CSE 403

Software Engineering

Build systems

This week

- **Build systems**
  - What is a build system?
  - Best practices
  - Gradle live demo

- Testing and Continuous Integration (CI)

- In-class exercise: Git

What does a developer do?

- Get the source code
- Install dependencies
- Compile the code
- Run static analysis
- Generate documentation
- Run tests
- Create artifacts for customers
- Ship!

Which of these tasks should be handled manually?

What does a developer do?

- Get the source code
- Install dependencies
- Compile the code
- Run static analysis
- Generate documentation
- Run tests
- Create artifacts for customers
- Ship!

Which of these tasks should be handled manually?
NONE!

How to automate these tasks?

- Get the source code
- Install dependencies
- Compile the code
- Run static analysis
- Generate documentation
- Run tests
- Create artifacts for customers
- Ship!

Orchestrate tasks with a build system!

What is a build system (build tool)?

A tool for automating software engineering **tasks**:
- Get the source code
- Install dependencies
- Compile the code
- Run static analysis
- Generate documentation
- Run tests
- Create artifacts for customers
- Ship!

Build systems: tasks

Tasks are code!

- Should be checked into version control
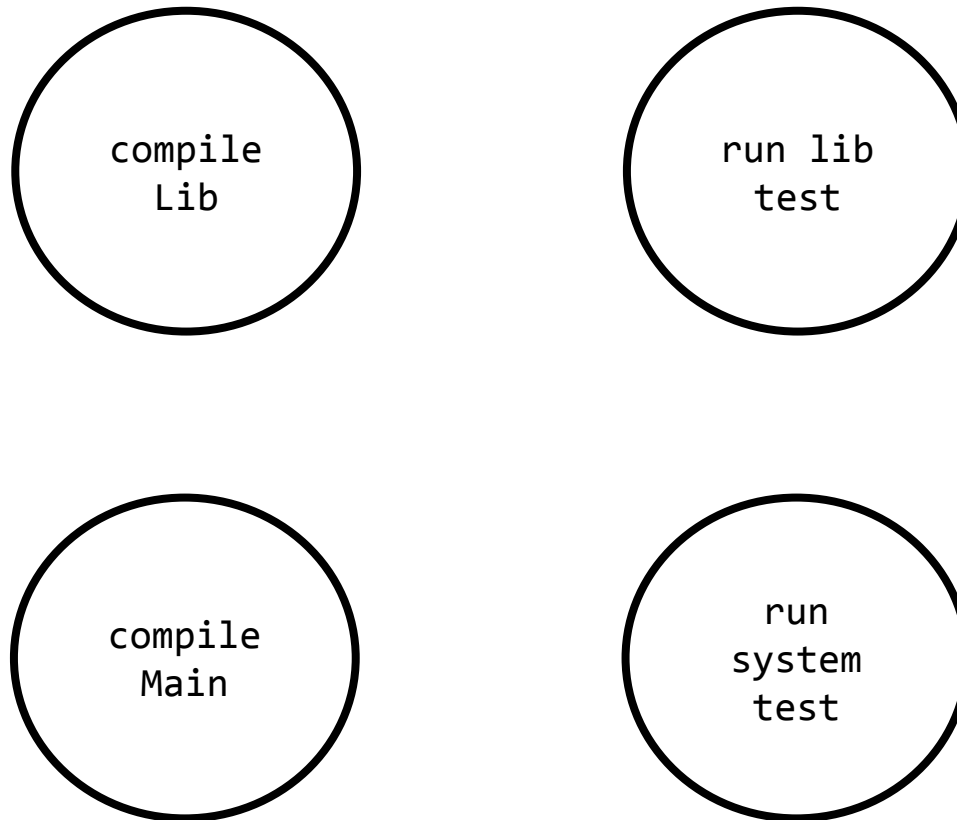- Should be code-reviewed
- Should be tested

