Codebase Structure

“Being deeply loved by someone gives you strength,
while loving someone deeply gives you courage.”
- Lao Tzu

Outline

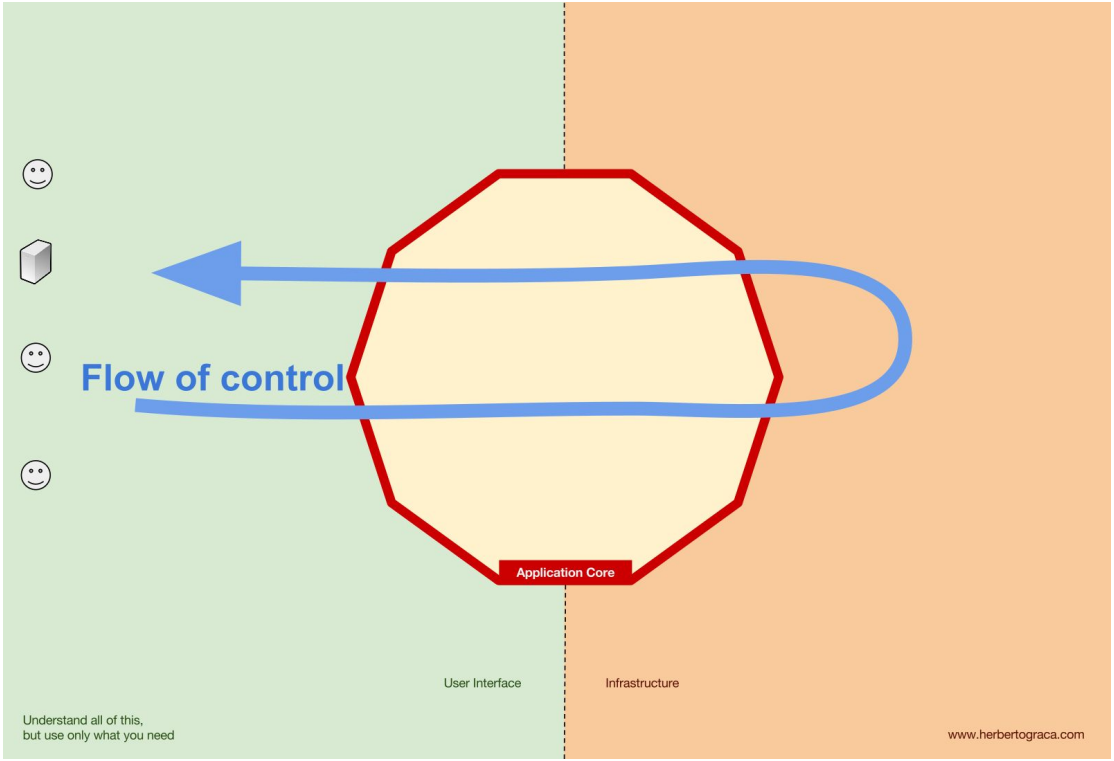
1. Architectural Patterns
    - Layer Architecture
    - Hexagonal Architecture
    - Onion Architecture
    - Clean Architecture
    - Functional Architecture
2. Project Structure
3. Domain Driven Design (DDD)

Problems:

- Have you even asked why the project structure is like this/that?
- When codebase grow bigger, is it hard to manage?
  Is it hard to find and place code logic?
- How to make architectural theories practical?

