# Designing classes

How to write classes in a way that they are easily understandable, maintainable and reusable

## Main concepts to be covered

- Responsibility-driven design
- Coupling
- Cohesion
- Refactoring

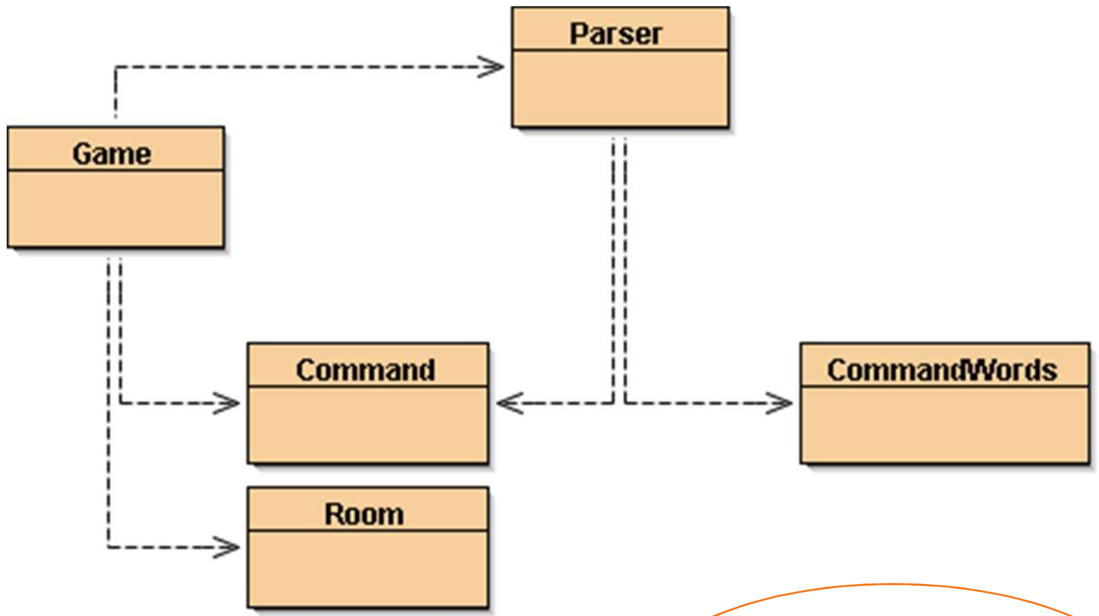
## Software changes

- Software is not like a novel that is written once and then remains unchanged.
- Software is extended, corrected, maintained, ported, adapted, …
- The work is done by different people over time (often decades).

## Change or die

- There are only two options for software:
  - Either it is continuously maintained
  - or it dies.
- Software that cannot be maintained will be thrown away.

# World of Zuul



**Explore**
**`zuul-bad`**

## The Zuul Classes

- **`Game`**: The starting point and main control loop.
- **Room**: A room in the game.
- **Parser**: Reads user input.
- **Command:** A user command.
- **CommandWords**: Recognized user commands.

## Code and design quality

- If we are to be critical of code quality, we need evaluation criteria.
- Two important concepts for assessing the quality of code are:
  - Coupling
  - Cohesion

## Coupling

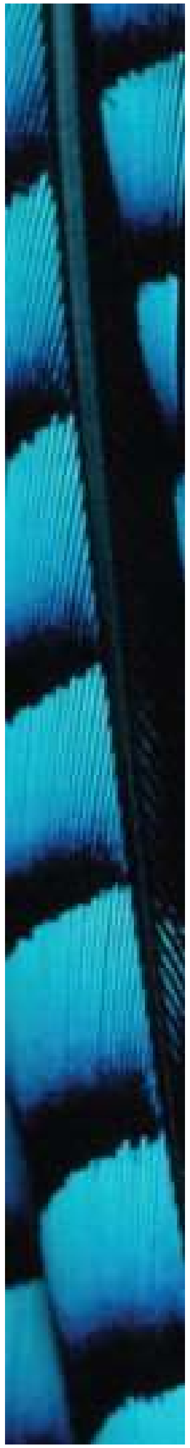
- Coupling refers to links between separate units of a program.
- If two classes depend closely on many details of each other, we say they are *tightly coupled*.
- We aim for *loose coupling*.
- A class diagram provides (limited) hints at the degree of coupling.