Build systems: dependencies between tasks

Example code and corresponding tests:
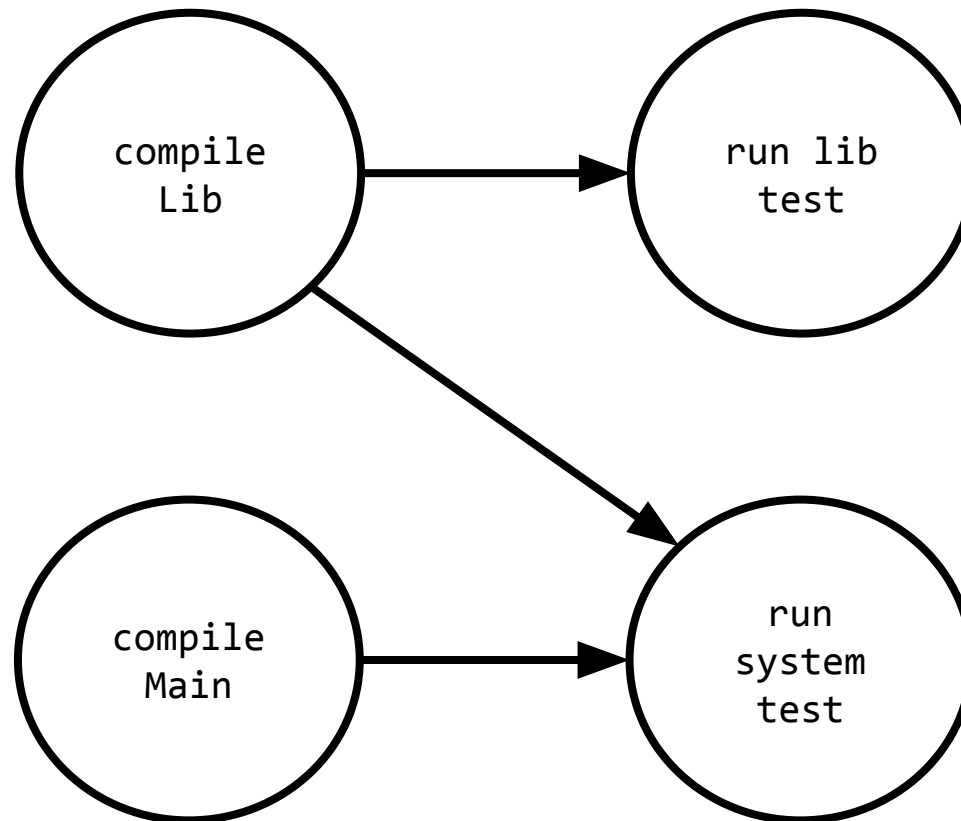
```
> ls src/

Lib.java    LibTest.java    Main.java    SystemTest.java
```
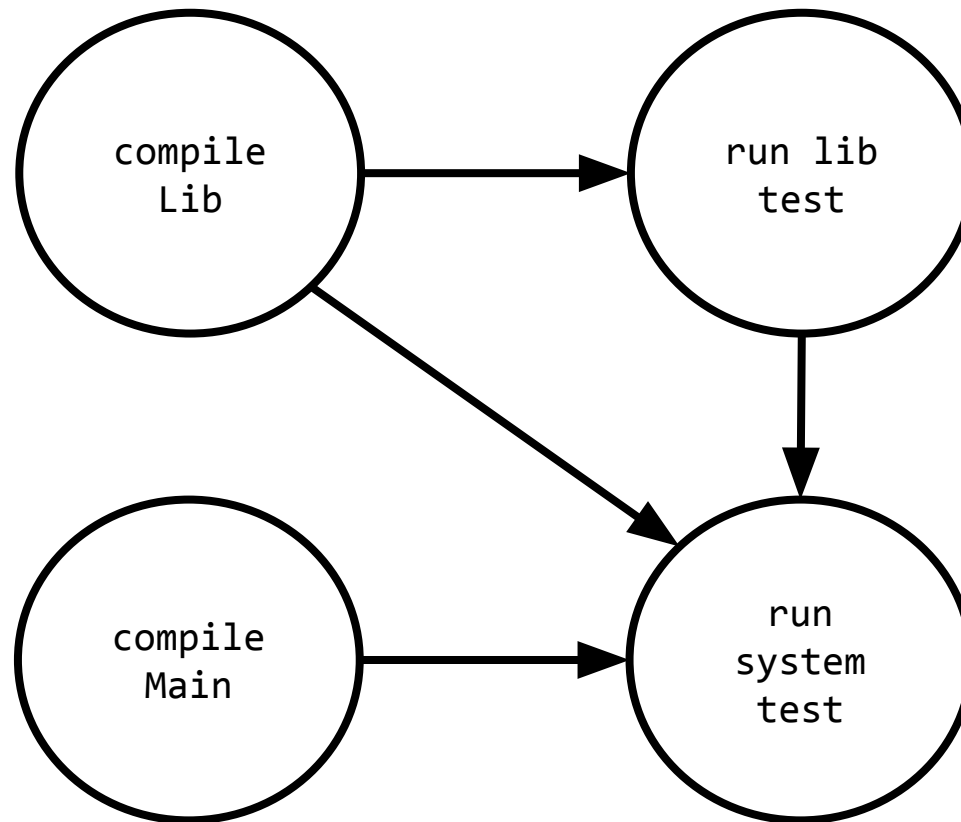
Build systems: dependencies between tasks