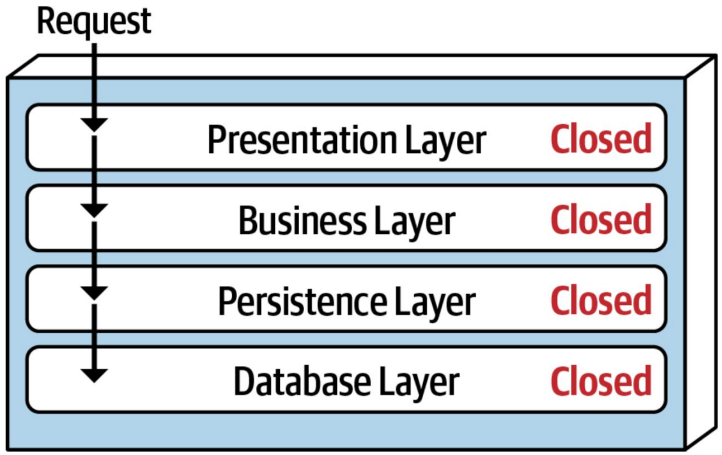
1. Architectural Patterns

1. Flow of Control



1.1. Layer Architecture

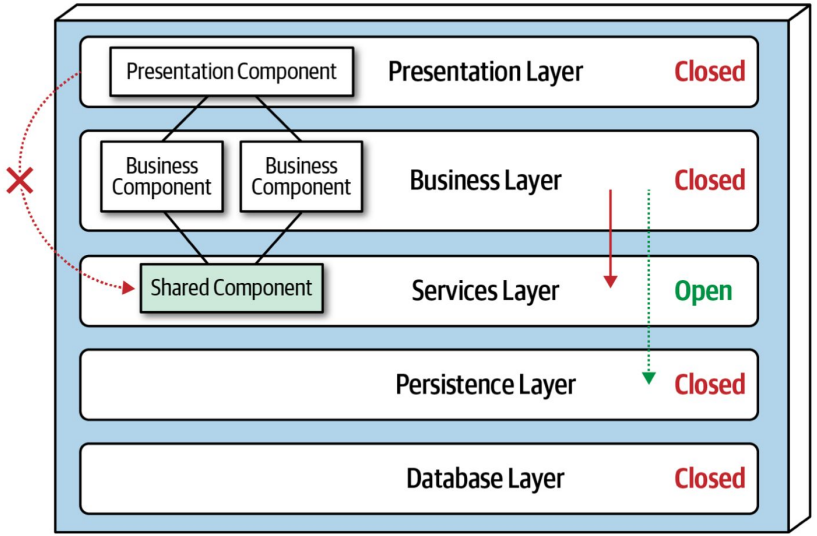
- Software architecture contains of several **separate horizontal layers** that function together as a single unit of software.
- No predefined number of layers
- **Closed: the request cannot skip any layer**
- Layers of isolation:
  - Tell what belongs to which layers and how they works as a single unit
  - Layers can be modified and the change won’t affect other layers



1.1. Layer Architecture

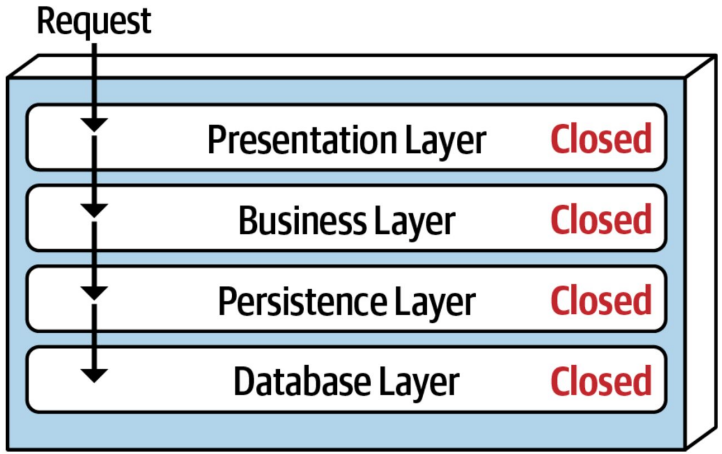
Problem: There are many share objects/components within the business layer?

Solution: Adding a new service layer (open)



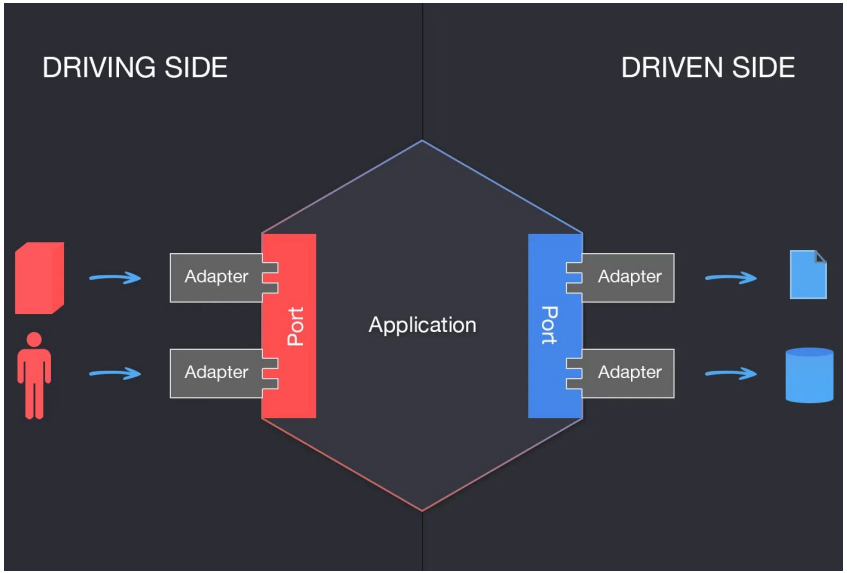
1.1. Layer Architecture

- Pros:
  - **Simple and easy to implement**
  - Testable
- Cons:
  - **Difficult to scale**
  - **Interdependence between layers**



