Java Cohesion and Coupling

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Introduced in 2026-04-02-refactoring[1] (Lecture, Week 6, Part 2). Practised in week10-tutorial-coupling-and-cohesion[2].

Modularization

The process of dividing a large system (a monolith) into smaller, more manageable pieces that can be worked on and tested independently before being reassembled into the final product. This raises the question everything below answers: **what if the resulting modules are highly dependent on each other?** Cutting a monolith into pieces buys nothing if every piece still has to know about every other one. The left panel of the coupling figure below shows exactly that failure: six modules tangled together with arrows in all directions.

Two measures separate a real decomposition from a nominal one: **coupling** (how much the modules depend on *each other*) and **cohesion** (how well the contents of *one* module belong together).

Coupling

The degree of interdependence between different modules, classes, or components of a system.

- **High coupling** — strong interconnections, where a change in one module can cascade through others.

[1] courses/csse2002/2026-04-02-refactoring.pdf
[2] courses/csse2002/week10-tutorial-coupling-and-cohesion.pdf

- **Low coupling** — greater independence and isolation between modules.

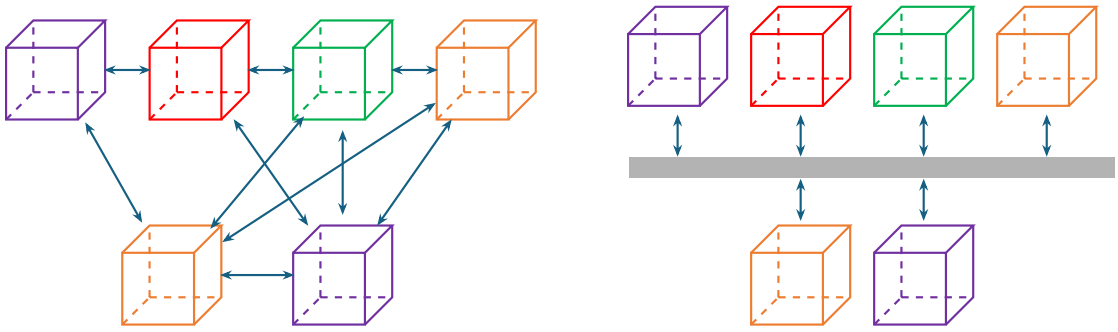


Figure 1: High versus low coupling. Left: every module talks directly to several others, so a change in any one can reach any other. Right: the same six modules each talk only to a shared interface — the grey bar — so nothing propagates further than that bar. A module is a wireframe cube, and its colour only tells the modules apart; a dependency is a teal double-headed arrow. The tangle of arrows on the left is schematic — the count is the point, not which cube joins which.

Levels of coupling (tightly → loosely coupled)

1. **Content** — one class directly manipulates another's data (e.g. public fields instead of private).
2. **Common** — sharing access to the same global data/variables.
3. **External** — sharing something imposed by an external source, e.g. a data format.
4. **Control** — one class controls what happens in another by passing it information/instructions.
5. **Stamp** — sharing a data structure, but each class only needs access to a select part of it.
6. **Data** — sharing data through means such as parameter passing in methods.
7. **None** — no dependency at all (most loosely coupled).

The list is ordered, and the order is the assessable part: the same two classes can be joined in any of these ways, and the further down the list you can get, the less a change in one can force a change in the other.

Worked classification examples

Four snippets, each with the same question: what type of coupling do these methods have? Each answer is reasoned from the definitions above.

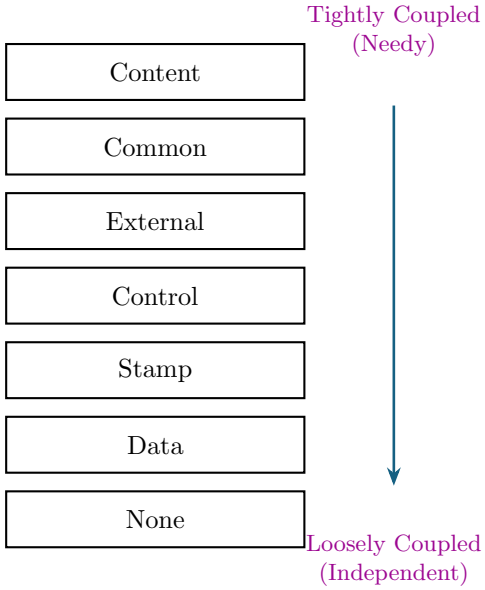


Figure 2: The coupling-levels ladder. Most tightly coupled at the top, least at the bottom, with the arrow running down from tightly coupled (needy) to loosely coupled (independent).

```
public void sinh(int x) {...}
public void cosh(int x) {...}
public void tanh(int x) {
    return sinh(x) / cosh(x);
}
```

