Introduction to Modular Development

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September 2016

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Sessions

1 Prepare for JDK 9

2 Introduction to Modular Development

3 Advanced Modular Development

4 Modules and Services

5 Project Jigsaw: Under The Hood

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Background: Modularity Landscape

- Java Platform Module System
  - JSR 376, targeted for Java SE 9
- Java SE 9
  - JSR 379, will own the modularization of the Java SE APIs
- OpenJDK Project Jigsaw
  - Reference implementation for JSR 376
  - JEP 200, 201, 220, 260, 261, 282

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Part 1: Modular development starts with a modular platform

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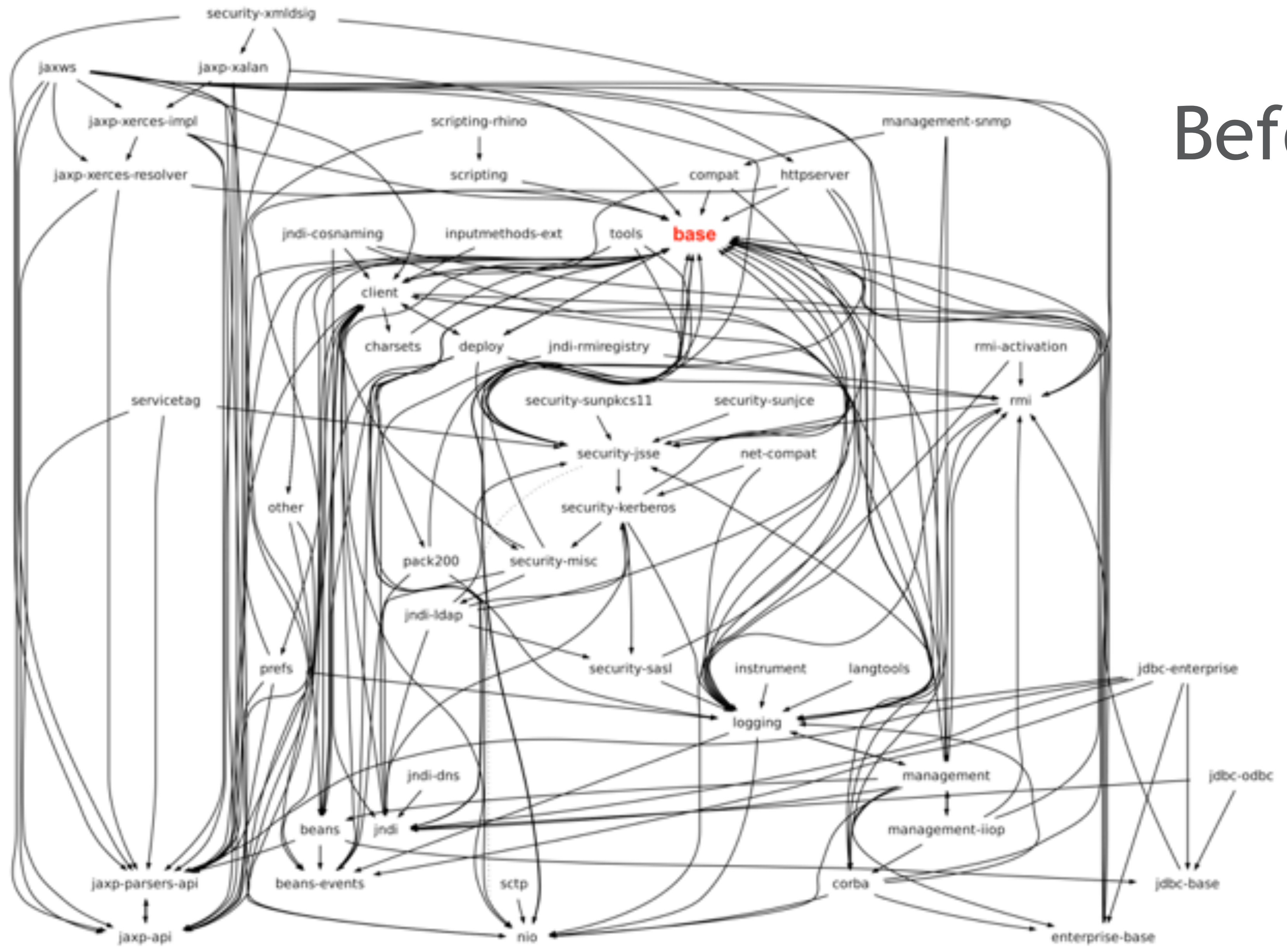
Before



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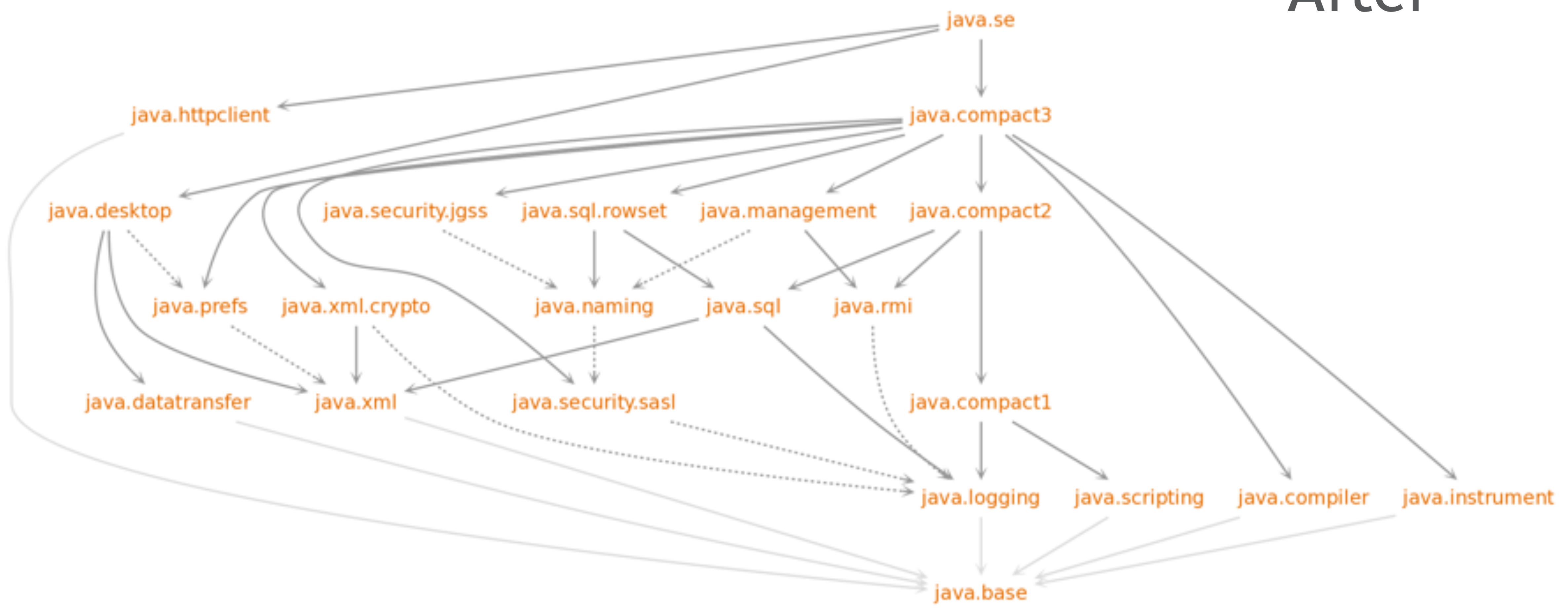
After



