Build Systems

CSE 403

What does a developer do?

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- Run static analysis
- Generate documentation
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Which should be handled manually?

NONE!

What to do instead?

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Orchestrate with a build system!

What is a build system?

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All tasks!

Tasks

Tasks are code!

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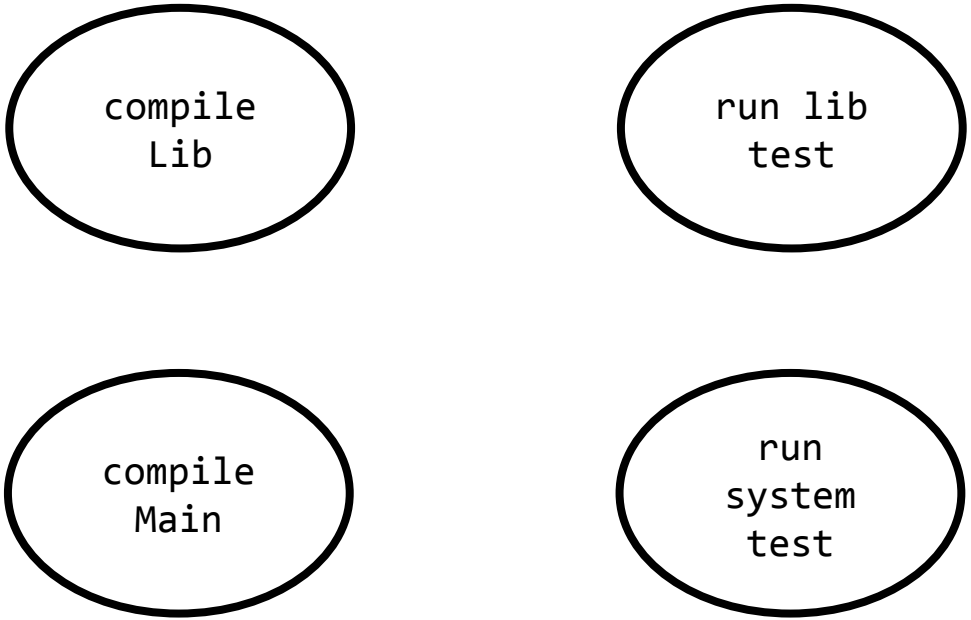
- Should be checked into version control
- Should be code-reviewed
- Should be tested

Dependencies between tasks

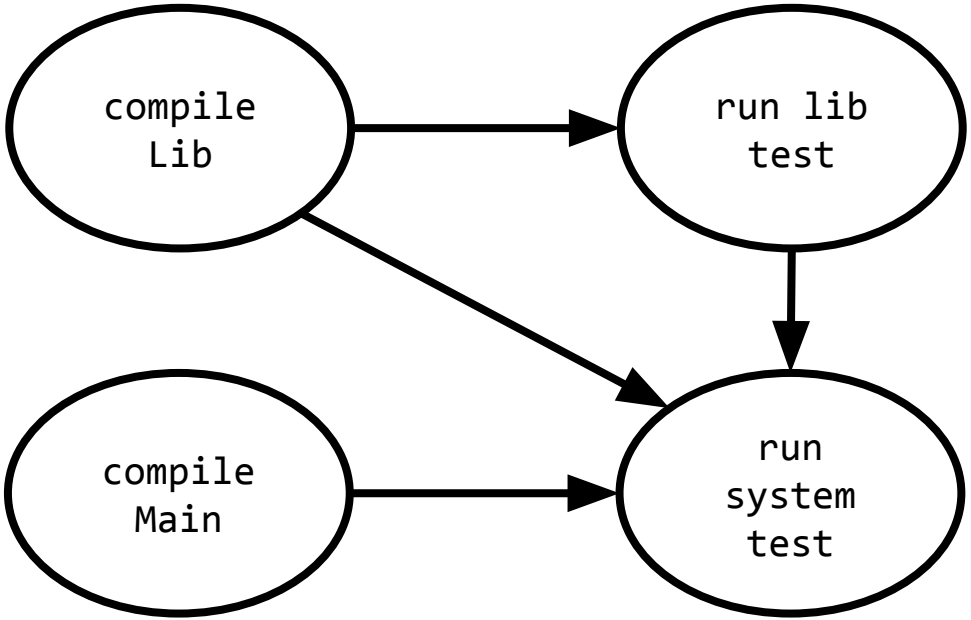
```
> ls src/

Lib.java   LibTest.java   Main.java    SystemTest.java
```

Dependencies between tasks



Dependencies between tasks



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Topological sort!

