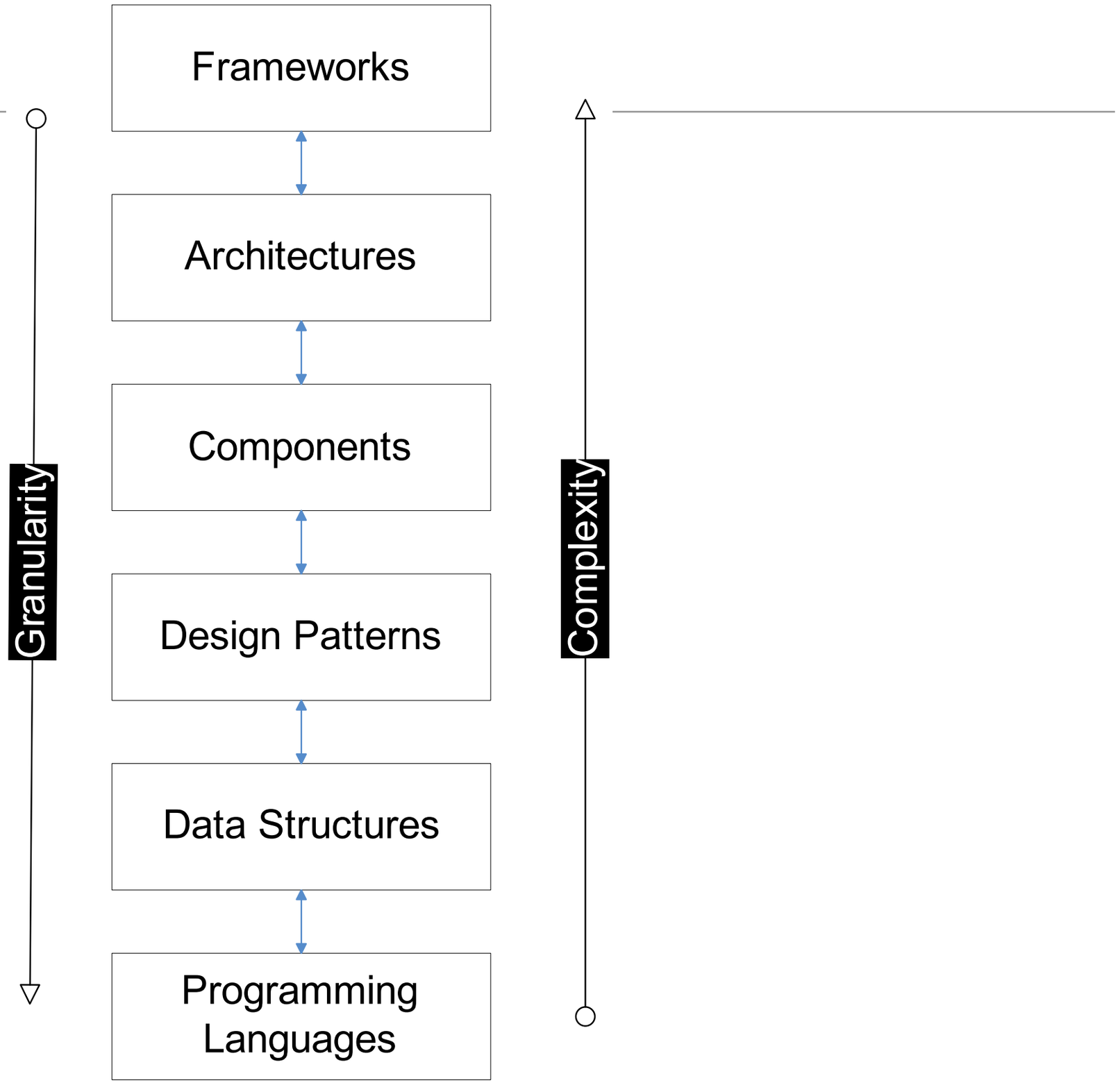
Design Patterns Context

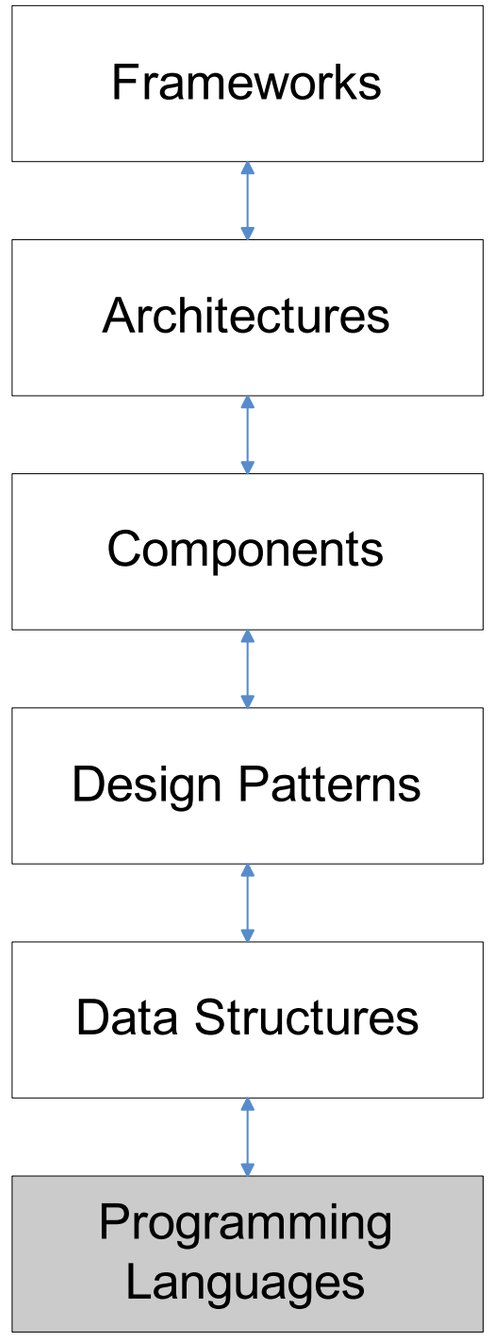
Agile Software Development

Context


Frameworks
Architectures
Components
Design Patterns
Data Structures
Programming Languages
Granularity
Complexity

Programming Languages

- A programming language is a system of signs used to communicate a task/algorithm to a computer, causing the task to be performed
- The task to be performed is called a computation, which follows absolutely precise and unambiguous rules.
- Three components:
  - The syntax of the language is a way of specifying what is legal in the phrase structure of the language; (analogous to knowing how to spell and form sentences English)
  - The second component is semantics, or meaning, of a program in that language.
  - Certain idioms that a programmer needs to know to use the language effectively - are usually acquired through practice and experience