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```
$ java -version
java version "9-ea"
Java(TM) SE Runtime Environment (build 9-ea+136)
Java HotSpot(TM) 64-Bit Server VM (build 9-ea+136, mixed mode)
```

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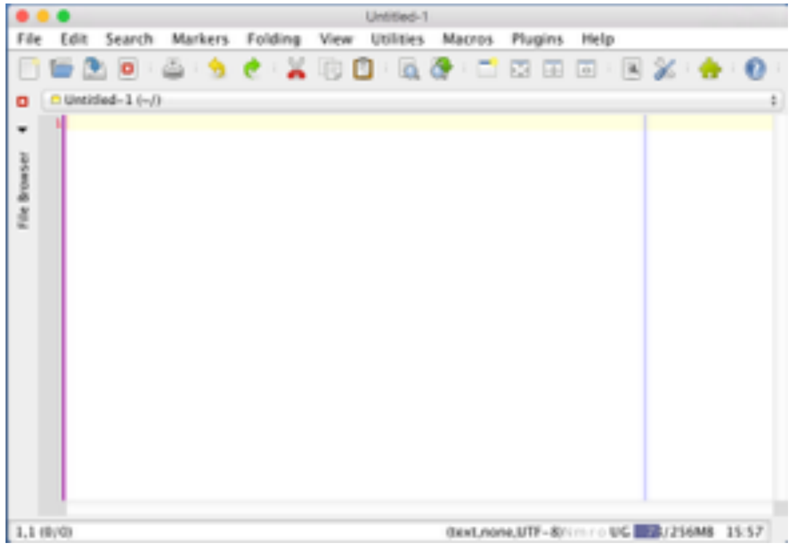
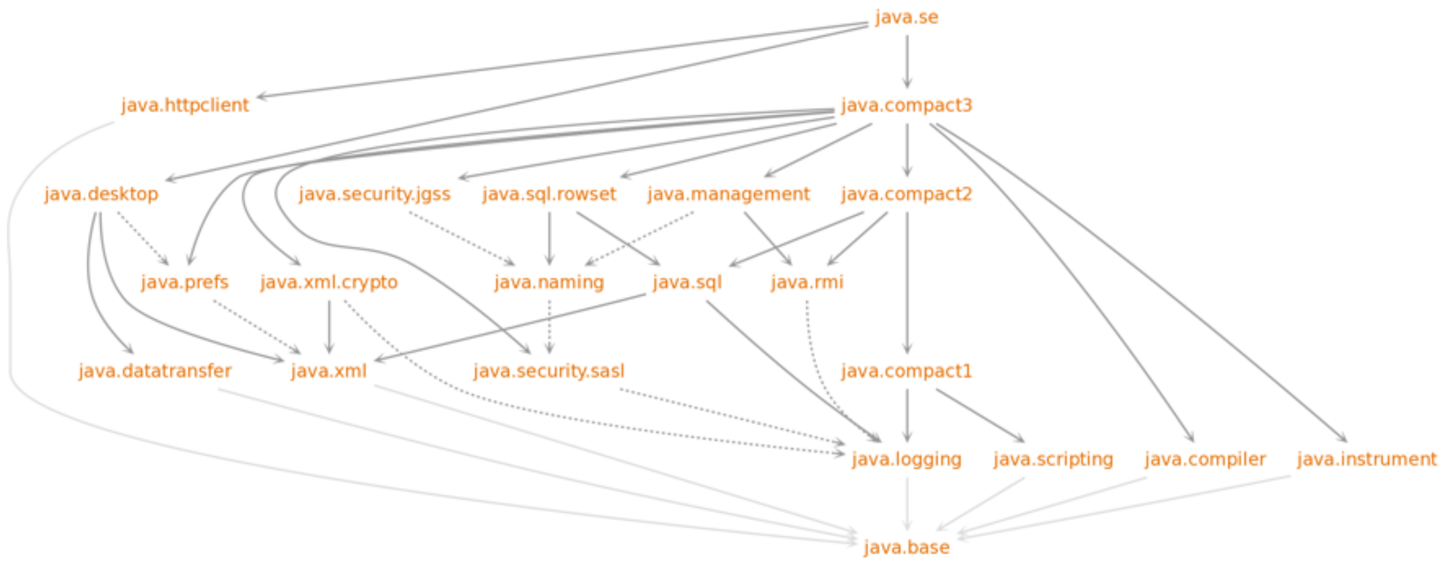
```
$ java -version
java version "9-ea"
Java(TM) SE Runtime Environment (build 9-ea+136)
Java HotSpot(TM) 64-Bit Server VM (build 9-ea+136, mixed mode)
```

```
$ java -jar jedit.jar
```



```
$ java --list-modules
java.base@9
java.compact1@9
java.compact2@9
java.compact3@9
java.compiler@9
java.datatransfer@9
java.desktop@9
java.httpclient@9
java.instrument@9
java.logging@9
java.management@9
java.naming@9
java.prefs@9
java.rmi@9
java.scripting@9
java.se@9
java.security.jgss@9
java.security.sasl@9
java.sql@9
java.sql.rowset@9
java.xml@9
java.xml.crypto@9
```



JavaOne ORACLE

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```
$ java –list-modules java.base
module java.base@9
  exports java.io
  exports java.lang
  exports java.lang.annotation
  exports java.lang.invoke
  exports java.lang.module
  exports java.lang.ref
  exports java.lang.reflect
  exports java.math
  exports java.net
  exports java.net.spi
  exports java.nio
  :
  exports java.util
  exports java.util.concurrent
  exports java.util.concurrent.atomic
  exports java.util.concurrent.locks
  exports java.util.function
  exports java.util.jar
  exports java.util.regex
  exports java.util.spi
  exports java.util.stream
  exports java.util.zip
```

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```
$ java –list-modules java.desktop
module java.desktop@9
  exports java.awt
  exports java.awt.color
  exports java.awt.desktop
  exports java.awt.dnd
  exports java.awt.event
  exports java.awt.font
  exports java.awt.geom
  exports java.awt.image
  exports java.awt.image.renderable
  exports java.awt.print
  exports java.beans
  exports java.beans.beancontext
  exports javax.swing
  exports javax.swing.border
  exports javax.swing.colorchooser
  exports javax.swing.event
  exports javax.swing.filechooser
  :
  requires java.prefs
  requires transitive java.datatransfer
  requires transitive java.xml
  requires mandated java.base
```

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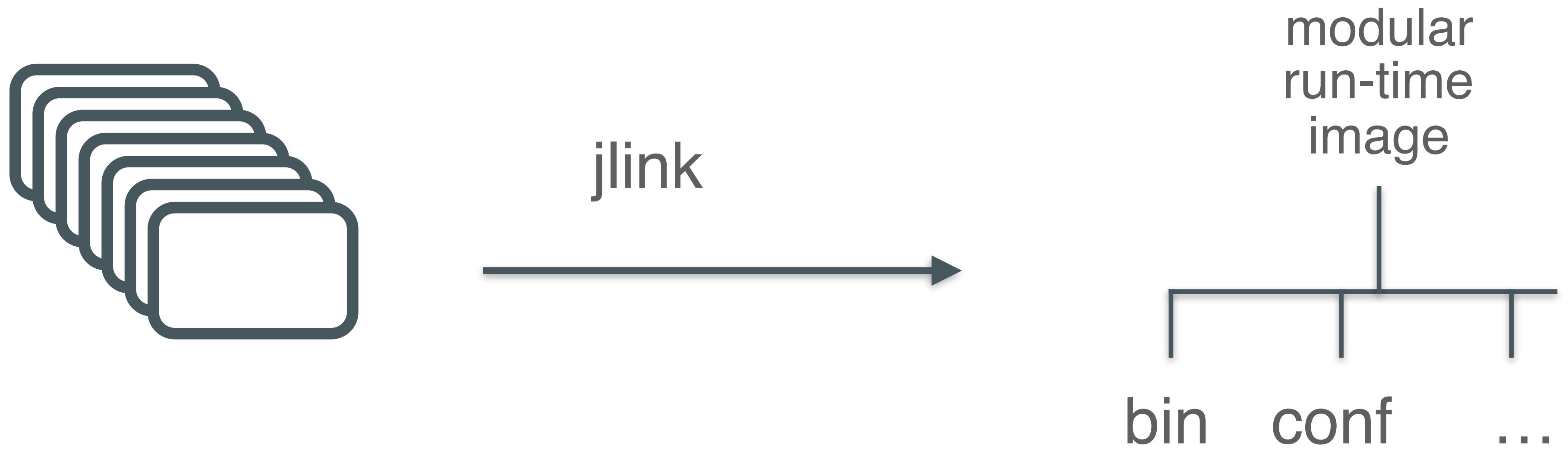
jlink: The Java Linker



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```
$ jlink --module-path jmods/ --add-modules java.desktop --output myimage

$ myimage/bin/java --list-modules
java.base@9
java.datatransfer@9
java.desktop@9
java.prefs@9
java.xml@9
```