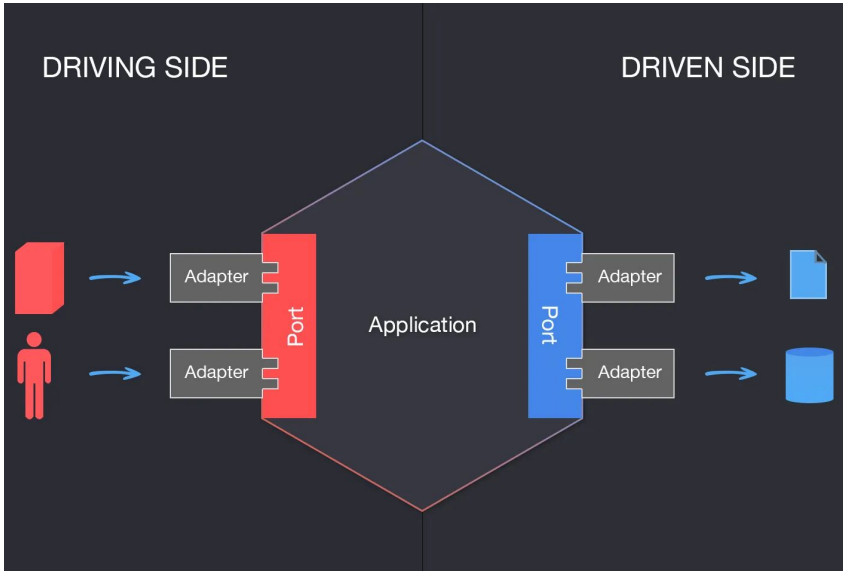
1.2. Hexagonal Architecture

- Idea: Put inputs and outputs at the edges to create **loosely coupled application components**
- The Hexagonal Architecture is an architectural pattern that allows input by users or external systems to arrive into the application logic at a Port via an Adapter
  - **Port: interface**
  - **Adapter: implementation** of the that interface
  - Creating a factory for adapters for a given service



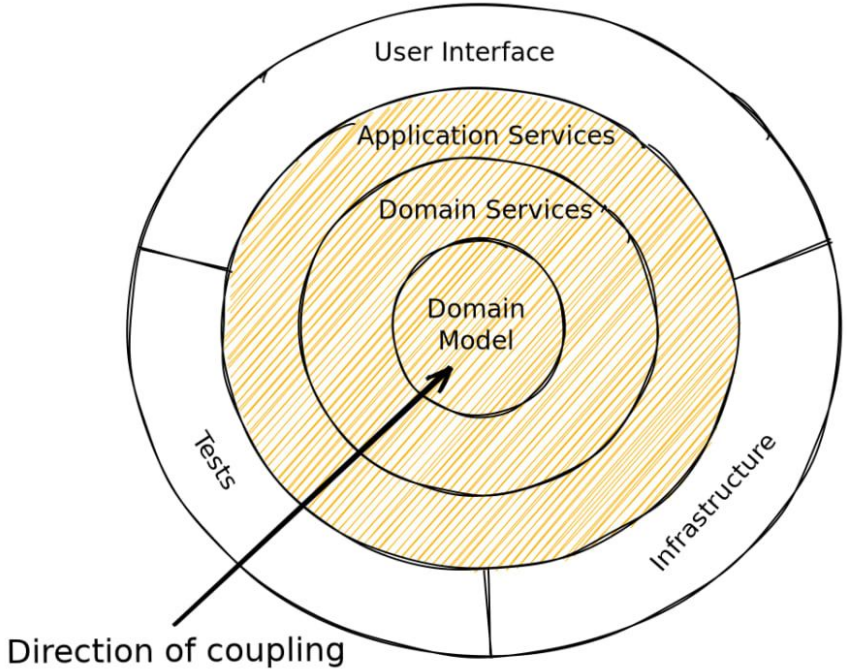
1.2. Hexagonal Architecture

- Pros:
  - Loose Coupling
  - The core logic can be **tested independent** of outside services.
  - **Flexibility**. Easy to change adapter (external services)
- Cons:
  - Learning Curve