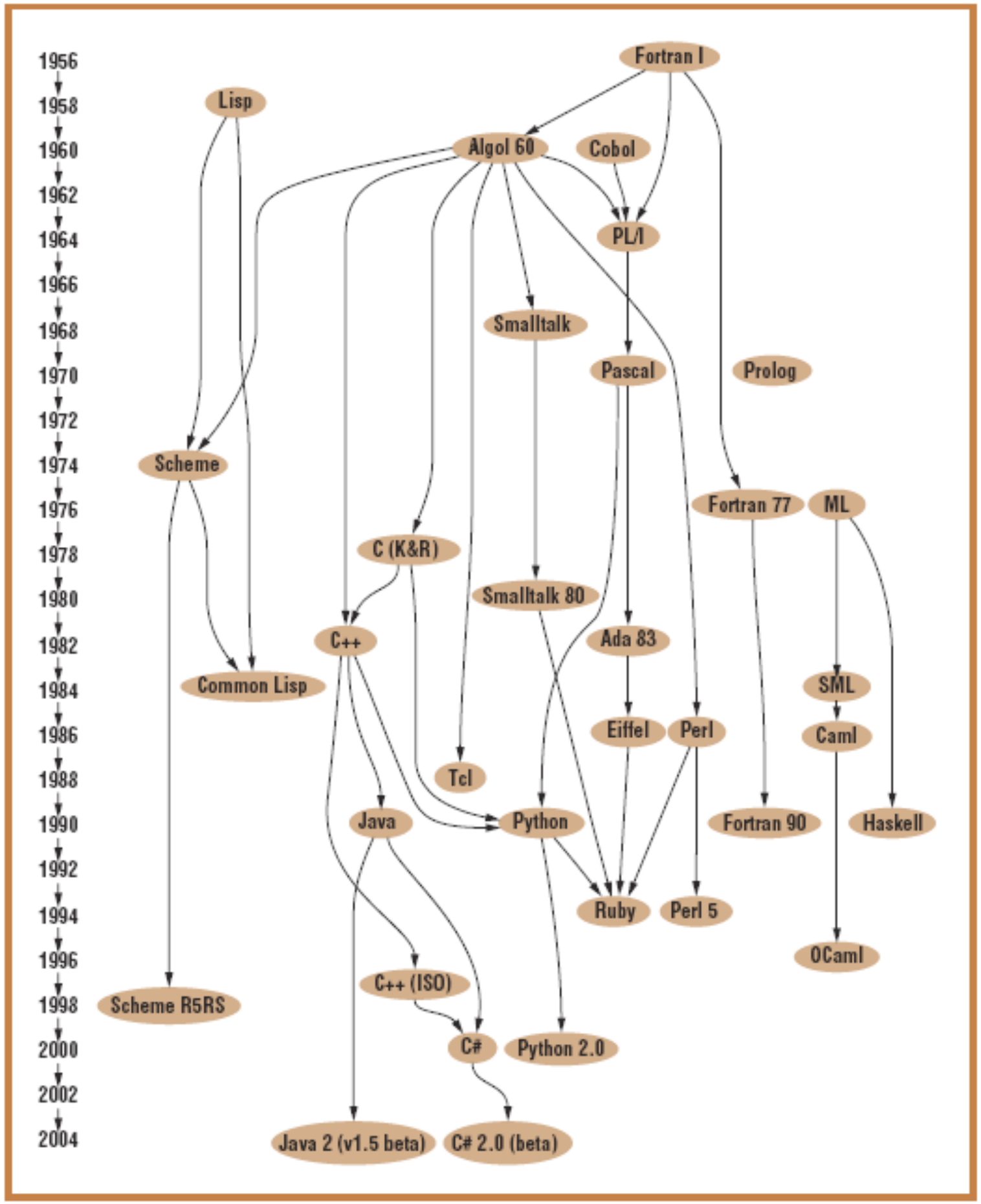


Family Tree

- Imperative languages: (Fortran, C, and Ada) enable programmers to express algorithms for solving problems.

- Declarative languages, (Lisp, Prolog, Haskell) allow the programmer to specify what has to be computed, but not how the computation is done.

- Object Oriented: can be viewed as a hybrid – of declarative (class structures) & imperative (methods) features.



Characteristics of OO Languages

1.Object-based modular structure.

2.Data abstraction.

3.Automatic memory management.

4.Classes.

5.Inheritance.