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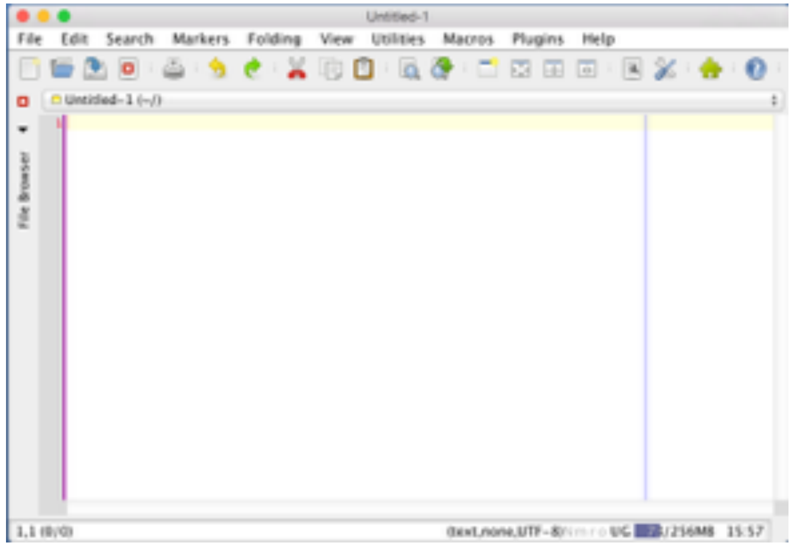
```
$ jlink --module-path jmods/ --add-modules java.desktop --output myimage

$ myimage/bin/java --list-modules
java.base@9
java.datatransfer@9
java.desktop@9
java.prefs@9
java.xml@9
```

```
$ myimage/bin/java -jar jedit.jar
```



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Summary for Part 1

- Moved from a monolithic to a set of (mostly) cohesive modules
- Each module has a clear set of exports and dependences
- You are using modules, even if stay on the class path until you retire
- jlink allows creating runtime images a subset of the platform modules
- Modular development starts with a modular platform

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Part 2: Introduction to modules

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What is a module?

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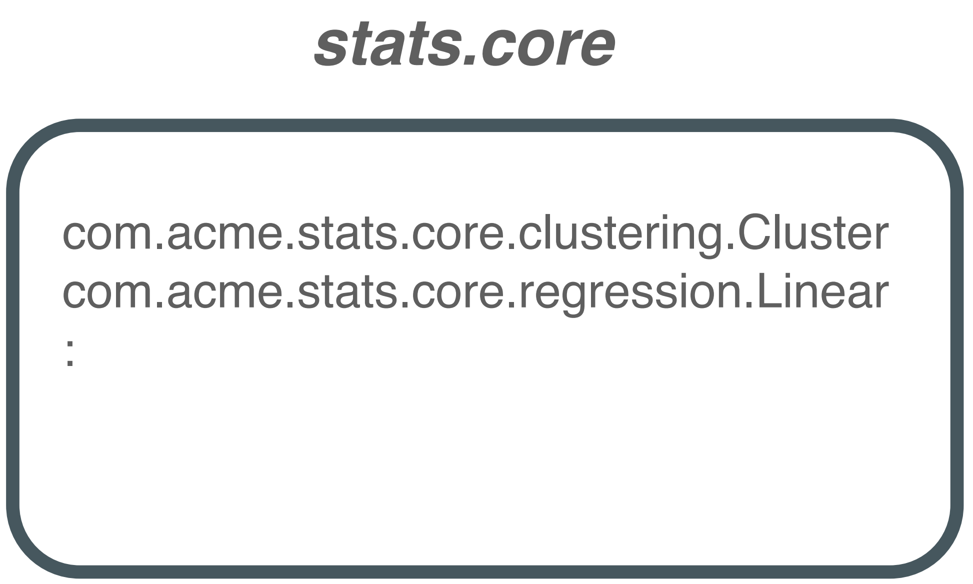
What is a module?


stats.core

com.acme.stats.core.clustering.Cluster
com.acme.stats.core.regression.Linear
:

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```
module stats.core {
}
```

module-info.java
com/acme/stats/core/clustering/Cluster.java
com/acme/stats/core/regression/Linear.java
:

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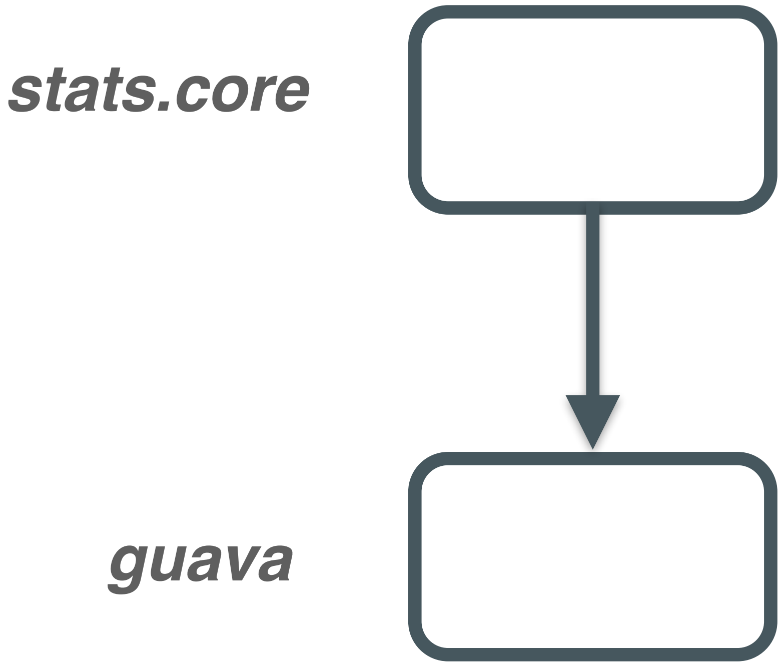
```
module stats.core {
    requires guava;
}
```



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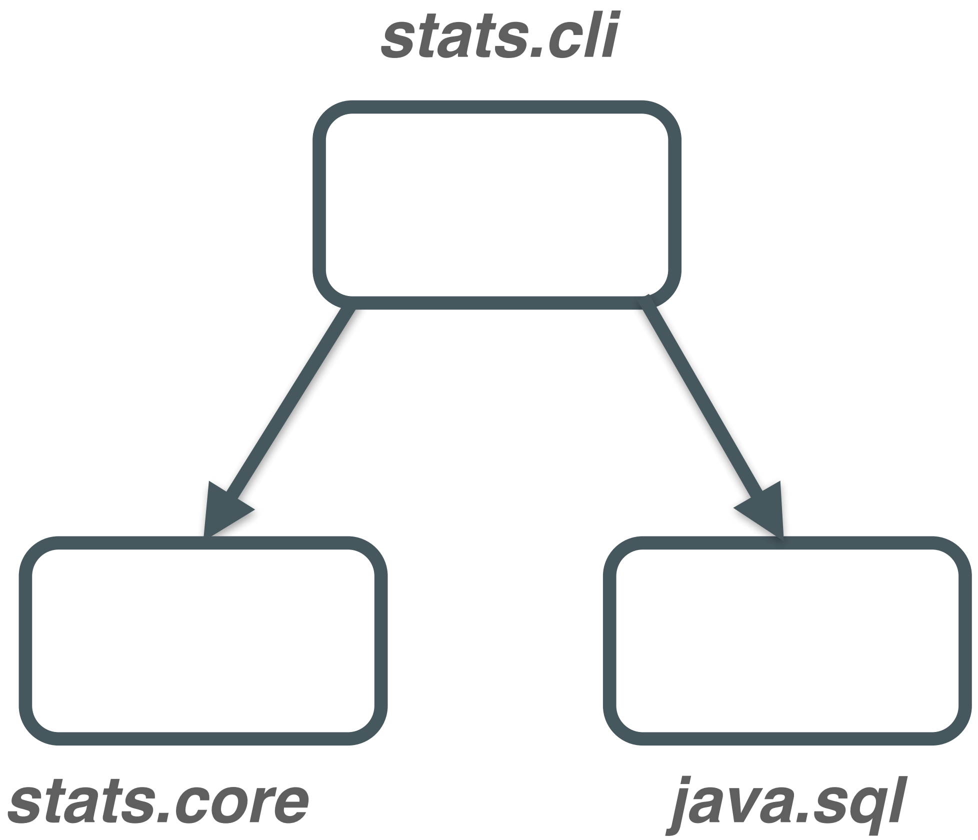
```
module stats.cli {
    requires stats.core;
    requires java.sql
}
```



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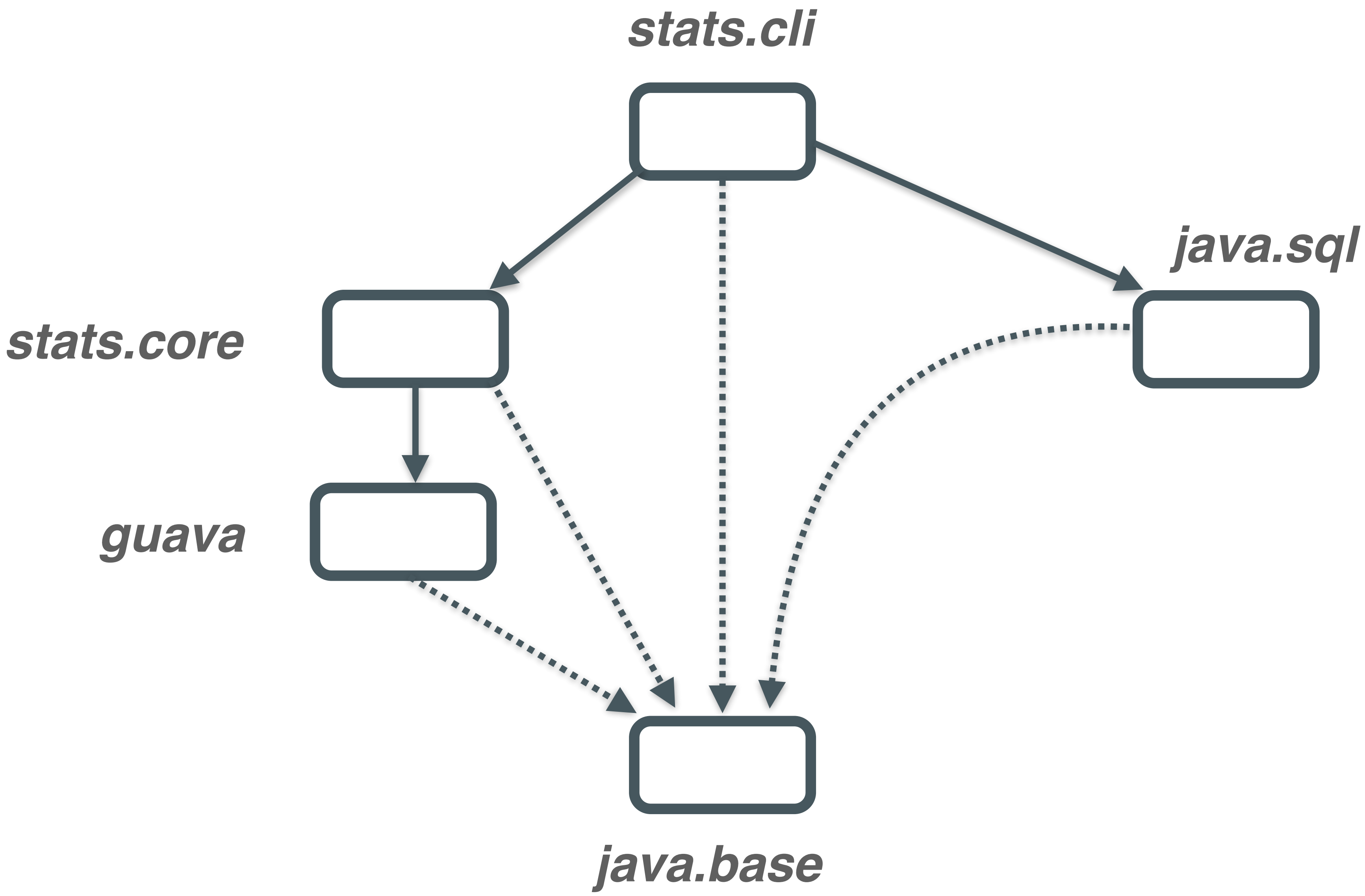

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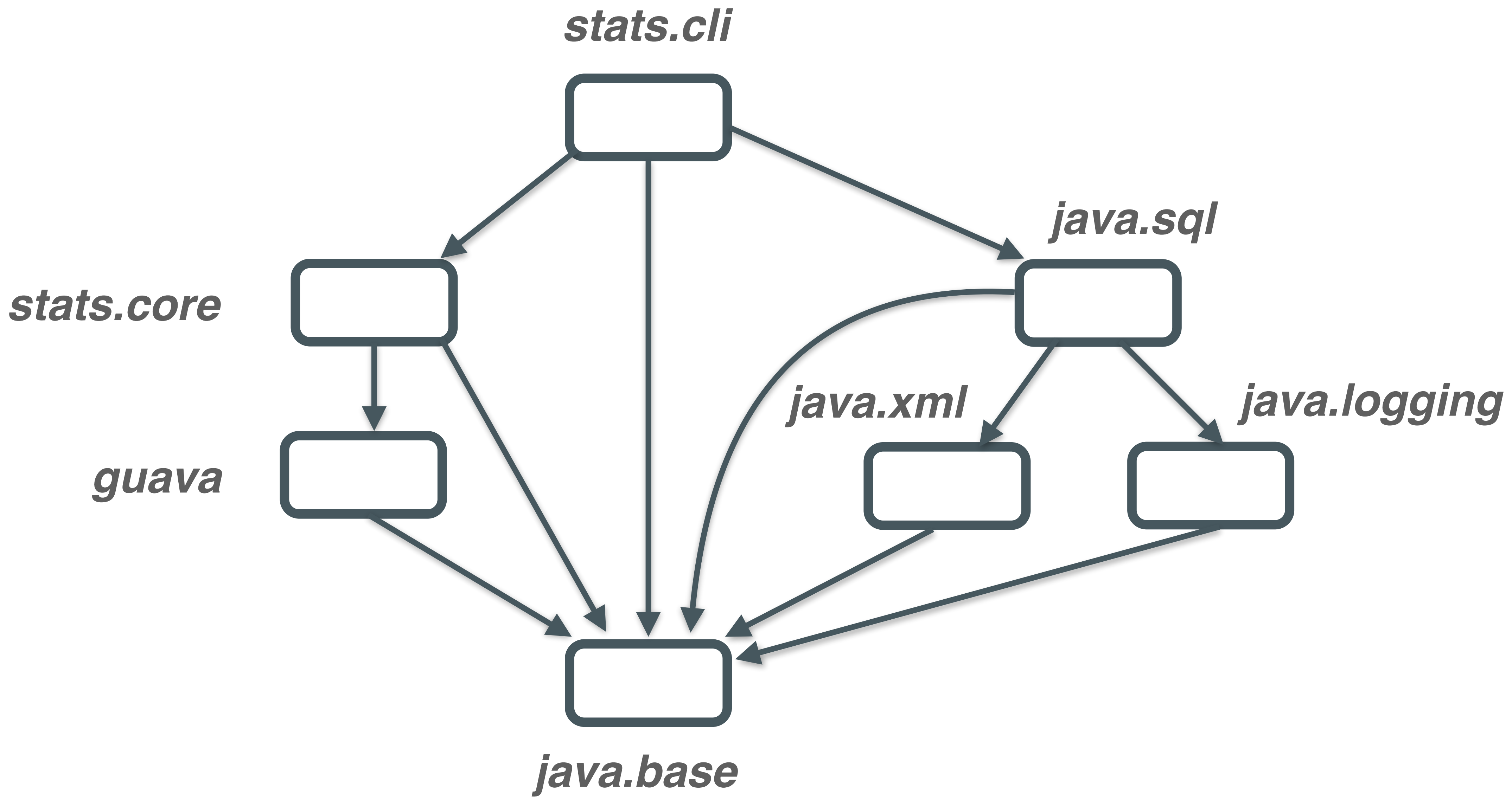

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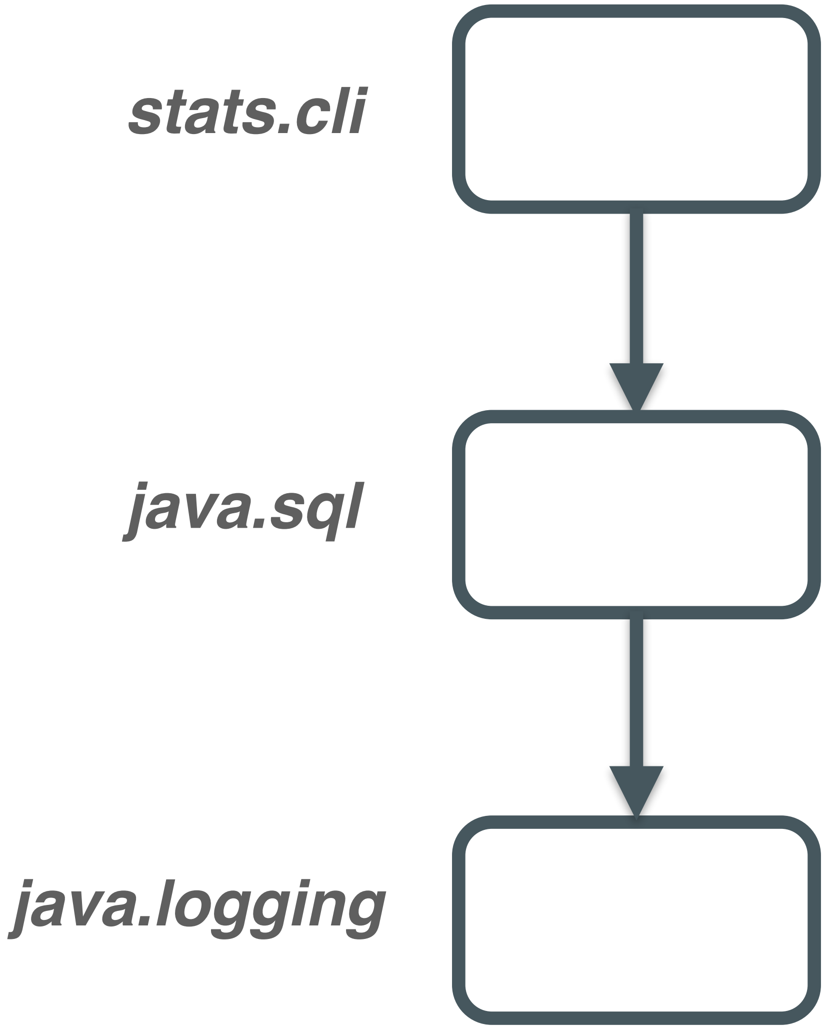

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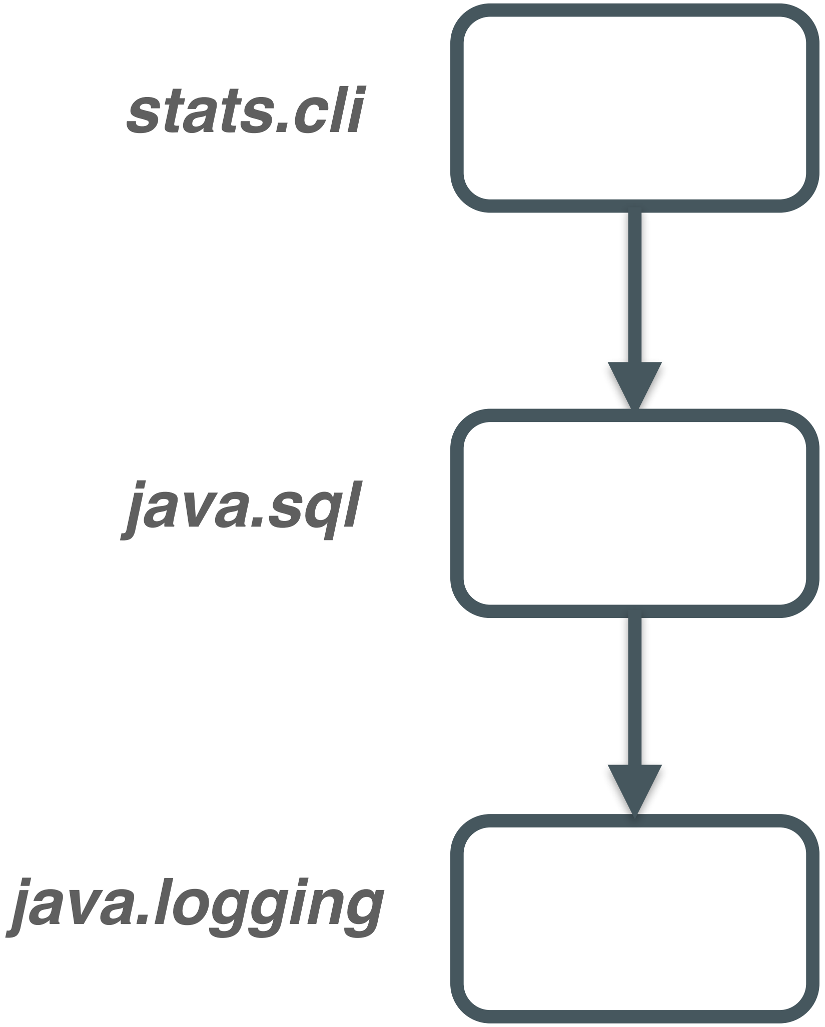