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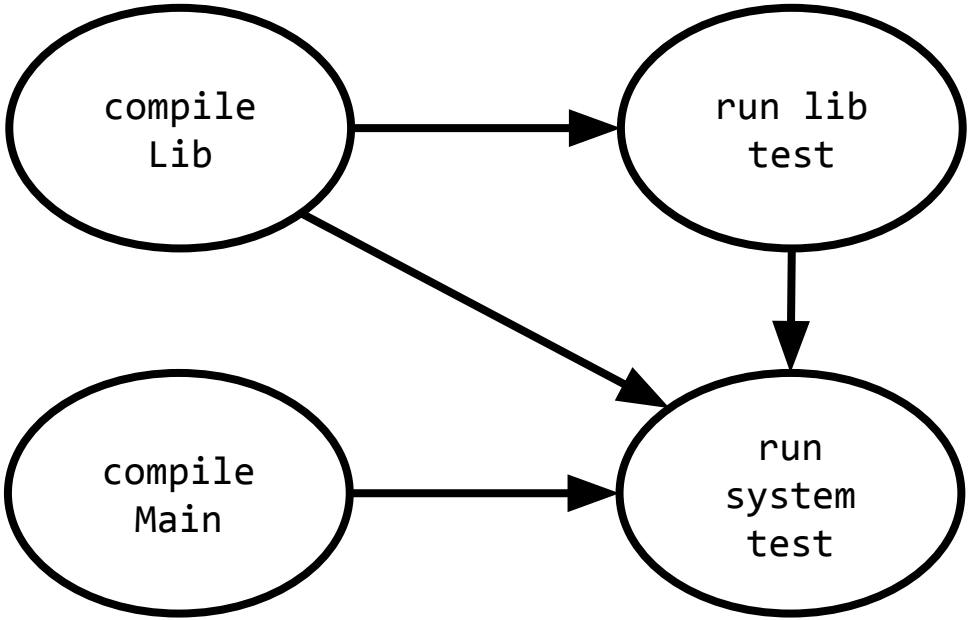
- Implement by computing *indegree* (number of incoming edges) for each node

Topological sort



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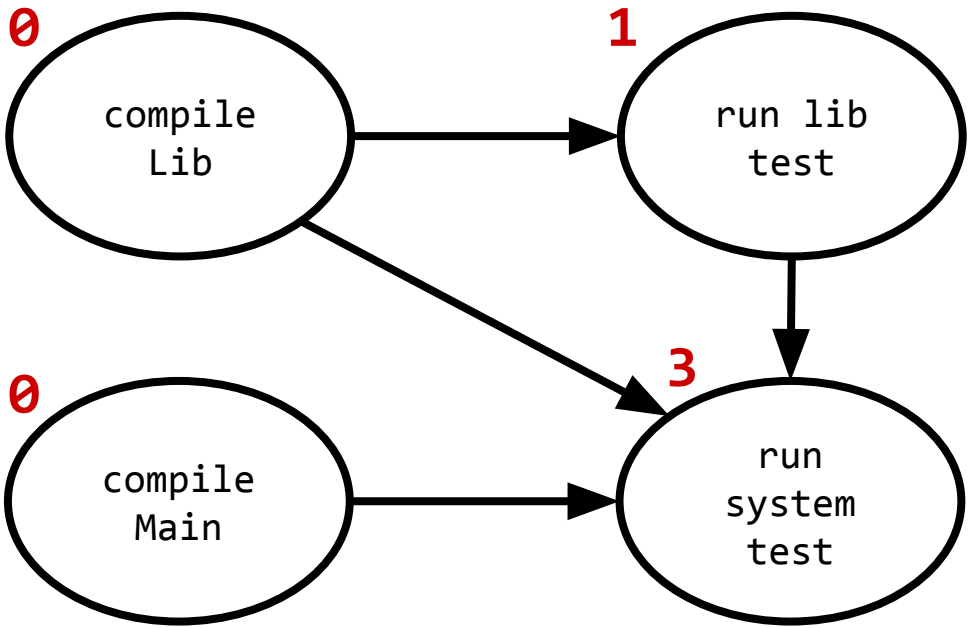