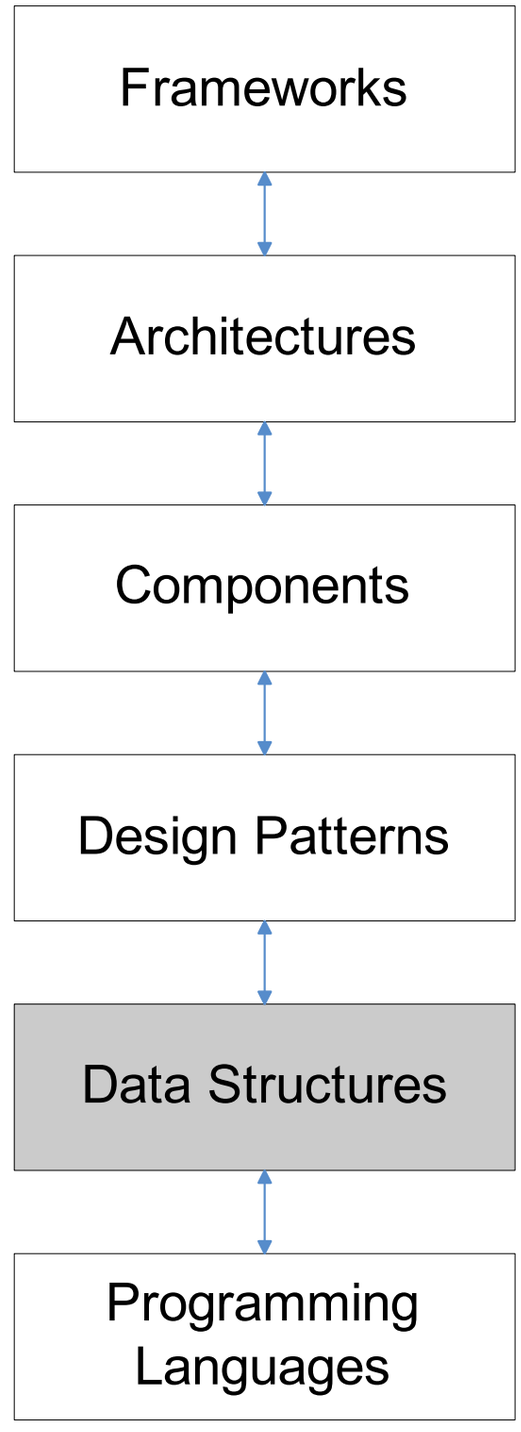
6.Polymorphism and dynamic binding.

7.Multiple and repeated inheritance.

(Meyer)

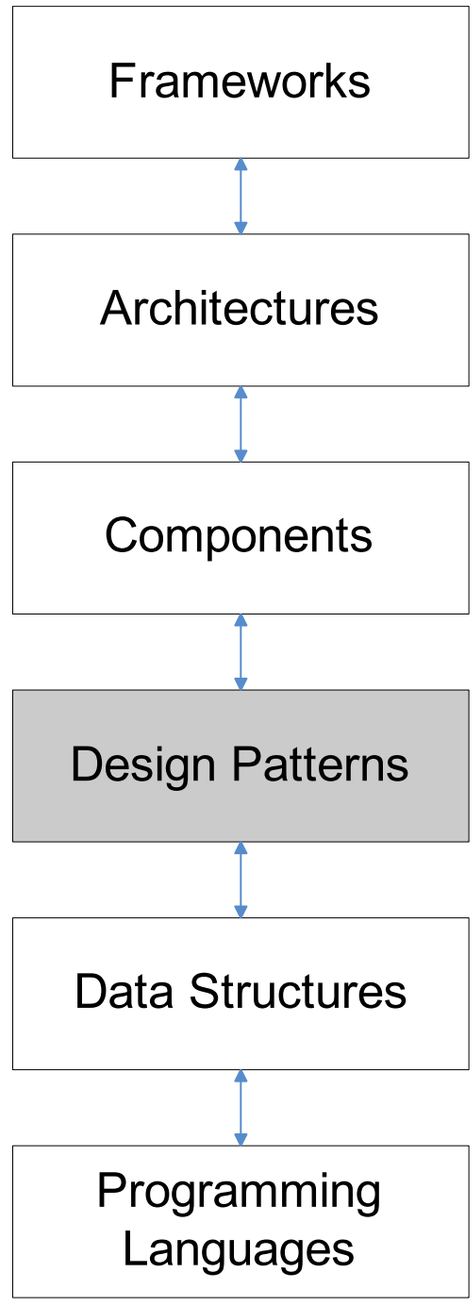
Data Structures & Problems

- Typical Data Structures:
  - Lists, Stacks, Queues, Trees, Heaps
  - Static and Dynamic implementations
- Typical Problem Categories:
  - Search
  - Decision
  - Classification
  - Generation & Enumeration
  - Aggregation & Clustering
  - Sorting
  - Traversal