```
Driver d = …
d.getParentLogger().log(…)
```

```
package java.sql;
import java.util.logging.Logger;

public class Driver {
    public Logger getParentLogger() { .. }
    :
}
```

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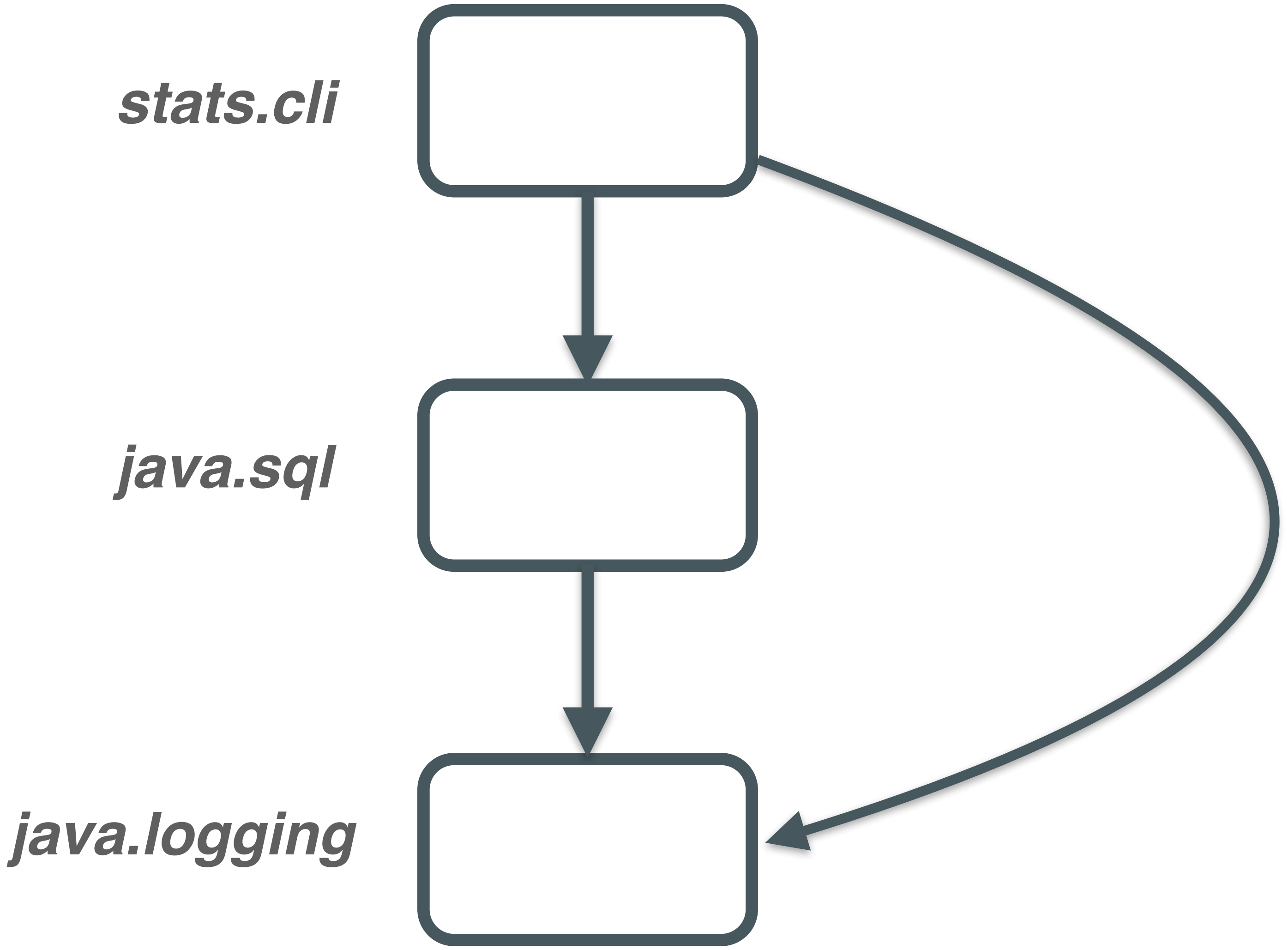

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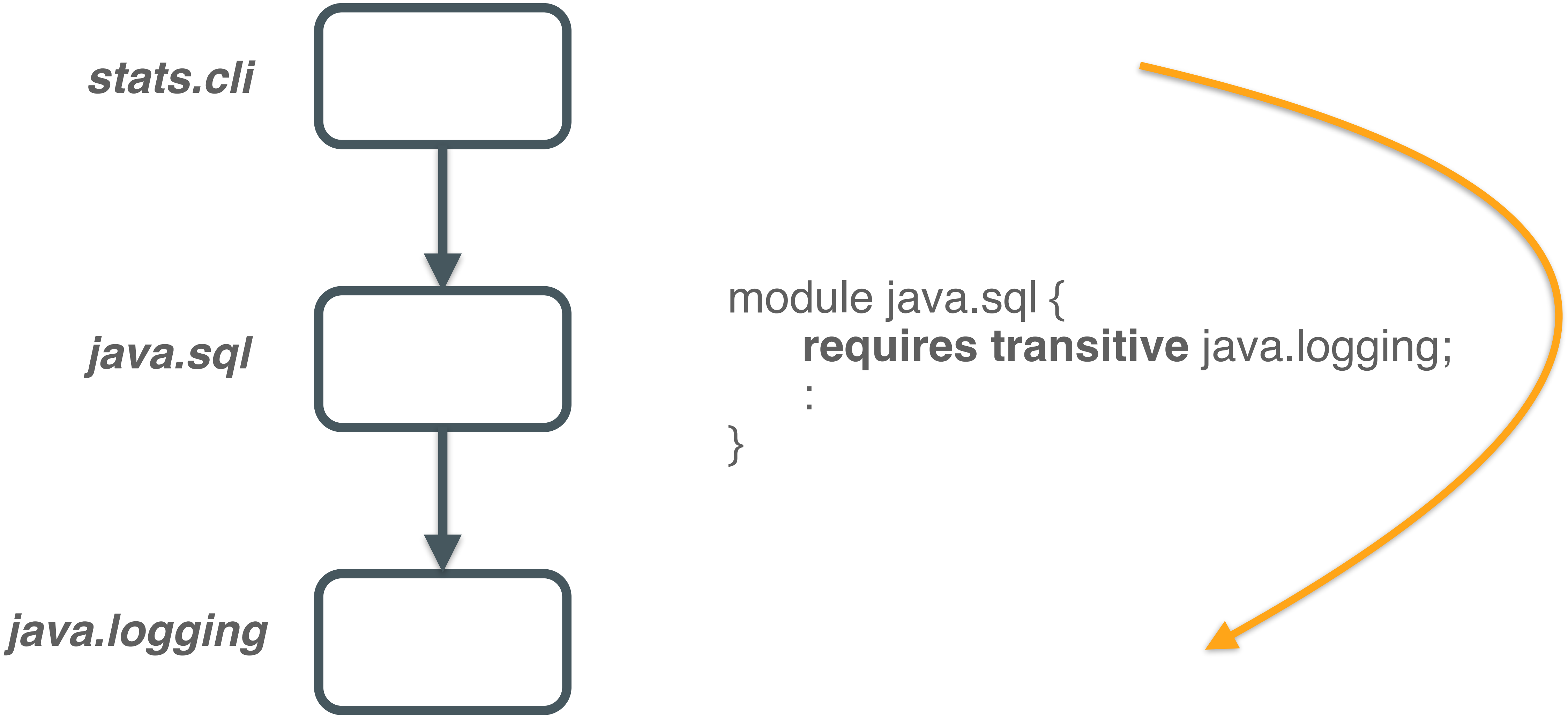