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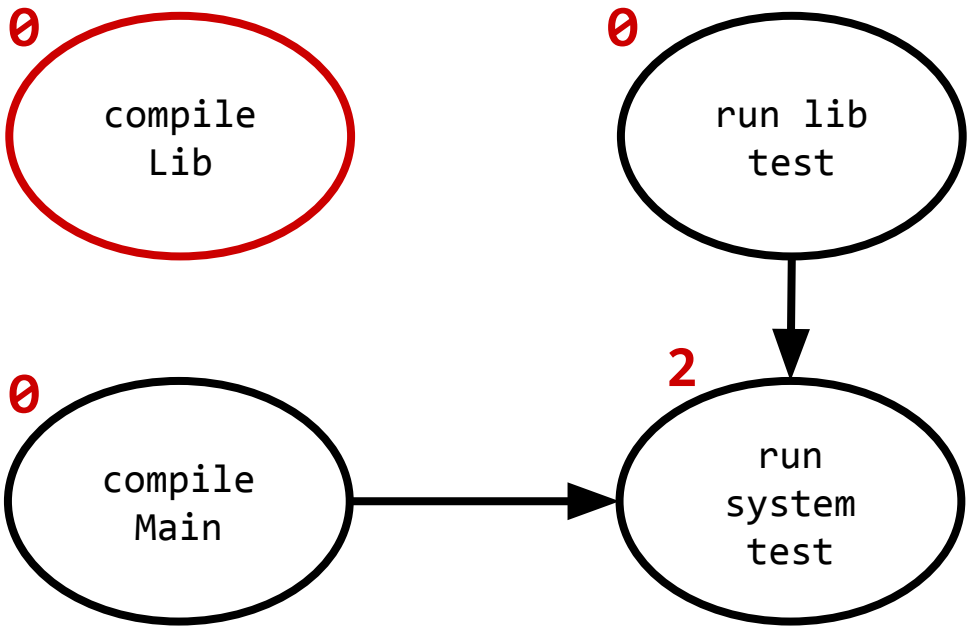

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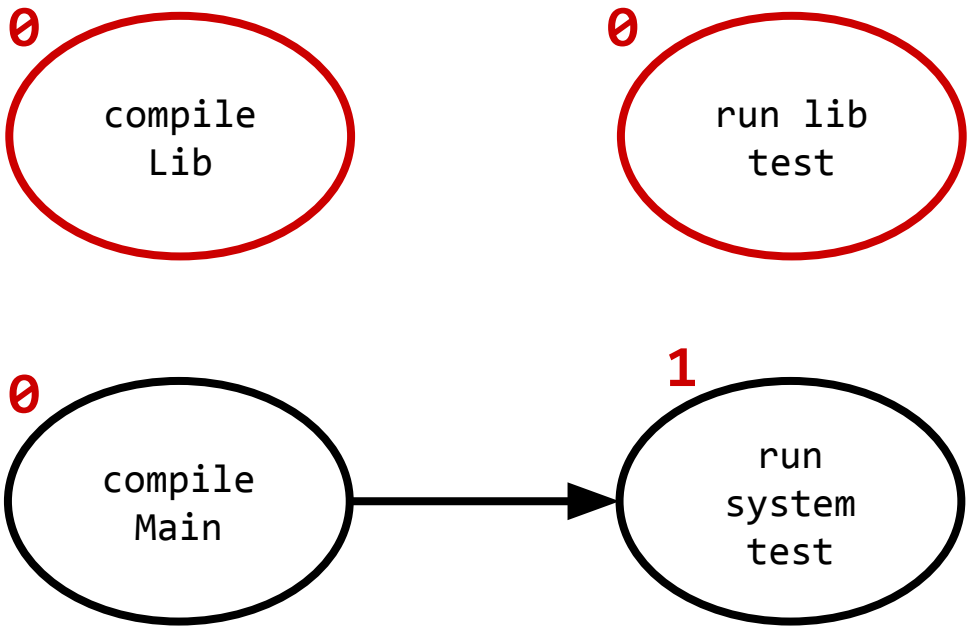