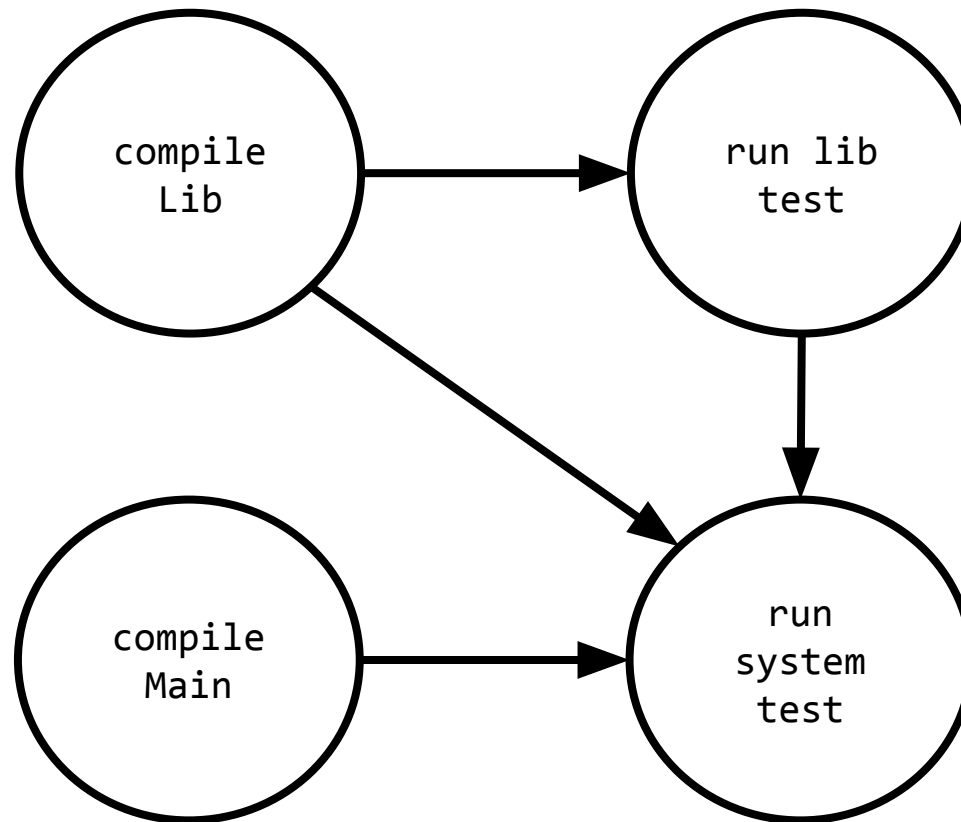What are the dependencies between these tasks?

Build systems: dependencies between tasks

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In what order should we run these tasks?

Build systems: determining task order

Large projects have thousands of tasks
- Dependencies between tasks form a directed acyclic graph.
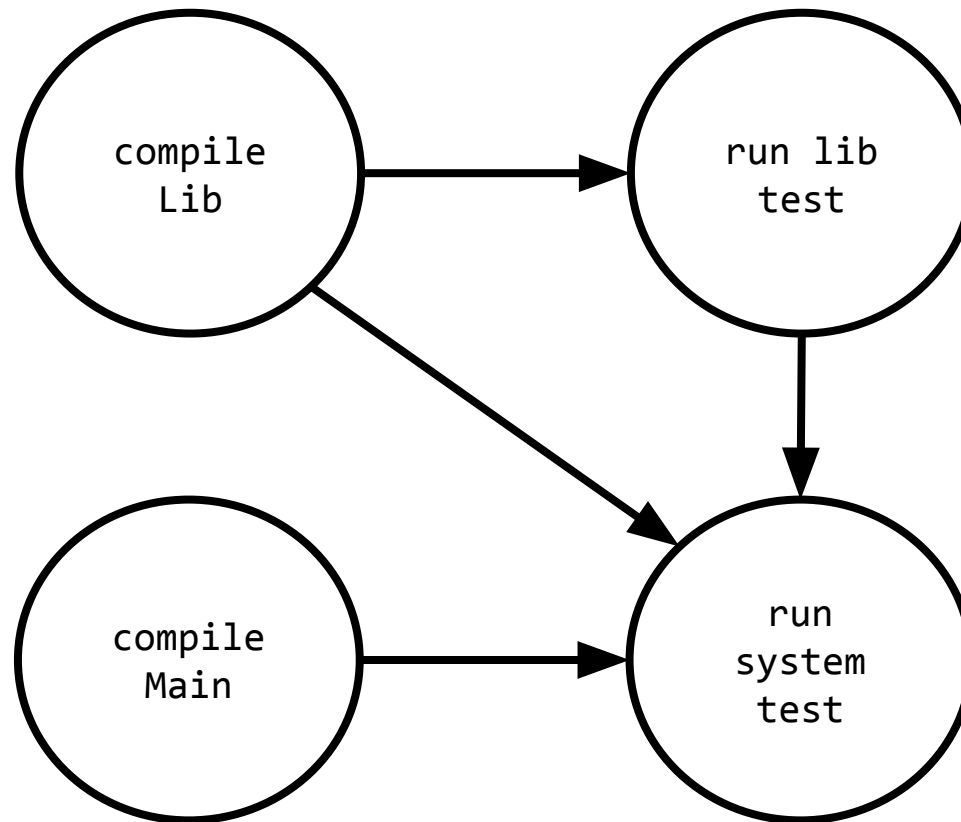
Build systems: determining task order

