Object Oriented Programming – Design

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Outline

History & Definitions

- Developed slowly from the 1950s – 1960s.
- Simula (1962) is largely regarded as the first true object oriented language.
- OOP Rose to prominence in the 1980s – 1990s with languages such as C++, Objective C, & Java
- **Object Oriented Programming** – A design paradigm where we decompose a problem into a set of objects which work together to solve a problem.
- **Object** – An entity with state (attributes) and behavior (methods).
- **Class** – A set of objects with the same attributes and methods.

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Basic Principles of Object Oriented Programming

1. **Encapsulation/Data hiding** – Access to attributes is controlled so objects maintain a valid state at all times.
2. **Abstraction** – Objects act as a "black box", and their use is separated from their implementation. (We neither know nor care how the object works!)
3. **Inheritance** – Classes can be related in a hierarchy of "is-a" relationships. For example: "A squirrel is a mammal."
4. **Polymorphism** – An object can simultaneously belong to multiple classes, yet still act as itself. For example, if we know how to find the volume of a sphere, we can also find the volume of a basketball.

Design Goals

1. **High Cohesion** – Each object should have a well defined purpose for existing. No swiss army knives allowed!
2. **Loose Coupling** – Objects can use each other, but all code should depend upon only the public facing interface of an object. Keep the internals of objects on a strict “need to know” basis.

The Object Oriented Analysis and Design Process

1. Reason about the problem at hand, and identify objects from sample instances of the problem.
2. Identify attributes within each object.
3. Identify behaviors for each object.
4. Group objects into classes based on their attributes and methods.
5. List classes.
6. Define class attributes.
7. Define class methods & constructors.
8. Identify relationships among classes.

UML – Unified Modeling Language

- **UML** is a graphical design language which allows us to plan objects and classes in a programming language-agnostic way.
- There are many UML diagrams; the most common being:
  - Use Case Diagram
  - Object Diagram
  - Class Diagram
  - Sequence Diagram
- UML was developed by Rational Software from 1994-1996.
- UML became an ISO standard in 2005.

UML – Object Diagram

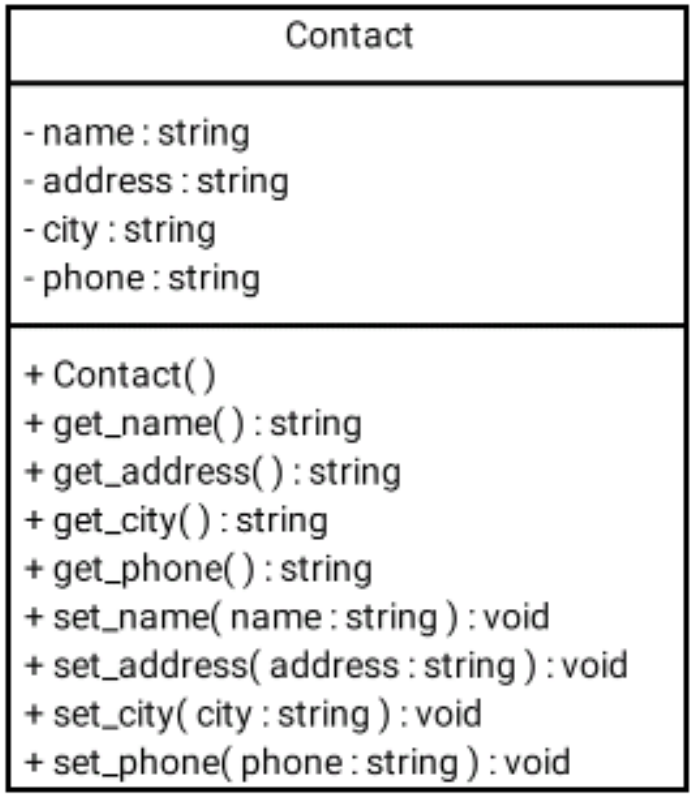
- An **Object Diagram** shows the state of various objects at some point in the program.
- Attributes and values are specified in the format:
  `name = value`
- Names of objects are specified in the format:
  `object : class`
- Lines between objects show that they are contained within each other.

UML – Class Diagram

- A class diagram shows classes and attributes.
- Attributes are listed in the format:

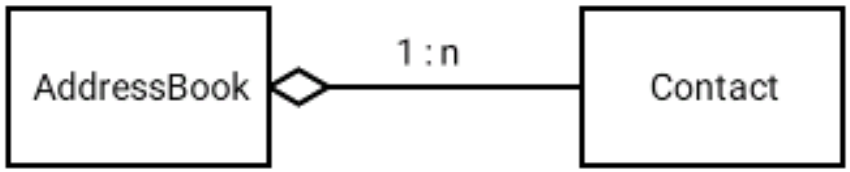
  `name: type`
- Methods are listed as:

  `name(p1:type, p2:type, ...) : type`
- Access modifiers are specified:
  - `+` public
  - `-` private
  - `#` protected



Class Relationships – Aggregation

- Aggregation is a basic “has-a” relationship.
- Objects of an aggregate class contain objects from another class.
- The objects are created and then given to the aggregate class.
- This is represented with an open diamond on the side of the aggregate.



Class Relationships – Composition

- Composition is a stronger “has-a” relationship.
- Objects of a composite class contain objects from another class.
- The objects are created by the composite class.
- Composite objects fully own their parts.
- This is represented with a filled diamond on the side of the aggregate.

An Intuitive Approach

1. Write out several scenarios for the use of your program. (This is a use case).
2. Search for parts of speech:
   - **Nouns** - Objects
   - **Adjectives** - Attributes
   - **Verbs** - Methods
3. Draw out objects.
4. Look for container objects.
5. Rework things until it is flexible enough.
6. Design your classes from the new set of objects.
7. Identify composition and aggregation relationships.

Pattern: Accessors and Mutators

- One common design pattern is the use of accessors and mutators.
- Recall that all attributes should be private!
- An **accessors** is a function which returns the current value of an attribute.
- A **mutator** is a function which sets the value of an attribute.
- Accessors are typically named `get_<attribute>`.
- mutators are typically named `set_<attribute>`.
- Why go to this level of trouble?
- This allows us to control/validate values and also make some attributes hidden and/or read only!

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Class Activity: Design an Address Book

- What sorts of thing do we want to do with an address book?
- What do the contact records look like?
- What do these things do with each other?
- Construct:
  - Object Diagram
  - Class Diagram
- What relationships exist between the classes?

The Stock Program (Program 5)

- Play with the stock program solution and read the program specification.
- Draw an object diagram.
- Draw a class diagram.
- Identify relationships.