`tanh` only interacts with `sinh`/`cosh` by passing/receiving simple parameters — **data coupling**.

```
public class R { int x, y, z; char a, b, c; }
public static void compute(R r) {
    return r.x * r.y; // only touches x and y
}
```

`compute` is handed the whole `R` object but only needs two of its six fields — **stamp coupling**.

```
public static void compute(R r) {
    return r.x * r.y * r.z / r.a + r.b + r.c; // uses every field
}
```

Here every field of `R` is actually used, so passing the whole object is fully justified — this is just **data coupling** via a composite value, not stamp coupling (contrast with the previous example, which only used part of the structure).

```
public static runReport(String name, int age, String phone, Date birth, String
 ↪  address) {...}
```

Five separate simple parameters — still **data coupling**, though a long parameter list like this is itself often a separate code smell (see java-refactoring[3]) worth considering bundling into an object.

Cohesion

The degree of interrelatedness and focus among the elements *within* a module, class, or component.

- **High cohesion** — elements are closely related and contribute collectively to one specific functionality.
- **Low cohesion** — elements are less focused, serving multiple unrelated purposes.

Asked of a class, cohesion comes down to two questions: **how well do the parts of the class (state and methods) fit together?** and **do they all contribute to a single, clear purpose?**

> High cohesion is preferable. (Low cohesion usually indicates that a class should be split.)

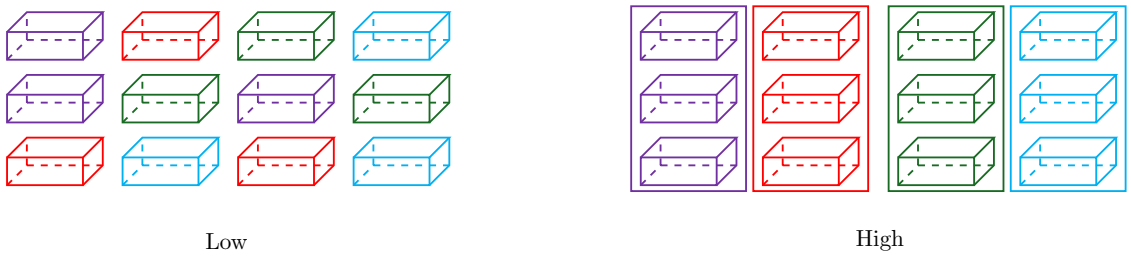


Figure 3: Low versus high cohesion. The same twelve elements in both panels: on the left the four kinds are scattered across the grid, on the right each kind is gathered into one module. Colour means kind only, and each high-cohesion group is enclosed by a rectangle in that group's own colour. This figure says nothing about coupling — it is only about what sits inside one module. The good case is again on the right.

[3] courses/csse2002/java-refactoring.pdf

Levels of cohesion (low → high)

1. **Coincidental** — elements grouped arbitrarily, with no clear relationship.
2. **Temporal** — elements grouped because they execute at the same time/phase.
3. **Procedural** — elements grouped by their involvement in a specific sequence of steps.
4. **Communicational** — elements work together to manipulate a shared data structure.
5. **Sequential** — elements organised in a linear sequence, where one's output is the next's input.
6. **Functional** — elements grouped around a single, specific functionality or task (most cohesive).

Worked example

```java
public void performTasks(int[] numbers, String text) {
    // Task 1: sum the numbers
    int sum = 0;
    for (int num : numbers) { sum += num; }
    System.out.println("Sum of numbers: " + sum);

    // Task 2: reverse the text
    StringBuilder reversedText = new StringBuilder();
    for (int i = text.length() - 1; i >= 0; i--) {
     ↪  reversedText.append(text.charAt(i)); }
    System.out.println("Reversed text: " + reversedText);
}
```

Summing numbers and reversing text share no real purpose — they're only in the same method because they happen to run one after another. This is low (coincidental, or at best temporal) cohesion, and a sign `performTasks` should be split into two focused methods.