Large projects have thousands of tasks
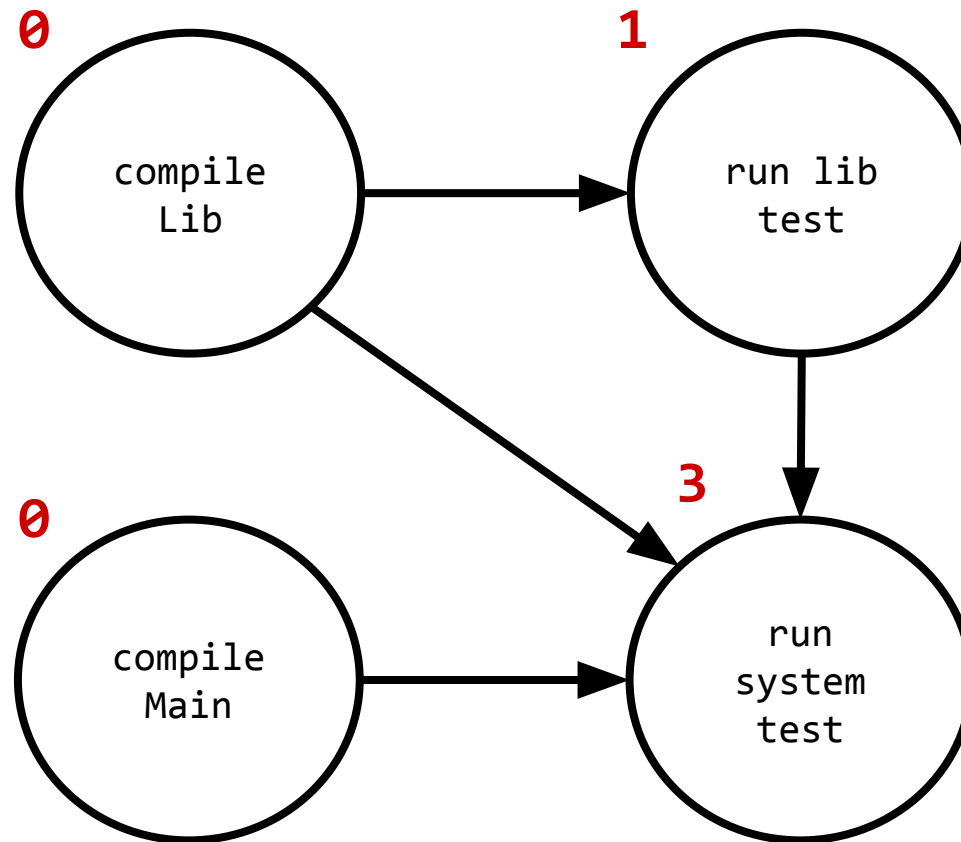- Dependencies between tasks form a directed acyclic graph.

Topological sort
- Order nodes such that all dependencies are satisfied
- **Implemented by computing indegree**
  (number of incoming edges) for each node
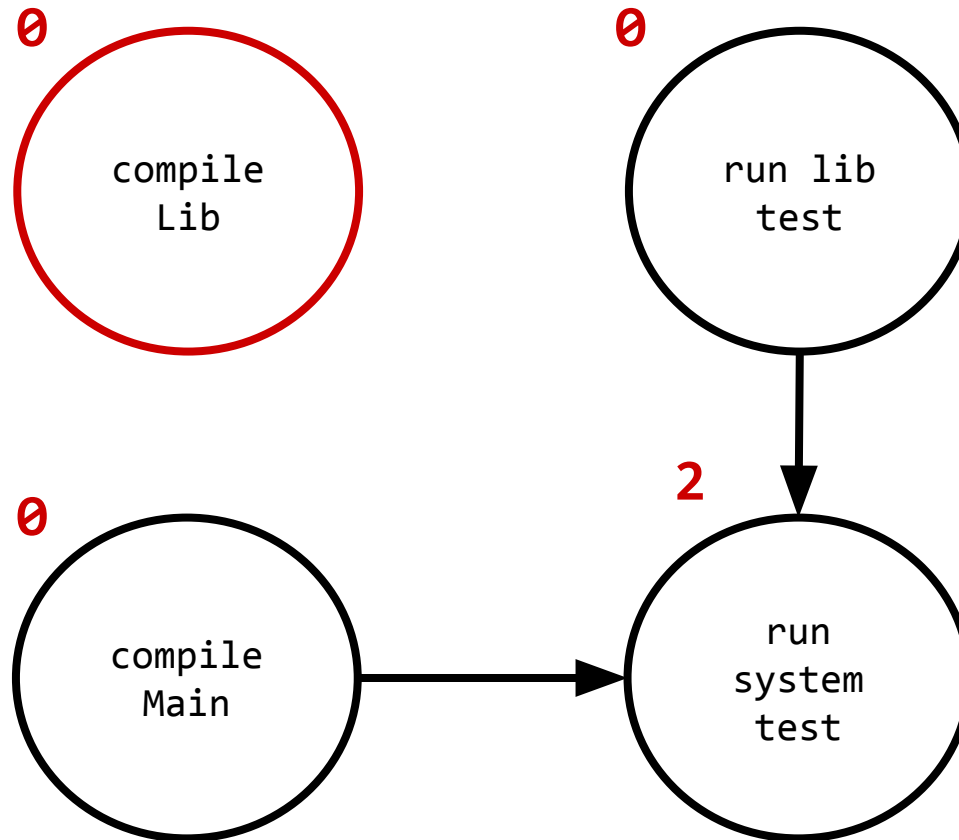
Build systems: topological sort
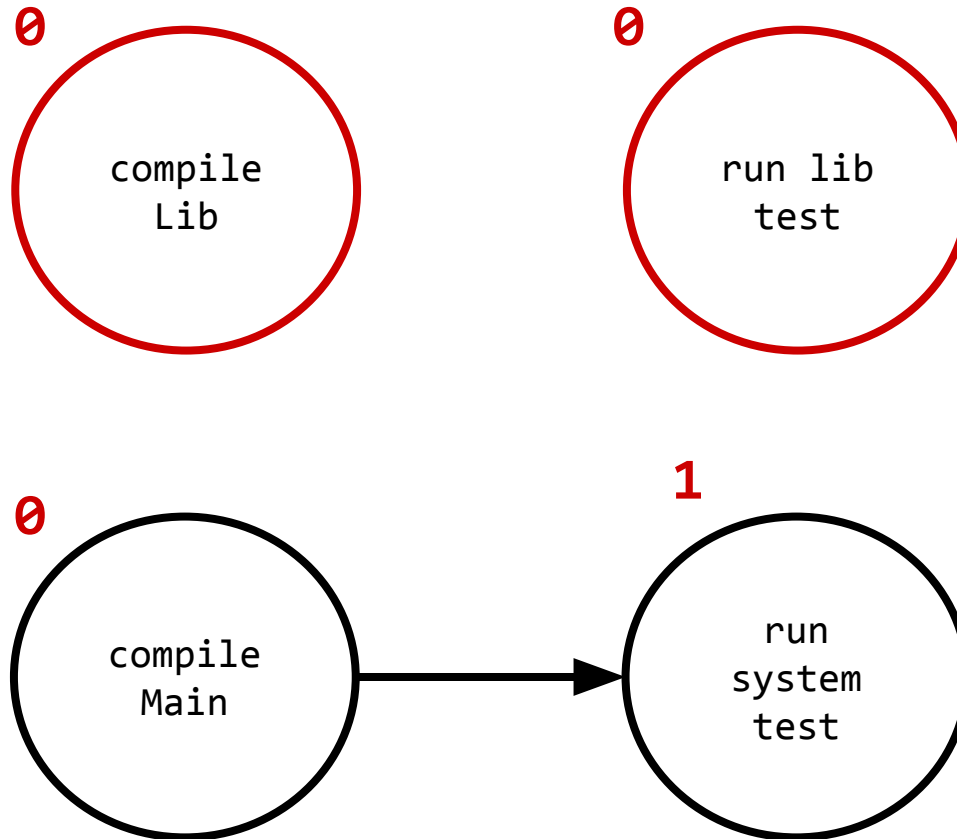

