

Design Principles

aka Object Oriented Programming

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Goal

- Become vaguely familiar with these principles.
- Have a starting off point for further research.

Why?

- Allow change (of system capacities) without redesign.
- Allow reuse in other applications.

Encapsulate what varies.

- Encapsulate ...
 - Restrict outside access to a thing's parts.
 - Bundle operations with the things they use.
- ... what varies.
 - This refers to changes to source code.
 - Source code changes due to changing requirements.
 - Requirements change for a lots of reasons.
 - E.g. A change in government may cause a change in tax law.
- Restrict outside access to parts of the source code that might change due to changing requirements.
- “what [do] you want to be *able* to change without redesign?”
(Gamma et al, 1977)

Program to interfaces not to implementations.

- an interface says only what requests it will receive
- an implementation says how it will handle those requests
- programming to interfaces helps because it
 - lets us easily change an implementation, even at runtime
 - allows applications to send the same request to different classes

Depend on abstractions not on concrete classes.

- interfaces and abstractions are similar: neither can exist
- concrete classes can exist (i.e. can become objects)
- to depend on something means a direct reference to it
- The Dependency Inversion Principle (Martin, 1996)
 - Traditionally, high-level modules depend on low-level modules:
 - Higher \rightarrow Middle \rightarrow Lower \rightarrow ...
 - Dependency Inversion inverts that:
 - Higher \rightarrow Abstraction \leftarrow Middle \rightarrow Abstraction \leftarrow Lower ...
- When layering, higher-levels define the abstractions
- and lower-levels implement the abstractions.
- Why? Enable reuse of higher-level modules.

Only talk to your friends.

- The Law of Demeter (Holland, 1987)
- aka The Principle of Least Knowledge
- Why? Promotes loose coupling via encapsulation.
- “Only talk to your friends”
- “Only use one dot”
 - More than one dot is cause for reflection;
 - it is not necessarily a violation of the LoD.
 - E.g. fluent interfaces use many dots.

A class should have only one reason to change.

- The Single Responsibility Principle (Martin, 2003)
- “A class should have only one reason to change”
 - Recall from “encapsulate what varies.”
 - This refers to changes to source code.
 - Source code changes due to changing requirements.
- Why?
 - (Re)use feature X without bringing feature A-Z.
 - Change feature X without breaking/recompiling what depends on feature A-Z.

Don't call us, we'll call you.

- "Hollywood Principle" (Sweet, 1983)
- "Inversion of Control" (Johnson and Foote, 1988)
 - Dependency injection is a type of Inversion of Control
 - IoC containers are a type of Dependency Injection
- Dependency Inversion - who owns the abstraction?
- Inversion of Control - when do things happen?
- "coordinating and sequencing application activity"
- "makes a framework different from a library":
 - library: "a set of functions you can call"
 - framework: "insert your behavior into various places"
- How? subclassing, implementing interfaces, binding/events

Classes should be open to extension and closed for modification.

- The Open-Closed Principle
- Once it is shipped, the source code is sacrosanct.
- Rather than change the source code and risk breaking it,
- extend the source code via inheritance or wrapping.
- E.g. the Decorator Pattern (Gamma et al, 1977)

Favour composition over inheritance.

- Composition means a has-a relationship.
 - It is often more semantically natural.
 - It lets us swap implementations at runtime.
- Inheritance means an is-a relationship.
 - Tall class hierarchies are brittle.
 - Changing an implementation is limited to compile time.
 - It is harder to do correctly.
- The Liskov Substitution Principle (Liskov and Wing, 1994)
 - A consumer that is expecting A,
 - should have no surprises on receiving a child of A.
 - Compilers do not help: this is a semantic syntactic constraint.
 - e.g. class Hemlock should probably not inherit class Vegetable.

Strive for loosely coupled designs among objects that interact.

- This is the summary statement for all the principles.
- When loosely coupled, we can ...
- ... change X without needing to change Y, and
- ... use X without needing to bring along Y.