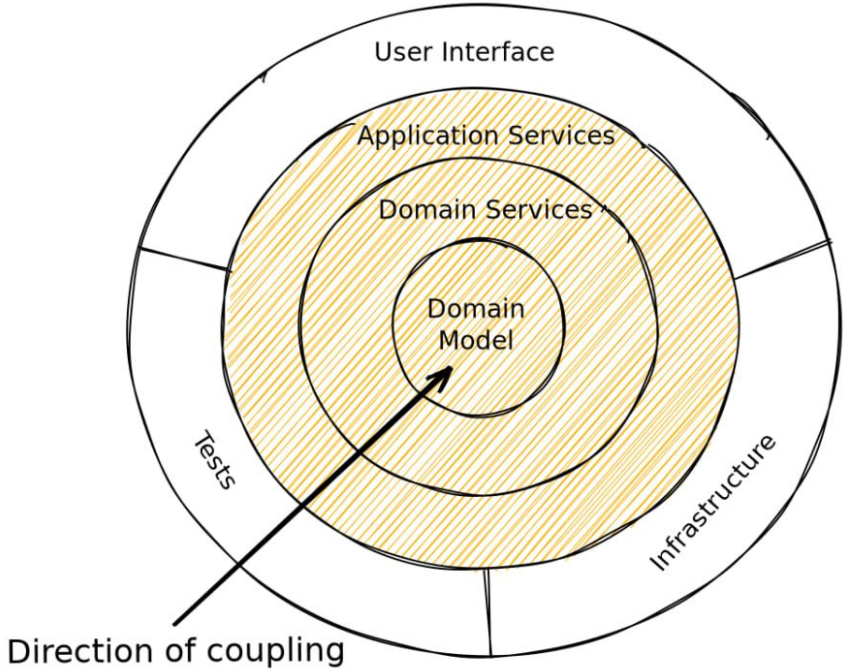
1.3. Onion Architecture

- Evolution of layer architecture.
  Solving 2 problems of layer architecture:
  - **Interdependence between layers**
  - **Coupling to various infrastructure**
- The database (infrastructure) is not the center. It is external. **Business Domain is the center**
- The Dependency Inversion
  - **Nothing in an inner layer can know anything at all about something in an outer layer.**
  - Isolation between layers. **Changes in a layer do not affect to other layers.**



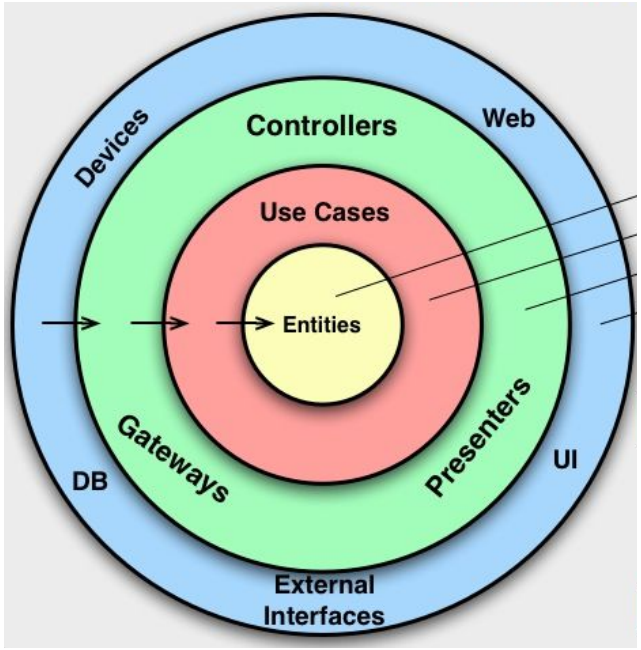
1.3. Onion Architecture

- Pros:
  - Focus on the Domain
  - **Loose Coupling**
  - Testability
- Cons:
  - Complexity
  - **Learning Curve**