Design Patterns

- A design pattern is a proven solution for a general design problem.
- It consists of communicating ‘objects’ that are customized to solve the problem in a particular context.
- Patterns have their origin in object-oriented programming where they began as collections of objects organized to solve a problem.
- There isn't any fundamental relationship between patterns and objects; it just happens they began there.
- Patterns may have arisen because objects seem so elemental, but the problems we were trying to solve with them were so complex.



Pattern Levels

Architectural Patterns:

- Expresses a fundamental structural organization or schema for software systems. It provides a set of predefined subsystems, specifies their responsibilities, and includes rules and guidelines for organizing the relationships between them.

Design Patterns:

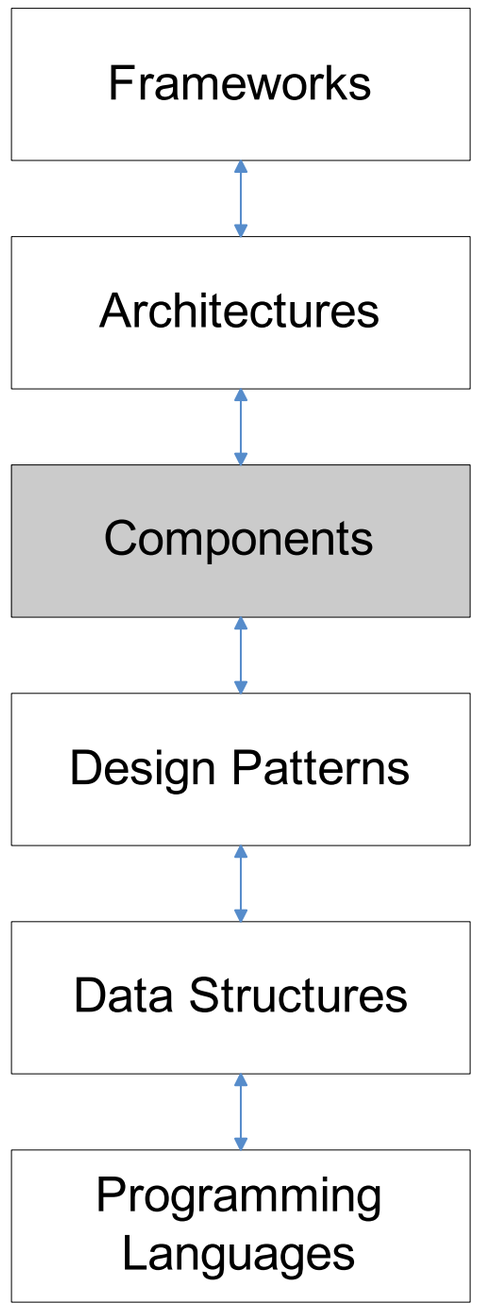
- Provides a scheme for refining the subsystems or components of a software system, or the relationships between them. It describes commonly recurring structure of communicating components that solves a general design problem within a particular context.

Idioms:

- A low-level pattern specific to a programming language. An idiom describes how to implement particular aspects of components or the relationships between them using the features of the given language.

Components

- Software components are binary units of:
  - independent production,
  - acquisition,
  - deployment
- that interact to form a functioning program. (Szyperski)
- Emphasis has on reusable units
- A component must be compatible and interoperate with a whole range of other components.
- Two main issues arise with respect to interoperability information:
  - How to express interoperability information
  - How to publish this information