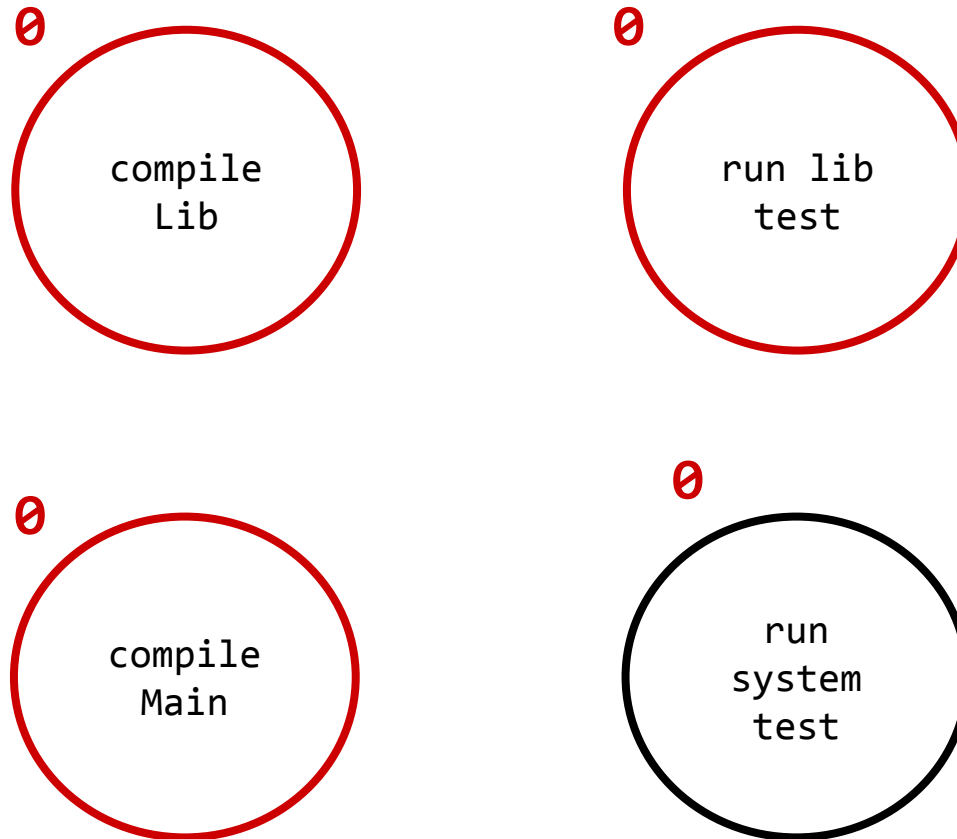What's the indegree of each node?