## Cohesion

- Cohesion refers to the number and diversity of tasks that a single unit is responsible for.
- If each unit is responsible for one single logical task, we say it has *high cohesion*.
- We aim for high cohesion.
- ‘Unit’ applies to classes, methods and modules (packages).

## An example to test quality

- Add two new directions to the 'World of Zuul':
    - “up”
    - “down”
- What do you need to change to do this?
- How easy are the changes to apply thoroughly?



# Designing classes

Coupling, cohesion, and responsibility-driven design

## Coupling (reprise)

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- We aim for *loose coupling*.
- A class diagram provides (limited) hints at the degree of coupling.

## Loose coupling

- We aim for loose coupling.
- Loose coupling makes it possible to:
  - understand one class without reading others;
  - change one class with little or no effect on other classes.
- Thus: loose coupling increases maintainability.

## Tight coupling

- We try to avoid tight coupling.
- Changes to one class bring a cascade of changes to other classes.
- Classes are harder to understand in isolation.
- Flow of control between objects of different classes is complex.

## Cohesion (reprise)

- Cohesion refers to the number and diversity of tasks that a single unit is responsible for.
- If each unit is responsible for one single logical task, we say it has *high cohesion*.
- We aim for high cohesion.
- ‘Unit’ applies to classes, methods and modules (packages).

## High cohesion

- We aim for high cohesion.
- High cohesion makes it easier to:
  - understand what a class or method does;
  - use descriptive names for variables, methods and classes;
  - reuse classes and methods.

## Loose cohesion

- We aim to avoid loosely cohesive classes and methods.
- Methods perform multiple tasks.
- Classes have no clear identity.

## Cohesion applied at different levels

- Class level:
  - Classes should represent one single, well defined entity.
- Method level:
  - A method should be responsible for one and only one well defined task.

## Code duplication

- Code duplication
  - is an indicator of bad design,
  - makes maintenance harder,
  - can lead to introduction of errors during maintenance.

## Responsibility-driven design

- Question: where should we add a new method (which class)?
- Each class should be responsible for manipulating its own data.
- The class that owns the data should be responsible for processing it.
- RDD leads to low coupling.

## Localizing change

- One aim of reducing coupling and responsibility-driven design is to localize change.
- When a change is needed, as few classes as possible should be affected.

## Thinking ahead

- When designing a class, we try to think what changes are likely to be made in the future.
- We aim to make those changes easy.

## Refactoring

- When classes are maintained, often code is added.
- Classes and methods tend to become longer.
- Every now and then, classes and methods should be *refactored* to maintain cohesion and low coupling.

## Refactoring and testing

- When refactoring code, separate the refactoring from making other changes.
- First do the refactoring only, without changing the functionality.
- Test before and after refactoring to ensure that nothing was broken.

## Design questions

- Common questions:
  - How long should a class be?
  - How long should a method be?

- These can now be answered in terms of cohesion and coupling.

## Design guidelines

- A method is too long if it does more then one logical task.
- A class is too complex if it represents more than one logical entity.

- Note: these are *guidelines* - they still leave much open to the designer.

## Enumerated Types

- A language feature.
- Uses **`enum`** instead of **`class`** to introduce a type name.
- Their simplest use is to define a set of significant names.
  - Alternative to static **`int`** constants.
  - When the constants' values would be arbitrary.

## A basic enumerated type

```
public enum CommandWord
{
    // A value for each command word,
    // plus one for unrecognised commands.
    GO, QUIT, HELP, UNKNOWN;
}
```

- Each name represents an object of the enum type, e.g., `CommandWord.HELP`.
- Enum objects are not created directly.
- Enum definitions can also have fields, constructors and methods.

## Review

- Programs are continuously changed.
- It is important to make this change possible.
- Quality of code requires much more than just performing correct at one time.
- Code must be understandable and maintainable.

## Review

- Good quality code avoids duplication, displays high cohesion, low coupling.
- Coding style (commenting, naming, layout, etc.) is also important.
- There is a big difference in the amount of work required to change poorly structured and well structured code.