More Component Definitions

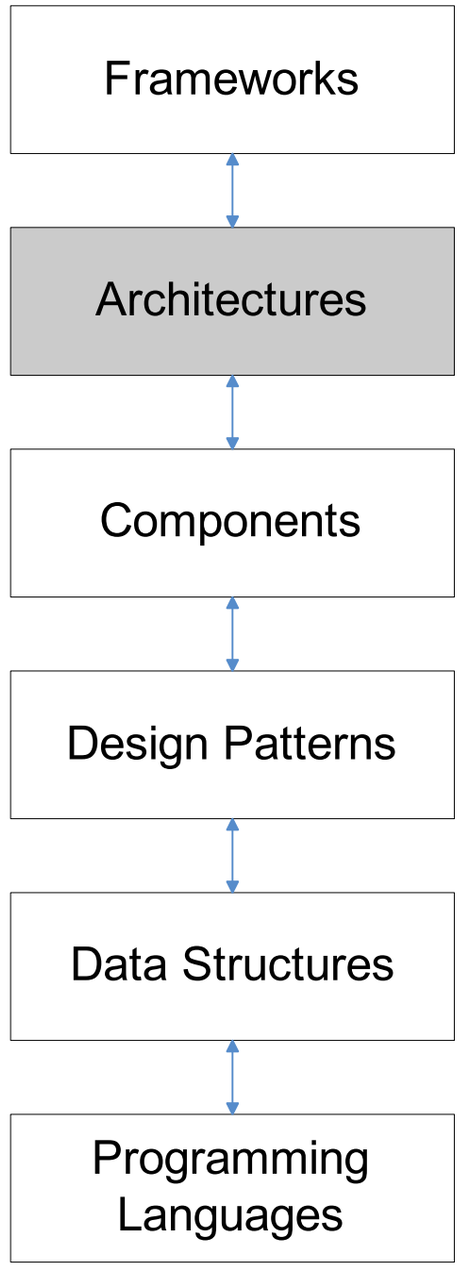
- "A component is a nontrivial, nearly independent, and replaceable part of a system that fulfills a clear function in the context of a well-defined architecture. A component conforms to and provides the physical realization of a set of interfaces." (Philippe Krutchen, Rational Software)

- "A runtime software component is a dynamically bindable package of one or more programs managed as a unit and accessed through documented interfaces that can be discovered at runtime." (Gartner Group)

- "A component is a physical and replaceable part of a system that conforms to and provides the realization of a set of interfaces...typically represents the physical packaging of otherwise logical elements, such as classes, interfaces, and collaborations." (Grady Booch, Jim Rumbaugh, Ivar Jacobson, The UML User Guide, p. 343)

Architecture

- The software architecture of a program or computing system is:
  - the structure or structures of the system, which comprise software components,
  - the externally visible properties of those components, and
  - the a set of rules that govern relationships among them.
- An architectural style is a family of software architectures, defining types of components and types of connections, and rules describing how to combine them.
- A software architecture is an instantiation of an architectural style for a certain system. The components and connections may be decomposed into architectures themselves.