Is this class cohesive?

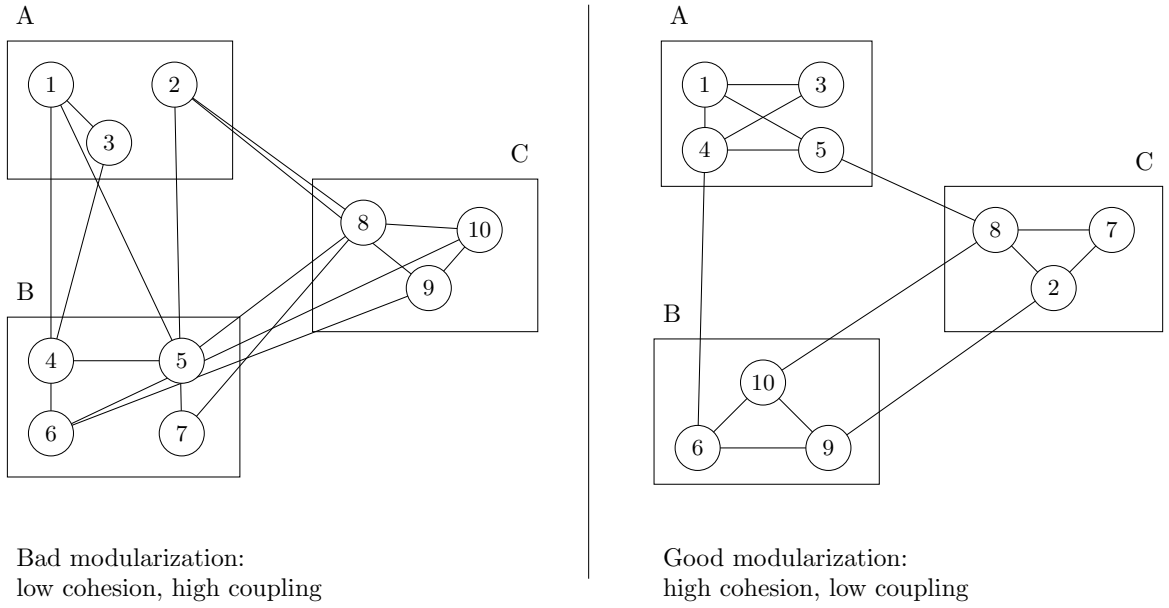
A `Car` class contains: Fuel, Steering, Speed, Route planner, Public holiday calculator.

Fuel/Steering/Speed are all core to a car's own physical behaviour, but a route planner and (especially) a public-holiday calculator are unrelated concerns bolted onto the class — this is **low cohesion**, and a sign the class is trying to do too much (a "God class"); the unrelated pieces should be split into their own classes.

Considerations

- Classes should be **highly cohesive** — a single, easily understood concept.
- Classes should have **loose coupling** to each other — this reduces overall system complexity.

Good modularization (high cohesion, low coupling) groups tightly-interconnected elements together into the same module and minimises connections *between* modules, unlike bad modularization, where connections are scattered across module boundaries with no clear grouping. The figure below makes this precise, because both panels are the *same system* — the same ten elements and the same fifteen dependencies — grouped into modules two different ways:



Bad modularization:
low cohesion, high coupling

Good modularization:
high cohesion, low coupling

Figure 4: Bad versus good modularization. Both panels draw the same ten elements and the same fifteen dependencies; only the assignment of elements to modules A, B and C differs. Left: 5 dependencies fall inside a module and 10 cross a boundary. Right: 11 fall inside and only 4 cross. Nothing was rewritten to achieve that — the code is identical, the grouping is not.

Read off the figure, the two measures are the same count seen from opposite sides: a dependency that stays inside a module is cohesion, and a dependency that leaves one is coupling. Maximising the first and minimising the second is one decision — *where to draw the boundaries* — which is why the goal is always stated as a pair.