```
module java.sql {
    requires transitive java.logging;
    :
}
```

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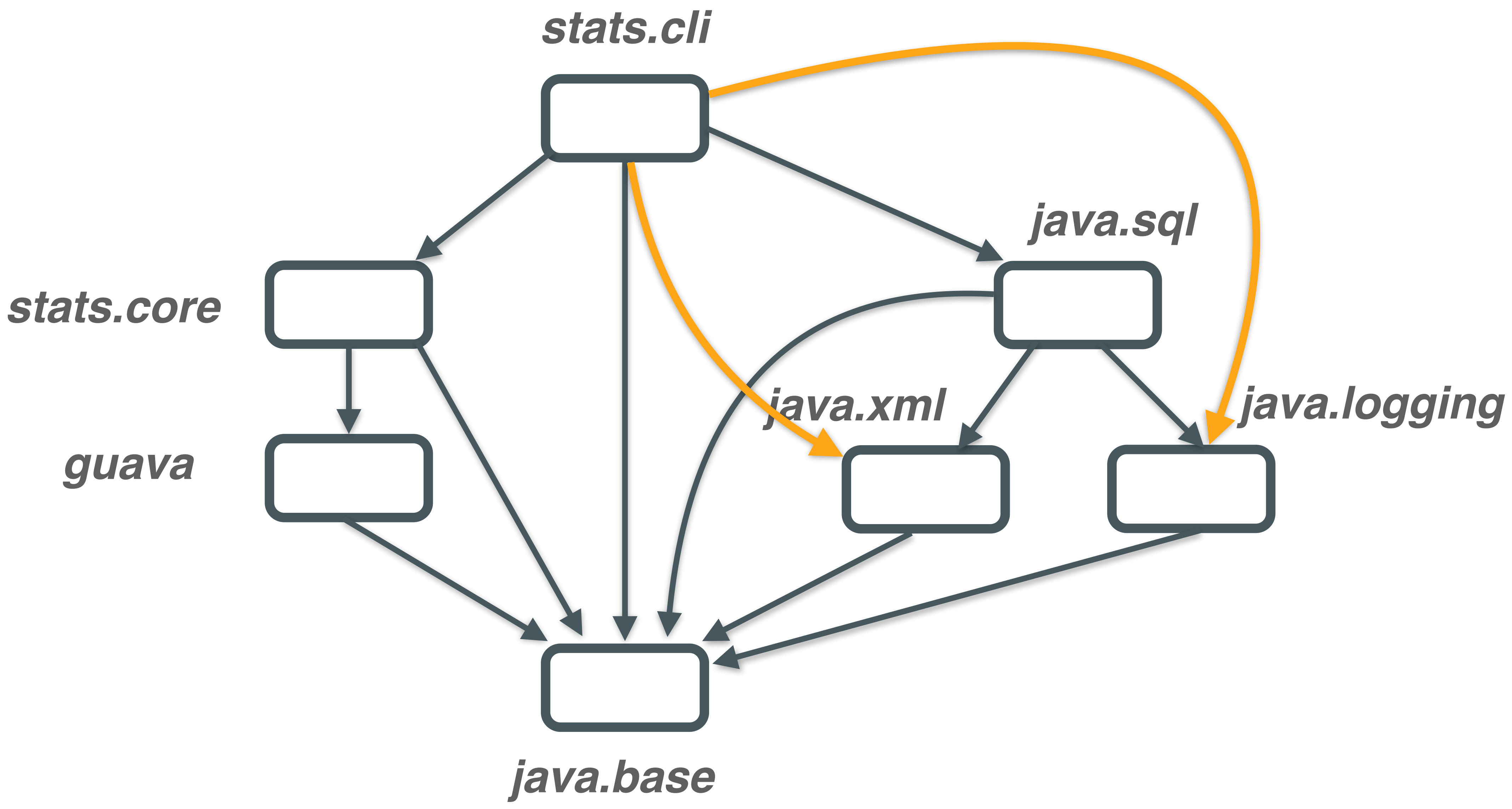

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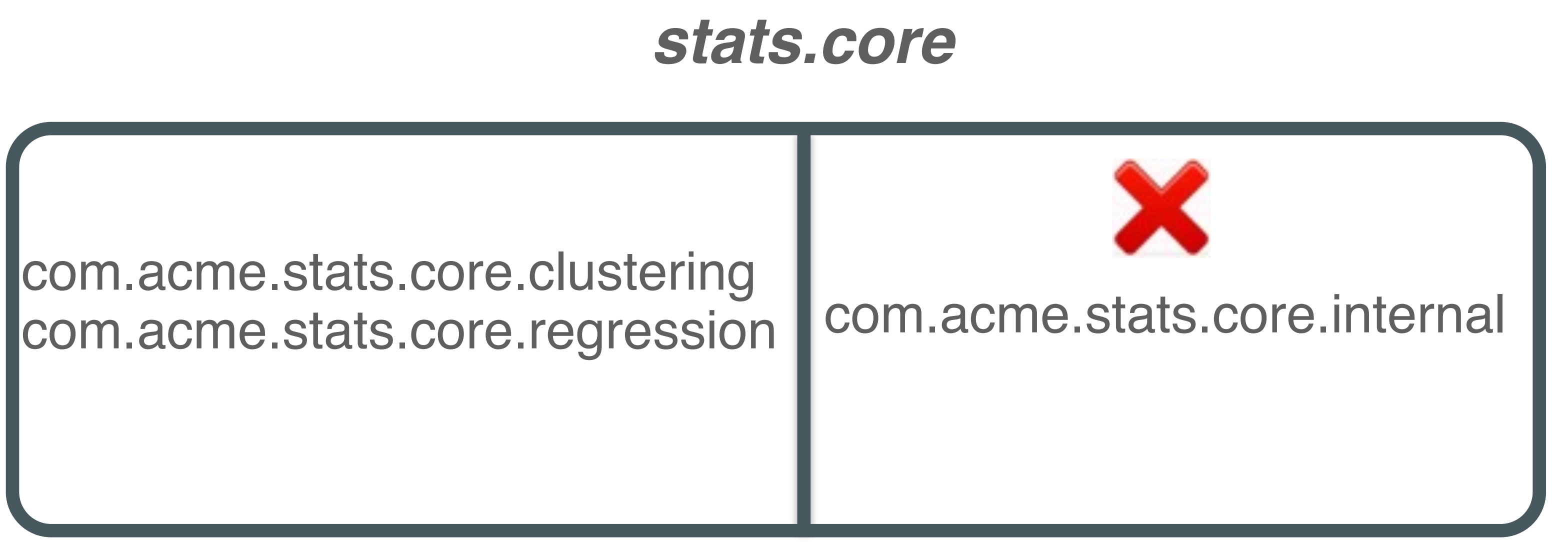
```
module stats.core {
    exports com.acme.stats.core.clustering;
    exports com.acme.stats.core.regression;
}
```


stats.core
com.acme.stats.core.clustering
com.acme.stats.core.regression
com.acme.stats.core.internal

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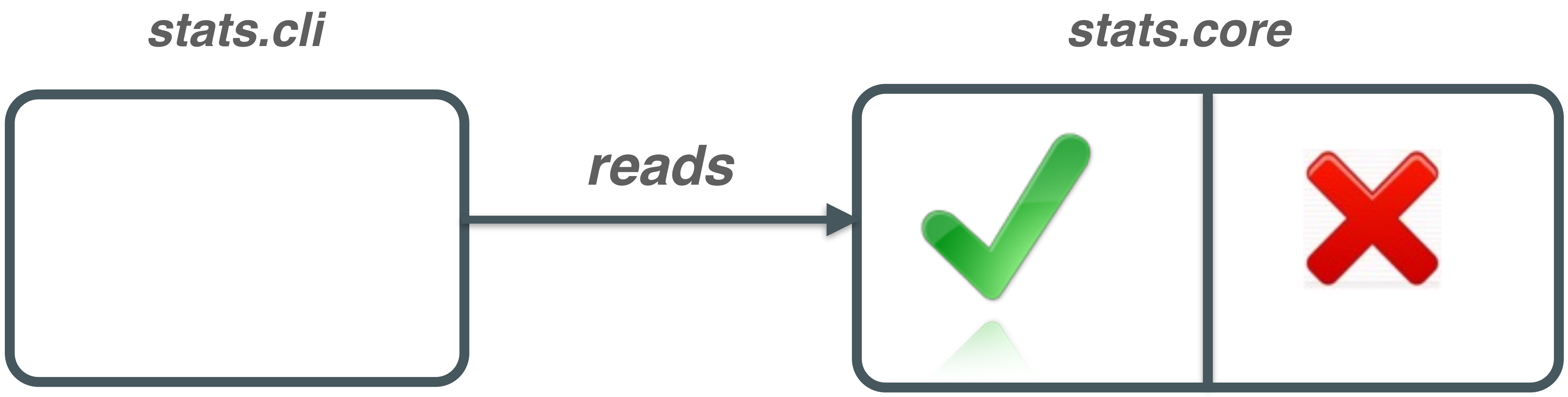
Accessibility



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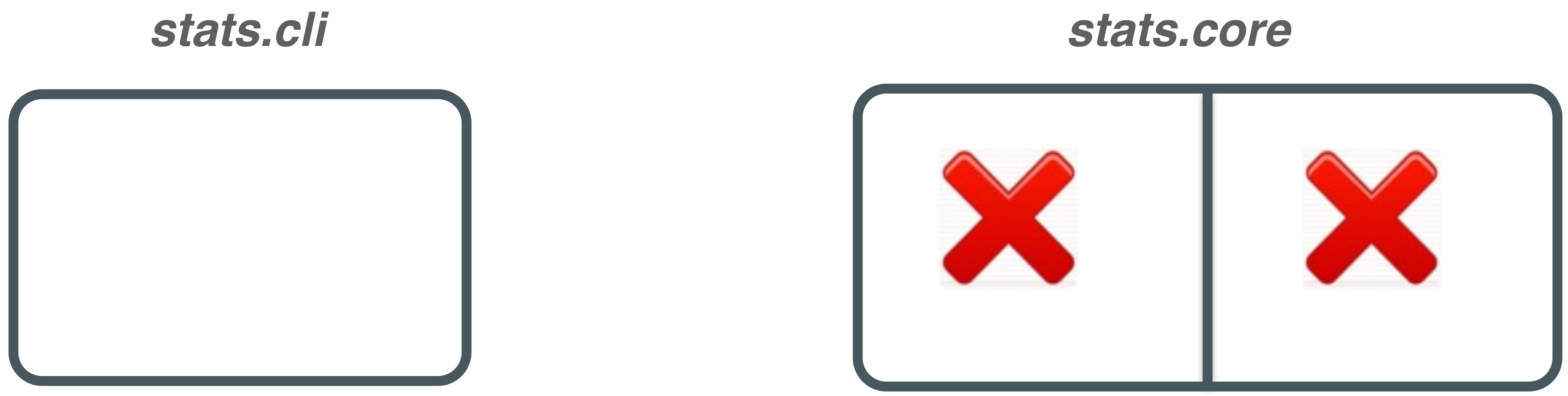
Accessibility



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public $\nRightarrow$ accessible

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Compile stats.core