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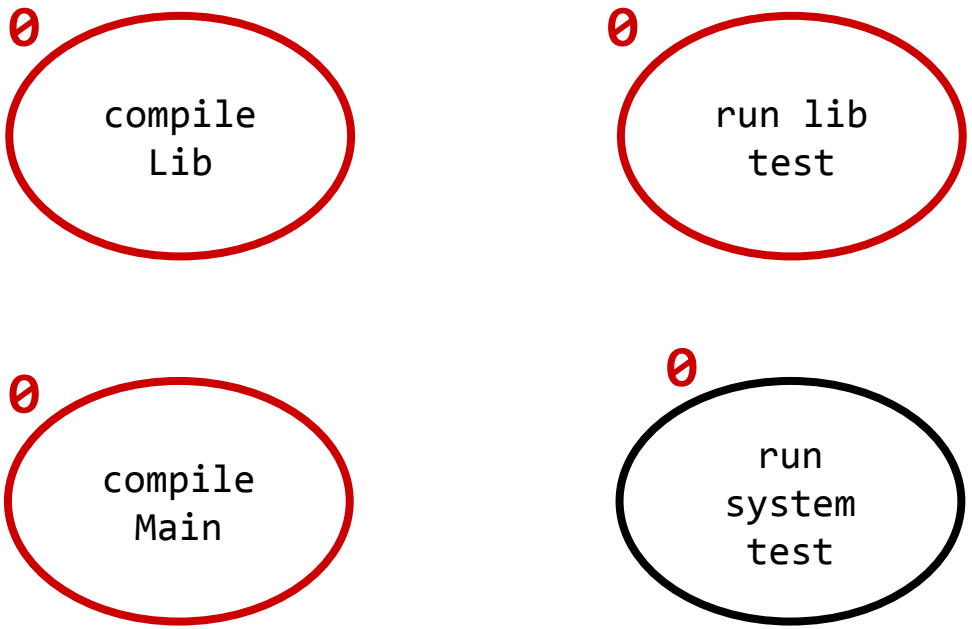