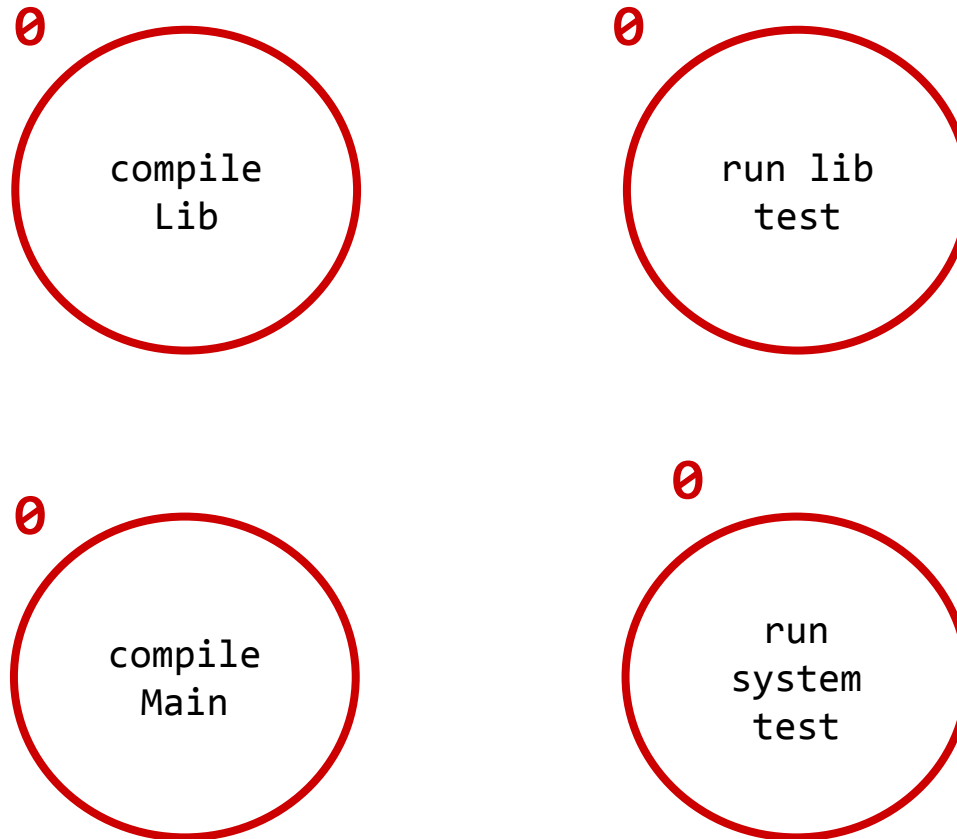# Build systems: topological sort

Build systems: topological sort

Build systems: topological sort

Build systems: topological sort

0

compile
Lib

0

run lib
test

0

compile
Main

0

run
system
test

Build systems: topological sort

0 compile Lib

0 run lib test

0 compile Main

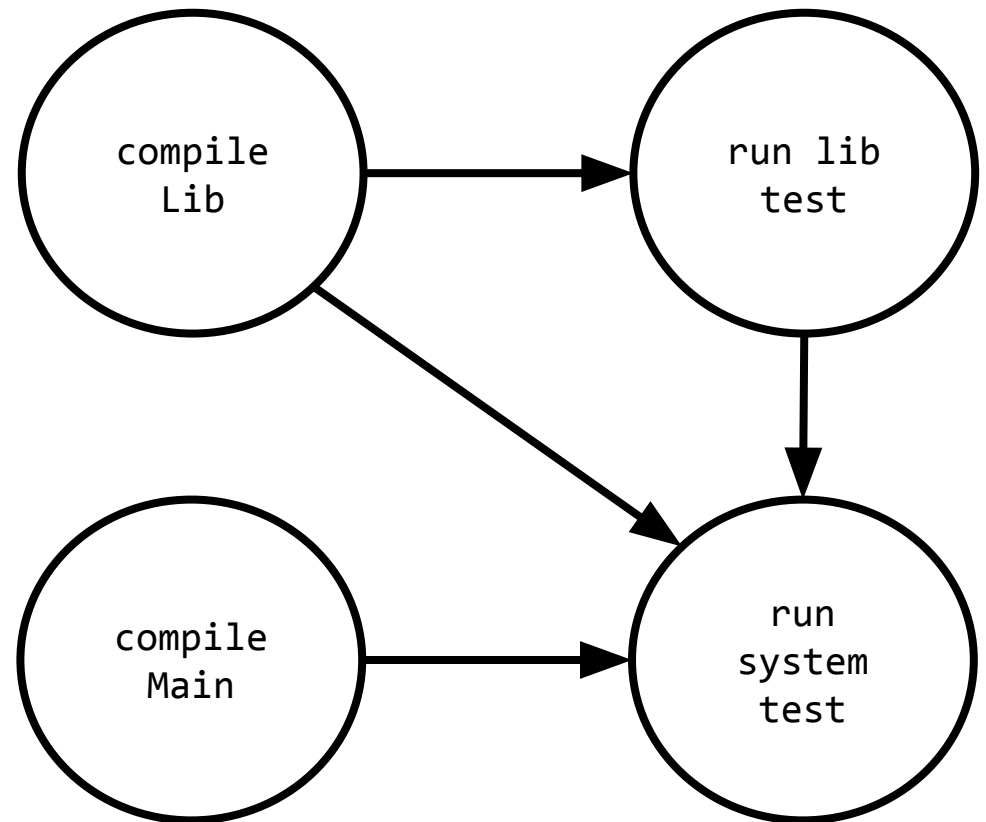**0** run system test

Build systems: topological sort

Valid sorts:

1. compile Lib, run lib test,
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Build systems: topological sort