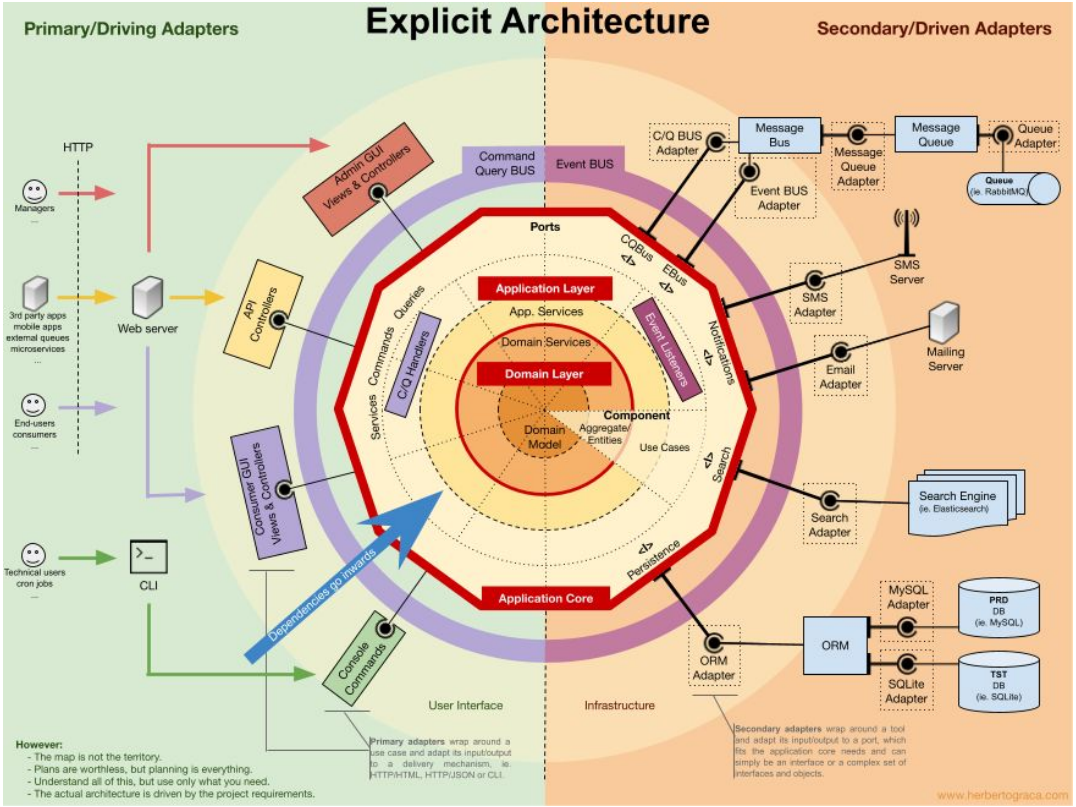


1.4. Clean Architecture

- Nothing new, just repack:
  - Hexagonal Architecture
  - Onion Architecture
  - …
- Note:
  - **Never violate Dependency Inversion**
  - No predefined number of layers

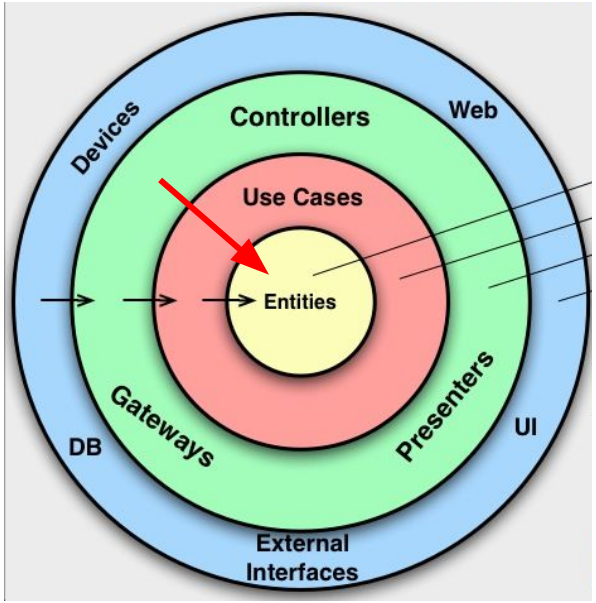


1.4. Clean Architecture



1.4. Crossing Boundary

- Problem:
  - Controller → Entity
  - Controller returns Entity to client
- Solution:
  - Use **DTO** (Data Transfer Object) in Domain Layer

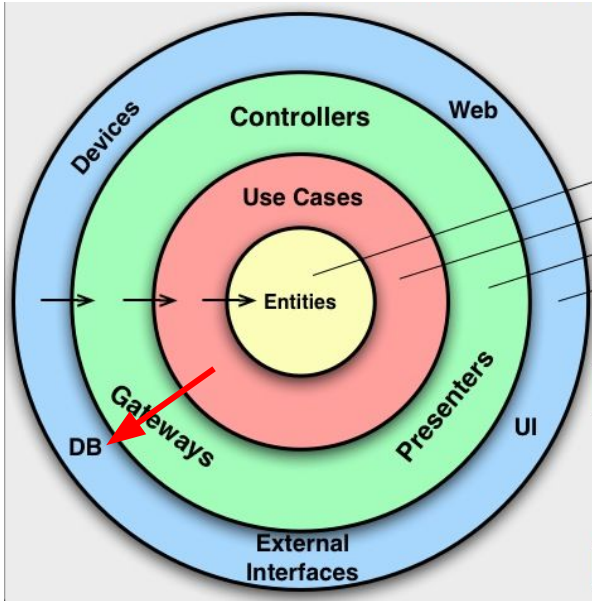


1.4. Crossing Boundary

- Problem:
  - Domain Layer needs to save entity into DB Layer
  - **This call must not be direct because that would violate The Dependency Inversion**