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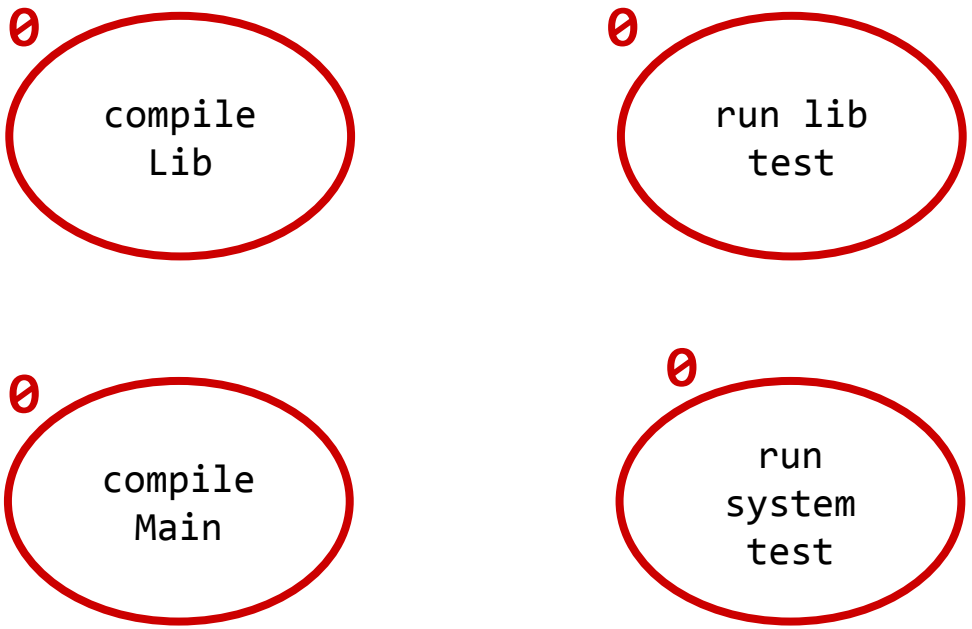
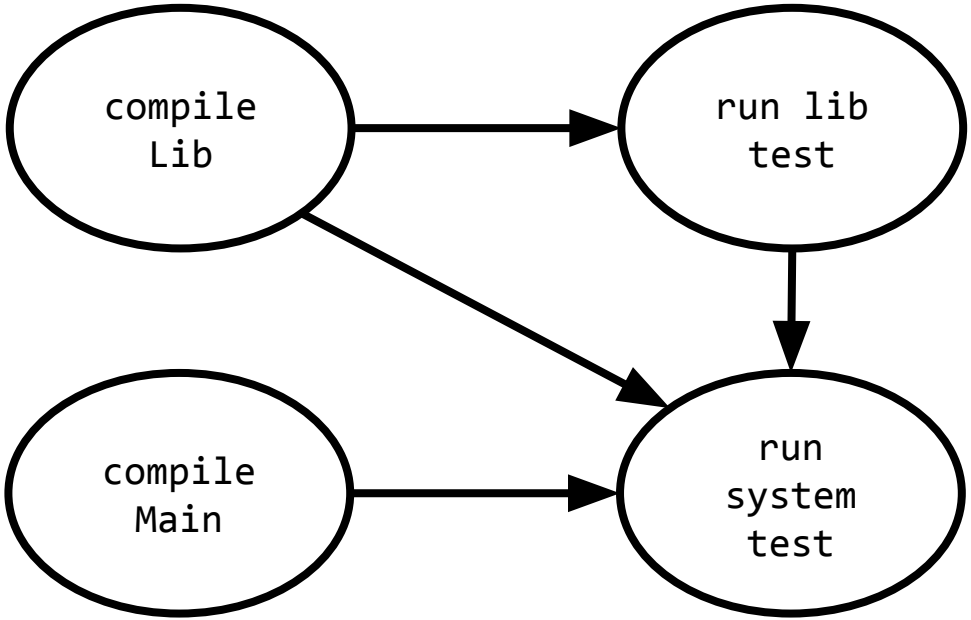


Topological sort

Valid sorts:

1. compile Lib, run lib test, compile Main, run system test



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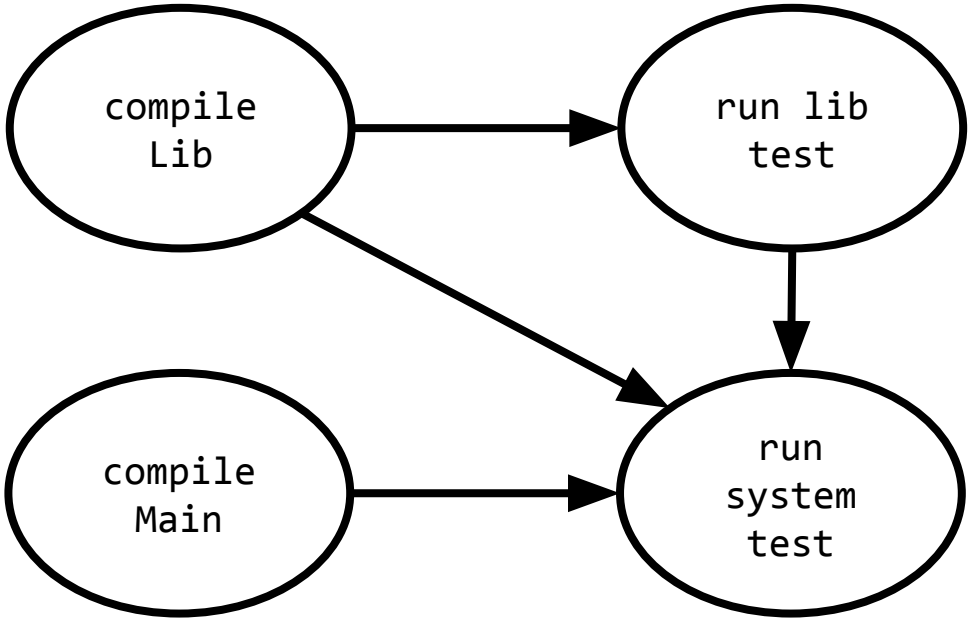