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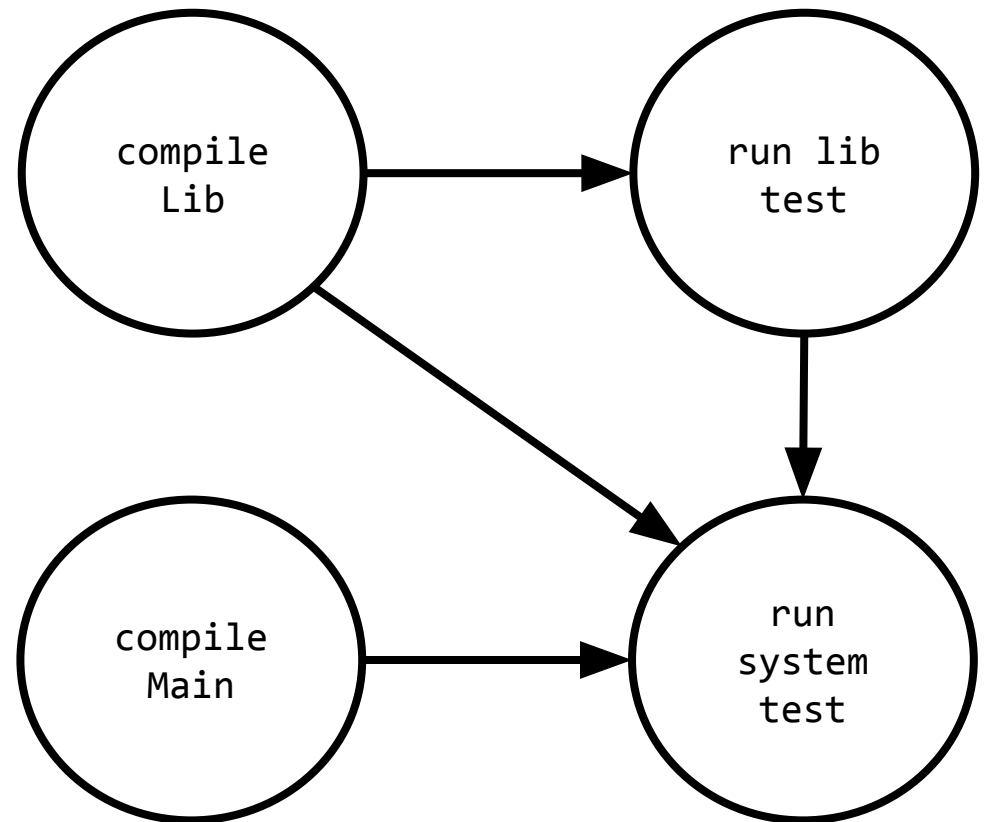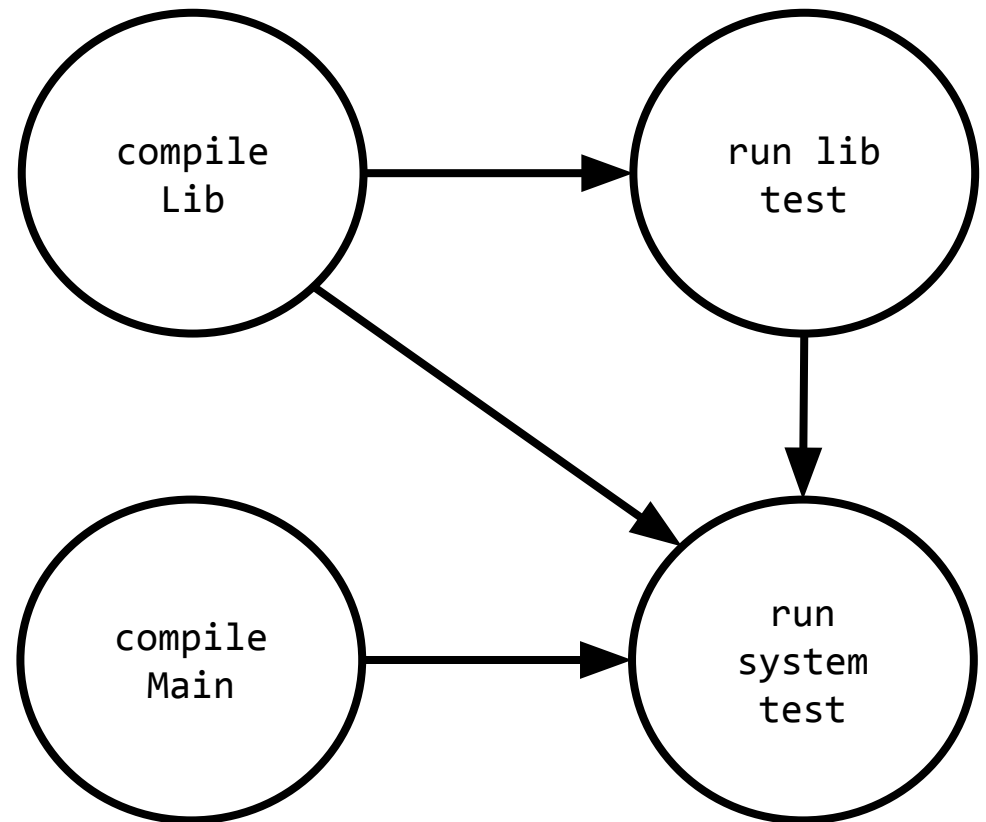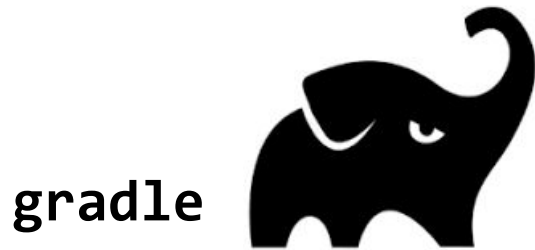
Build systems: topological sort