Solution:

- **Declare Repository Interface** in the inner Repository layer (that wraps entity layer)
- Have the **implementation of Repository Interface in the outer layer**



1.4. Clean Architecture

- Pros
  - Independent on frameworks, DB, external
  - Maintainable, Enhanced Collaboration
  - Testable
  - Flexible
  - Scalable
- Cons
  - Take time to set up a clean architecture
  - **Violating the rules at some points by using frameworks**
  - **Complexity → Learning curve, do it wrong**

- Apply it if:
  - Apps carry a lot of business logic
  - Large, long-live projects, large team size

- Do not apply it if:
  - Small project, small team (1-3)
  - Tools, core lib
    (having no / a few of business logic)

1.5. Functional Architecture

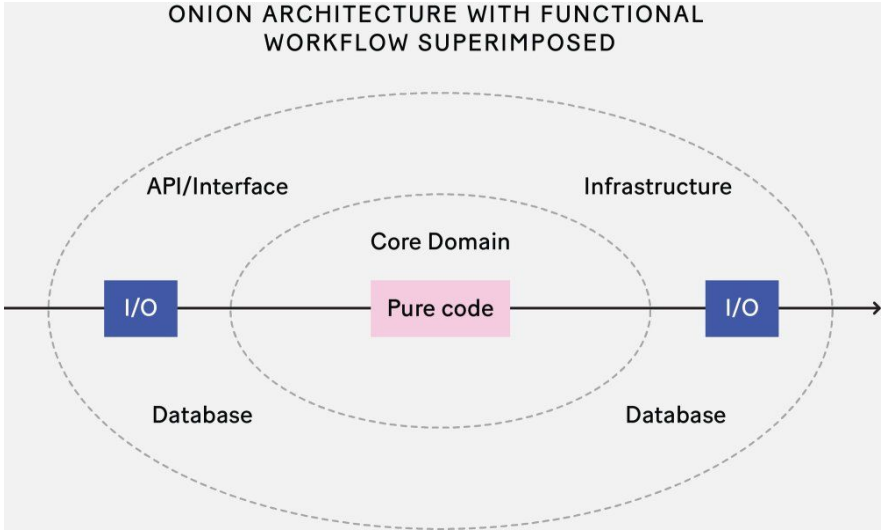
Functional Programming

Pure function: f(x) → y

- **A given input always results in the same output (Deterministic)**
- **No side effects (Mutation or I/O)**

Where to call I/O?

- Core domain: pure business logic
- External dependencies are one-way only and I/O is kept **at the edges**



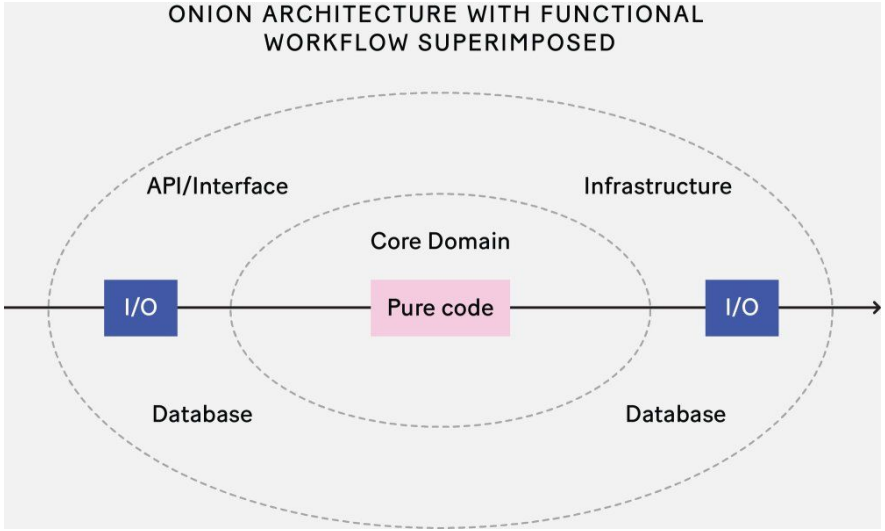
1.5. Functional Architecture

Pros:

- Distinction between unit testing and integration testing
  - Unit testing for domain layer
  - Integration testing for application layer
- **Isolation of business domain from infrastructure**

Cons:

- Transforming imperative or object-oriented to functional programming takes time
- **Learning Curve → Limited Industry Adoption**



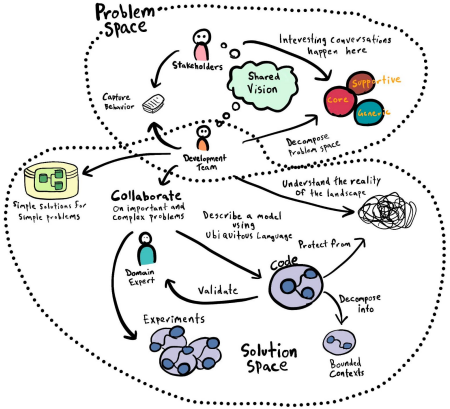
2. Project Structure

How to define/divide domains?

3. Domain Driven Design

3.1. Introduction

- Domain-Driven Design is a software design approach focusing on modeling software to match **a domain, business problems, and a constantly evolving model**, leaving aside irrelevant details like programming languages, infrastructure technologies, etc…
- Under domain-driven design, the structure and language of software **code (class names, class methods, class variables) should match the business domain**
- It is also a working methodology



3.2. Bounded Context

- A bounded context is **a grouping of related functionality, components and concepts.**
- Within the context, we share a common language
  - Example 1: a “letter” could mean 2 very different things
    - Post office: a message written on paper
    - Education: a character
  - Example 2: credit could have 2 meanings
    - Lending: the ability of a customer to obtain goods or services before payment, based on the trust that payment will be made in the future.
    - Payment: the account receiving money
- **Bounded contexts can continue operating independently**

3.2. Collaborative Modeling

- **Developers collaborate with domain experts** to refine the Domain Model
- Force developers understand business problem
- To collaborate effectively between business and technical teams
  → Ubiquitous Language
- **Ubiquitous Language will be embedded in the code.**

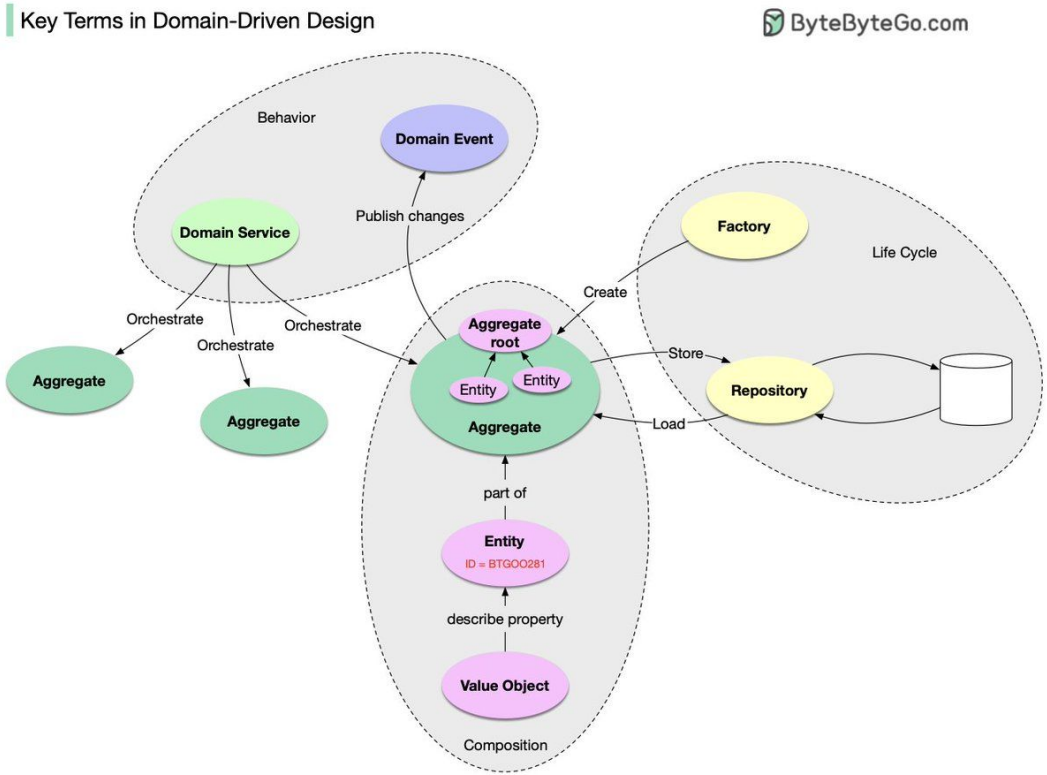
3.3.1. Tactical Design

- **Entity**:
  - Entity is an object that has **ID and lifecycle**
  - Entity is not defined solely by their attributes
  - For example: User, Flight, Booking, …
- **Value Object:**
  - Object is only identifiable by its value
  - Value objects describe **characteristics, dont have ID and immutable.**
  - Value Objects are attributes of, and can be shared by multiple entities
  - For example:
    - Address: Street, Postal Code
    - Money: Currency, Amount
    - Configuration, Enum, …