```
$ javac --module-path mlib -d mods/stats.core \
  src/stats.core/module-info.java \
  src/stats.core/com/acme/core/clustering/Cluster.java \
  :
```

src/stats.core/module-info.java
src/stats.core/com/acme/core/clustering/Cluster.java

mods/stats.core/module-info.class
mods/stats.core/com/acme/core/clustering/Cluster.class

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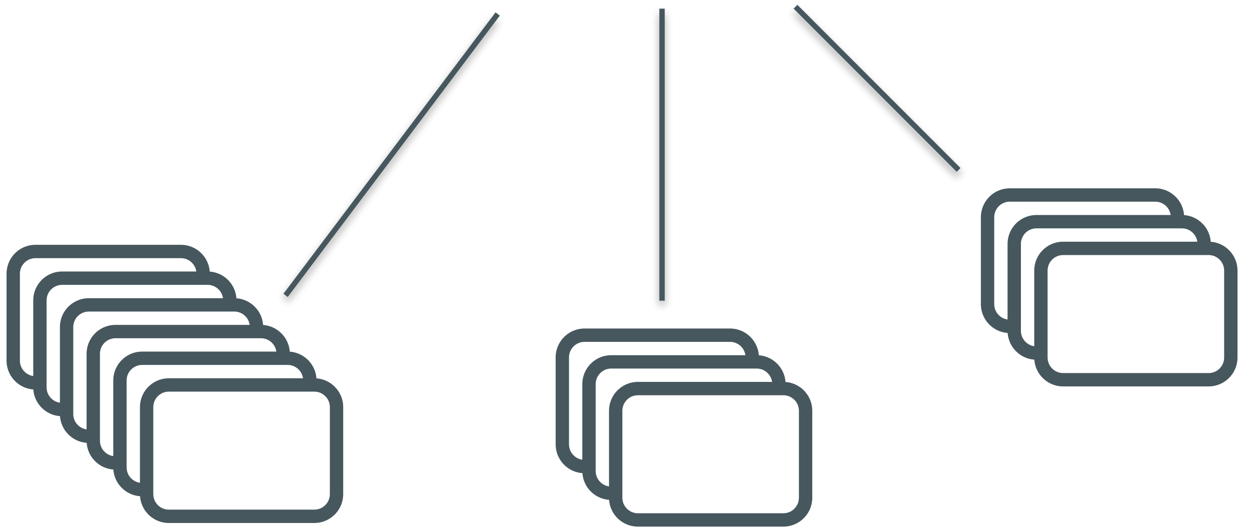
module path