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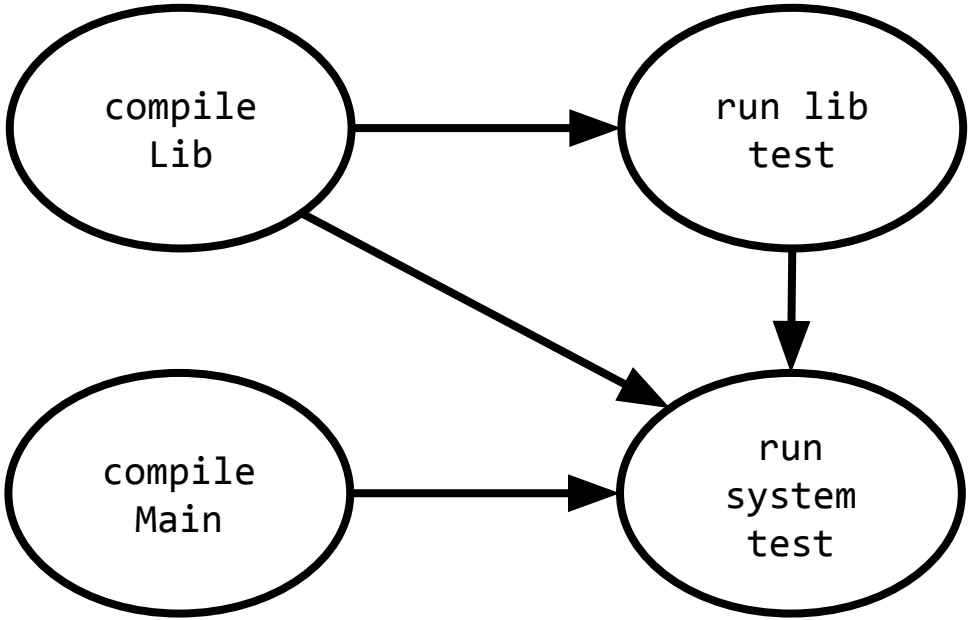

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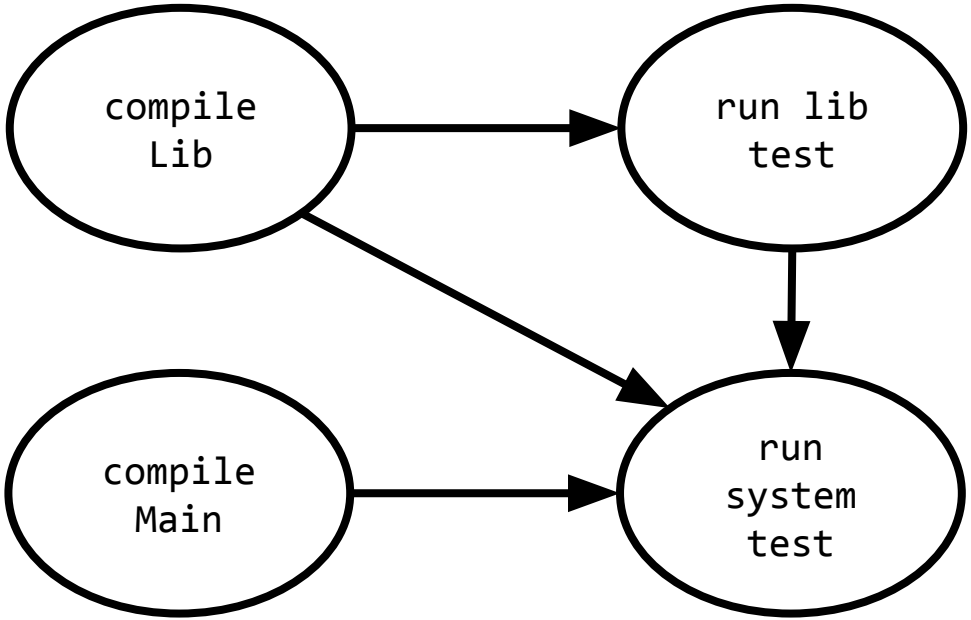

Why is this order silly?