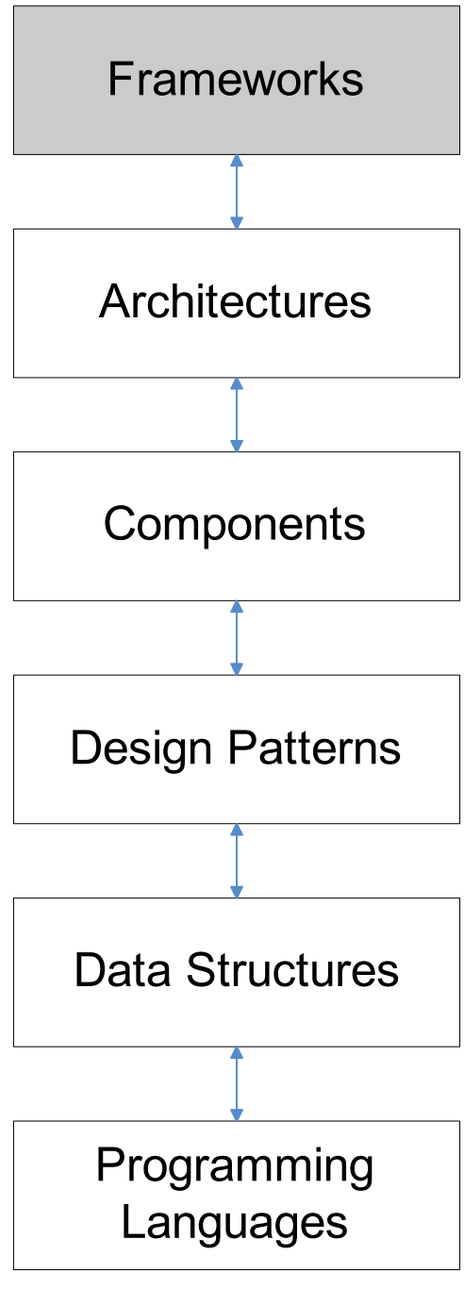


Architectural Styles

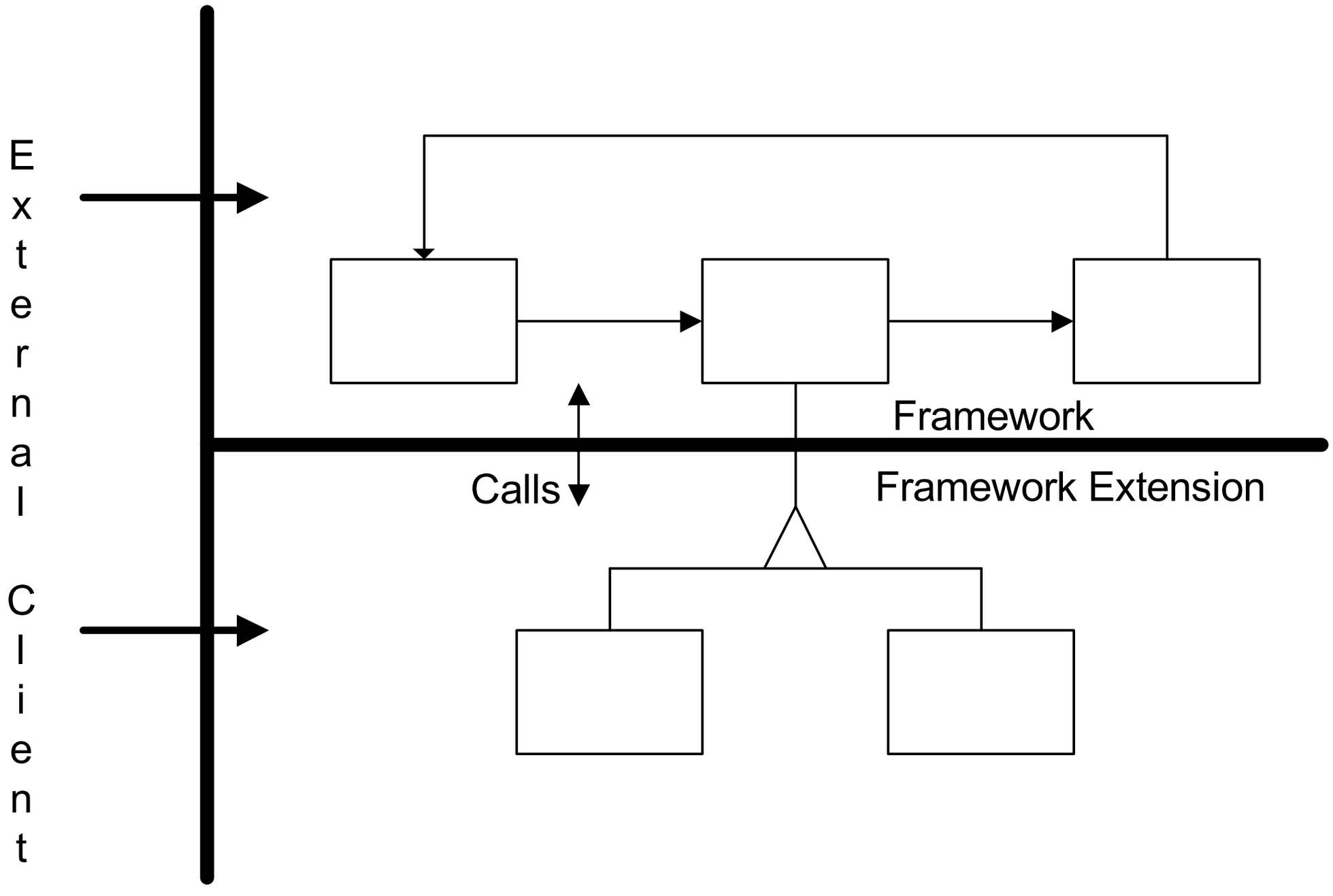
- Batch
- Pipe & Filter
- Client/Server
- Blackboard
- Event Driven
- Plug-in
- Space Based (Tuples)
- Three-Tier
- Network
  - Data Flow
  - Replication
  - Hierarchal
  - Mobile Code
  - Peer to Peer