Valid sorts:

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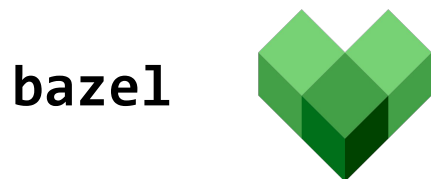

Which of these sorts is preferable?

Build systems: examples

gradle

Open-source successor to ant and maven
- Groovy/Kotlin DSL (vs. xml)
- Many defaults for (maven) conventions
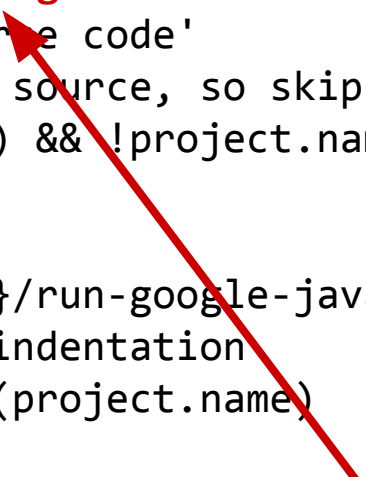- Can query Maven Central for dependency resolution

bazel

Open-source version of Google's internal build tool (blaze)

Example task: gradle

```
task reformat(type: Exec, dependsOn: getCodeFormatScripts, group: 'Format') {
    description 'Format the Java source code'
    // jdk8 and checker-qual have no source, so skip
    onlyIf { !project.name.is('jdk8') && !project.name.is('checker-qual') }
    executable 'python'
    doFirst {
        args += "${formatScriptsHome}/run-google-java-format.py"
        args += "--aosp" // 4 space indentation
        args += getJavaFilesToFormat(project.name)
    }
}
```

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explicitly specified dependencies

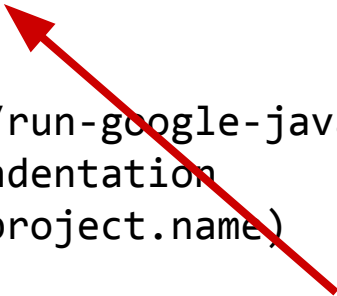# Example task: gradle

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```

actual source code (no xml)!

In many cases, following conventions and using built-in tasks is sufficient!

Best practices

- Automate everything (one-step build)!
- Always use a build tool.
- Use CI to build and test your code on every commit.
- Don't depend on anything that's not in the build file (hermetic)!
- Don't break the build!
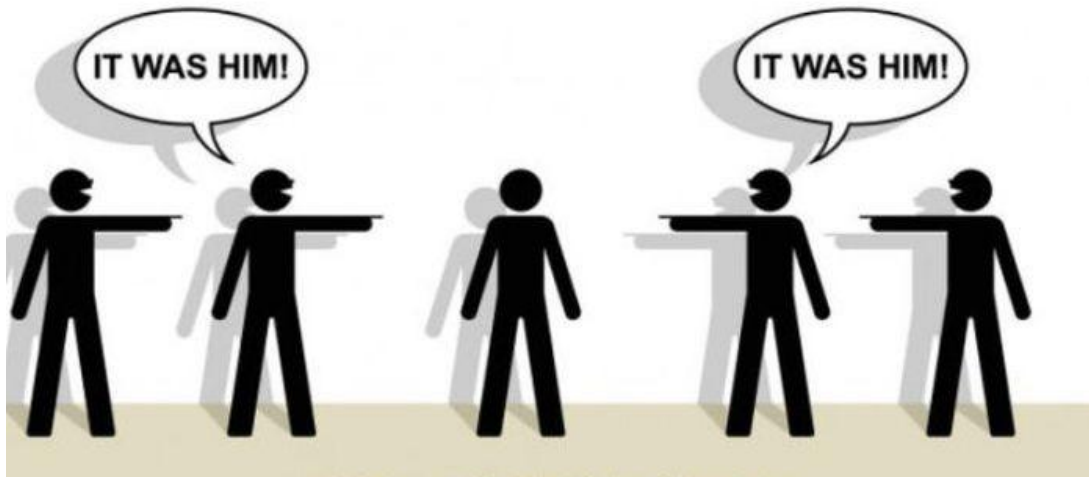
Live demo: Build systems

Set up:
1.   Two clones of the basic-stats repo.
2.   Goal: migrate from Ant to Gradle.

Two scenarios:
1.   Bad: Breaking the build on main with a non-hermetic build
2.   Good: New hermetic build on a branch with reviewed PR

Live demo Part 1: Breaking the build

René breaking the build on main

Collaborator making a small change

Live demo Part 2: New hermetic build

- Development on a branch
- Hermetic build
- Backward compatibility
- Testing and code review