Examples of modern build systems

`gradle`

https://gradle.org/

Apache's open-source successor to ant, maven

`bazel`

https://www.bazel.build/

Google's internal build tool, open-sourced

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)
   }
}
```

Example task: gradle

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explicitly specified dependencies

Example task: `gradle`

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task reformat(type: Exec, dependsOn: getCodeFormatScripts, group: 'Format') {
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code!

Example task: `bazel`

```
java_binary(
    name = "dux",
    main_class = "org.dux.cli.DuxCLI",
    deps = ["@google_options//:compile",
            "@checker_qual//:compile",
            "@google_cloud_storage//:compile",
            "@slf4j//:compile",
            "@logback_classic//:compile"],
    srcs = glob(["src/org/dux/cli/*.java",
                 "src/org/dux/backingstore/*.java"),
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explicitly specified dependencies (also bazel tasks)

External and internal dependencies

- A list of tasks (internal) or libraries (external)

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```

```
dependencies {
    compile group:
        'org.hibernate',
        name: 'hibernate-core',
        version : '3.6.7.Final'
    testCompile group:
        'junit',
        name: 'junit',
        version : '4.+'
}
```

https://docs.gradle.org/current/userguide/artifact_dependencies_tutorial.html

Why list dependencies?

- Reproducibility!

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- Reproducibility!
- *Hermetic builds*: “they are insensitive to the libraries and other software installed on the build machine”[1]

[1] https://landing.google.com/sre/sre-book/chapters/release-engineering/

Dependencies between tasks

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  - What order to run in?
  - **How to speed up?**

How to speed up builds?

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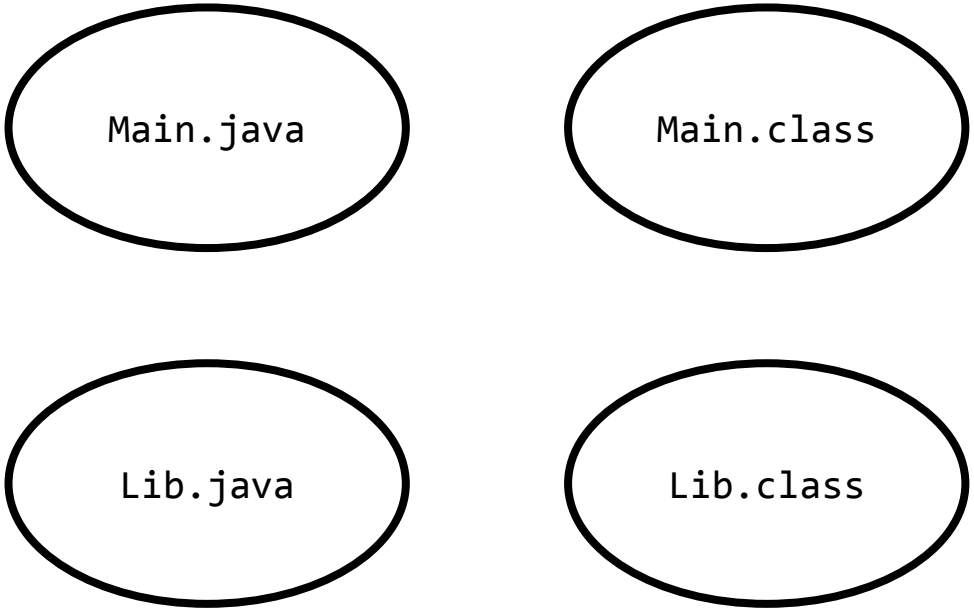
- Incrementalize - only rebuild what you have to

Incrementalization



Incrementalization

1:31 PM

modified 10:45 AM

Main.java

modified 11:06 AM

Main.class

modified 1:30 PM

Lib.java

modified 11:06 AM

Lib.class

Incrementalization

- Compute hash codes for inputs to each task
- When about to execute a task, check input hashes - if they match the last time the task was executed, skip it!

How to speed up builds?

- Incrementalize - only rebuild what you have to
- Execute many tasks in parallel
- Cache artifacts in the cloud

Best practices

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- Always use a build tool
- Have a build server that builds and tests your code on every commit (continuous integration)
- Don’t depend on anything that’s not in the build file (hermetic)
- Don’t break the build