Frameworks

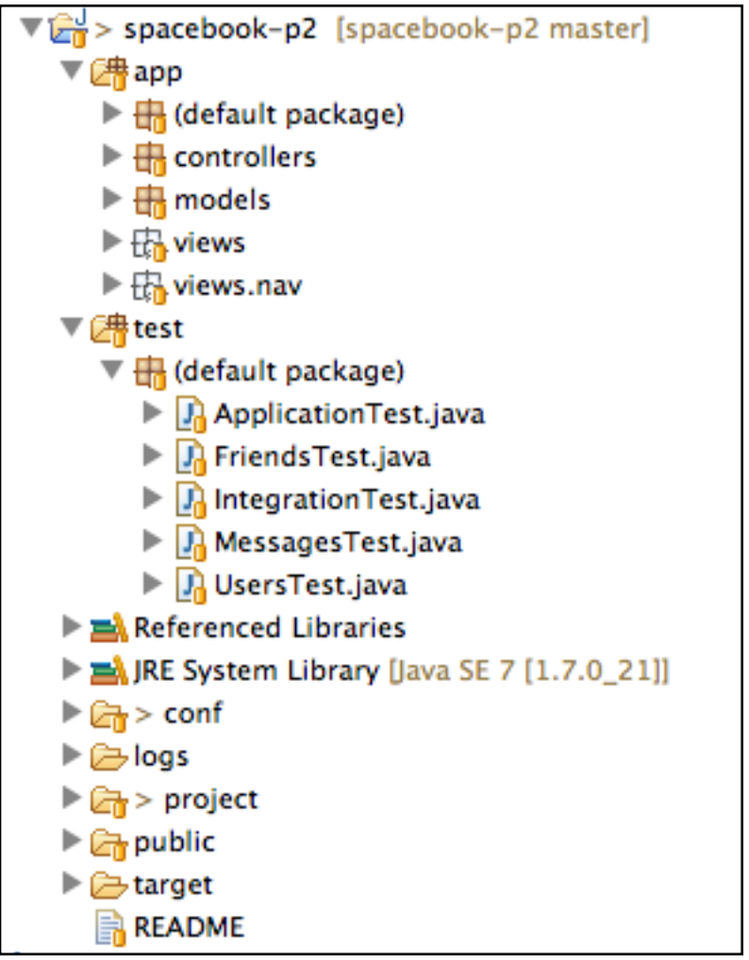
- A framework is a set of related components which you specialize, integrate and/or instantiate to implement an application or subsystem
  - Usually, a semi complete application containing dynamic and static components that can be customized to produce applications
- Frameworks are targeted for a particular application domain & consists of a set of classes (abstract & concrete), whose instances:
  - collaborate
  - are intended to be extended, i.e. reused (abstract design)
  - do not have to address a complete application domain (allowing for composition of frameworks)
- Emphasize stable parts of the domain and their relationships and interactions



Framework Structure



Framework Example



Android Framework