3.3.2. Tactical Design

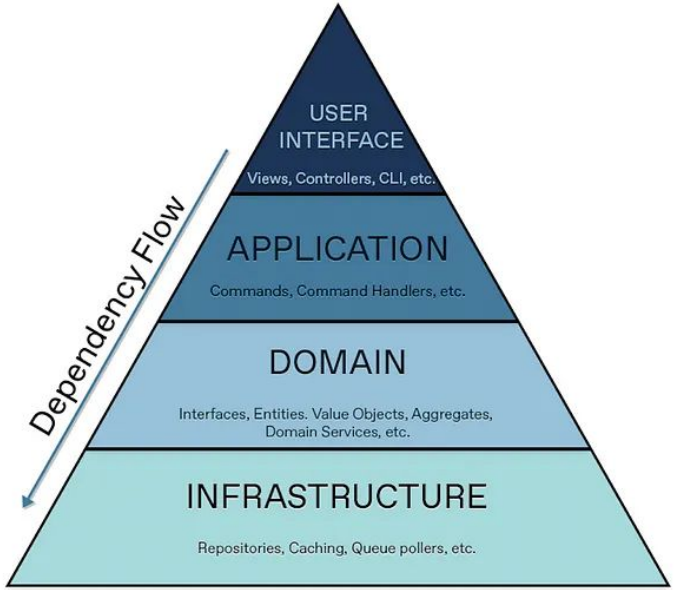
- **Aggregate**
  - An **aggregation of Entities and Value Objects** to restrict the violation of business invariants
  - Requires transactional consistency
  - Each Aggregate has an Aggregate Root that faces outwards and controls all access to the objects inside the boundary
  - Example: User, Booking, …
- **Service**
  - Service should **be stateless**
  - Example: BookingService
- **Repository**
  - All repository interface definitions should reside in the Domain Layer, but their concrete implementations belong in the Infrastructure Layer.
  - Example: BookingRepository in Domain layer, BookingRepositoryImpl in Infrastructure layer

3.3.2. Tactical Design



3.4. Layers

- DDD proposes a Layered Architecture, separating domain logic from all other functionality will reduce the leakage and will avoid confusion in a large and complex system.
    - **User Interface Layer**
    - **Application Layer**: an orchestrator of domain work, it does not know domain rules
    - **Domain Layer**: holds the business logic, rules and Domain Model
    - **Infrastructure Layer**: implements all the technical functionalities the application needs. For example: utility, persistence, messaging, …



Recap

- Isolation of layers
- Dependency Inversion vs Dependency Injection
- Developers understand business problem → code match business domain

References

- https://blog.cleancoder.com/uncle-bob/2012/08/13/the-clean-architecture.html
- https://increment.com/software-architecture/primer-on-functional-architecture/
- https://herbertograca.com/2017/11/16/explicit-architecture-01-ddd-hexagonal-onion-clean-cqrs-how-i-put-it-all-together
- https://beyondxscratch.com/2020/08/23/hexagonal-architecture-example-digging-a-spring-boot-implementation/
- https://medium.com/ssense-tech/hexagonal-architecture-there-are-always-two-sides-to-every-story-bc0780ed7d9c
- https://medium.com/kayvan-kaseb/the-layered-architecture-pattern-in-software-architecture-324922d381ad
- https://netflixtechblog.com/ready-for-changes-with-hexagonal-architecture-b315ec967749
- DDD:
  - https://medium.com/ssense-tech/domain-driven-design-everything-you-always-wanted-to-know-about-it-but-were-afraid-to-ask-a85e7b74497a
  - https://medium.com/raa-labs/part-1-domain-driven-design-like-a-pro-f9e78d081f10
  - https://medium.com/tacta/a-decade-of-ddd-cqrs-and-event-sourcing-74edc8211039
  - https://github.com/heynickc/awesome-ddd
  - https://www.youtube.com/watch?v=fO2T5tRu3DE&list=PLYpjLpq5ZDGtR5nMKGDCa031hx1jVuHXn

Homework

- Create a codebase
  - Apply Clean Architecture + DDD
  - Use case: Flight Booking
  - Implement in high-level
    - Create packages, classes only
    - Dont code

Thank you 🙏