```
$ java --module-path dir1:dir2:dir3 …
```



Compile stats.cli

```
$ javac --module-path mods:mlib -d mods/stats.cli \
    src/stats.cli/module-info.java \
    src/stats.cli/com/acme/stats/cli/Main.java \
    :
```

src/stats.cli/module-info.java
src/stats.cli/com/acme/stats/cli/Main.java

mods/stats.cli/module-info.class
mods/stats.cli/com/acme/stats/cli/Main.class

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module name

main class

```
$ java -p mods:mlib -m stats.cli/com.acme.stats.cli.Main
Welcome to the Stats CLI
>
```

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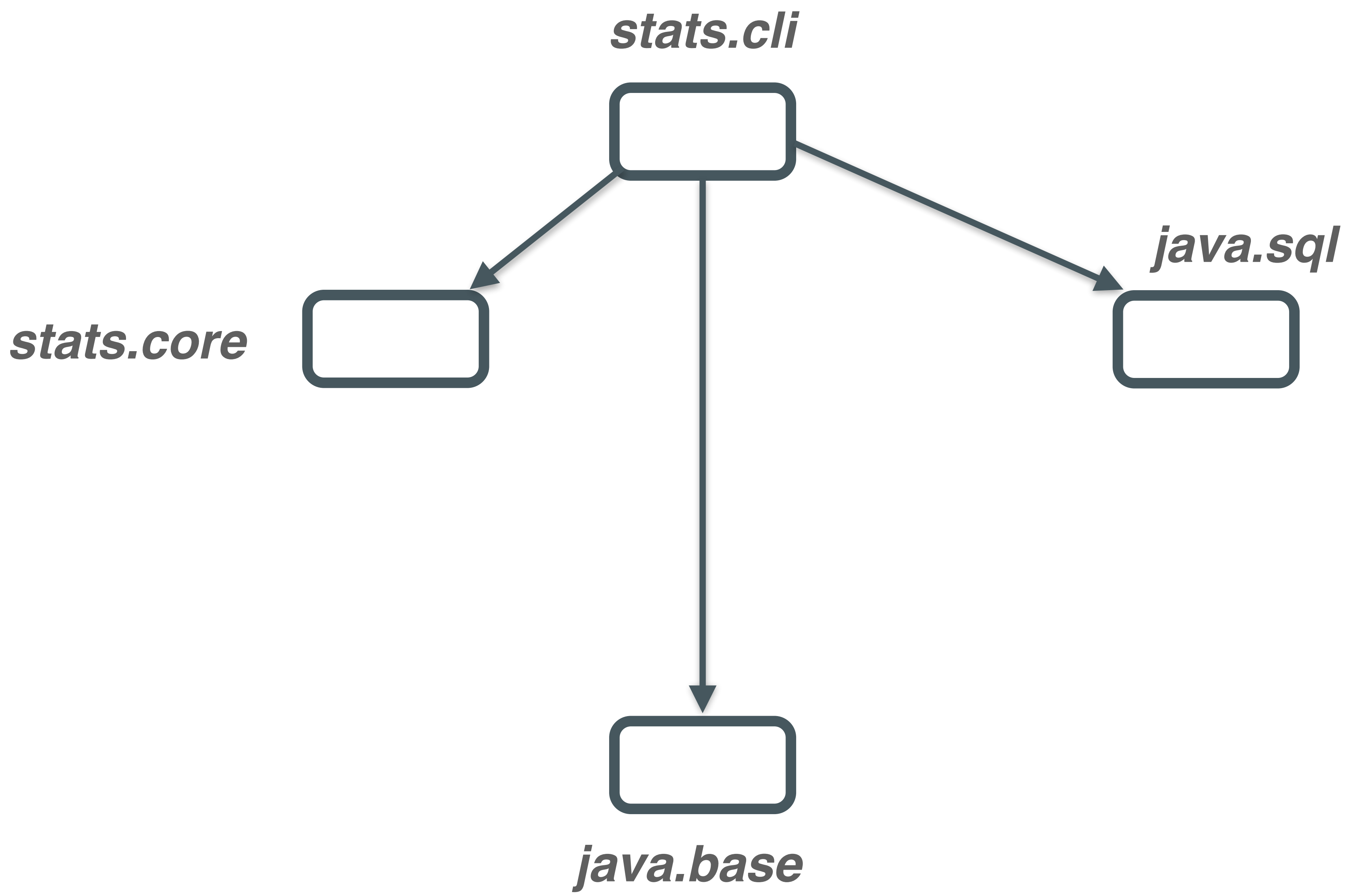

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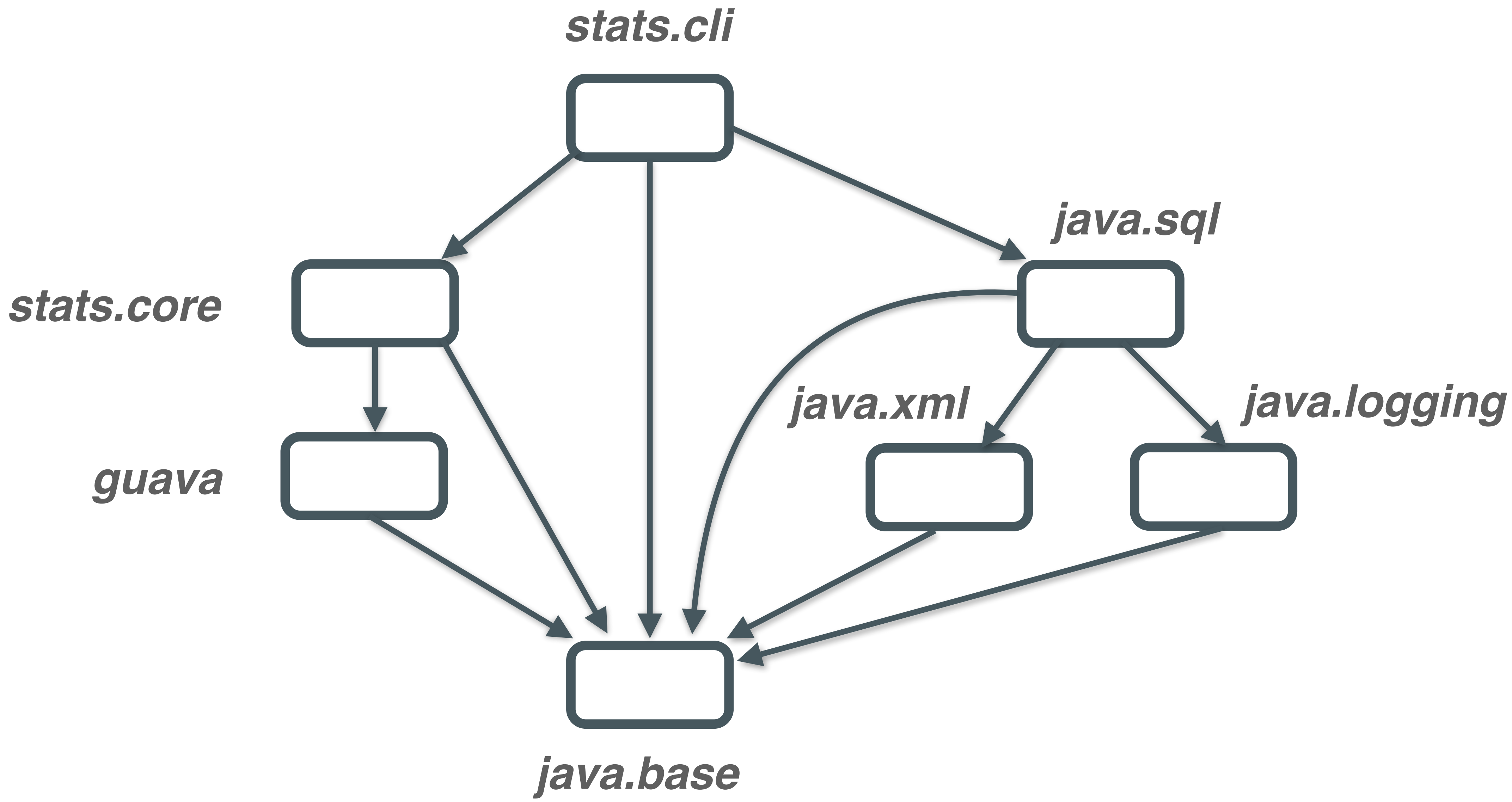

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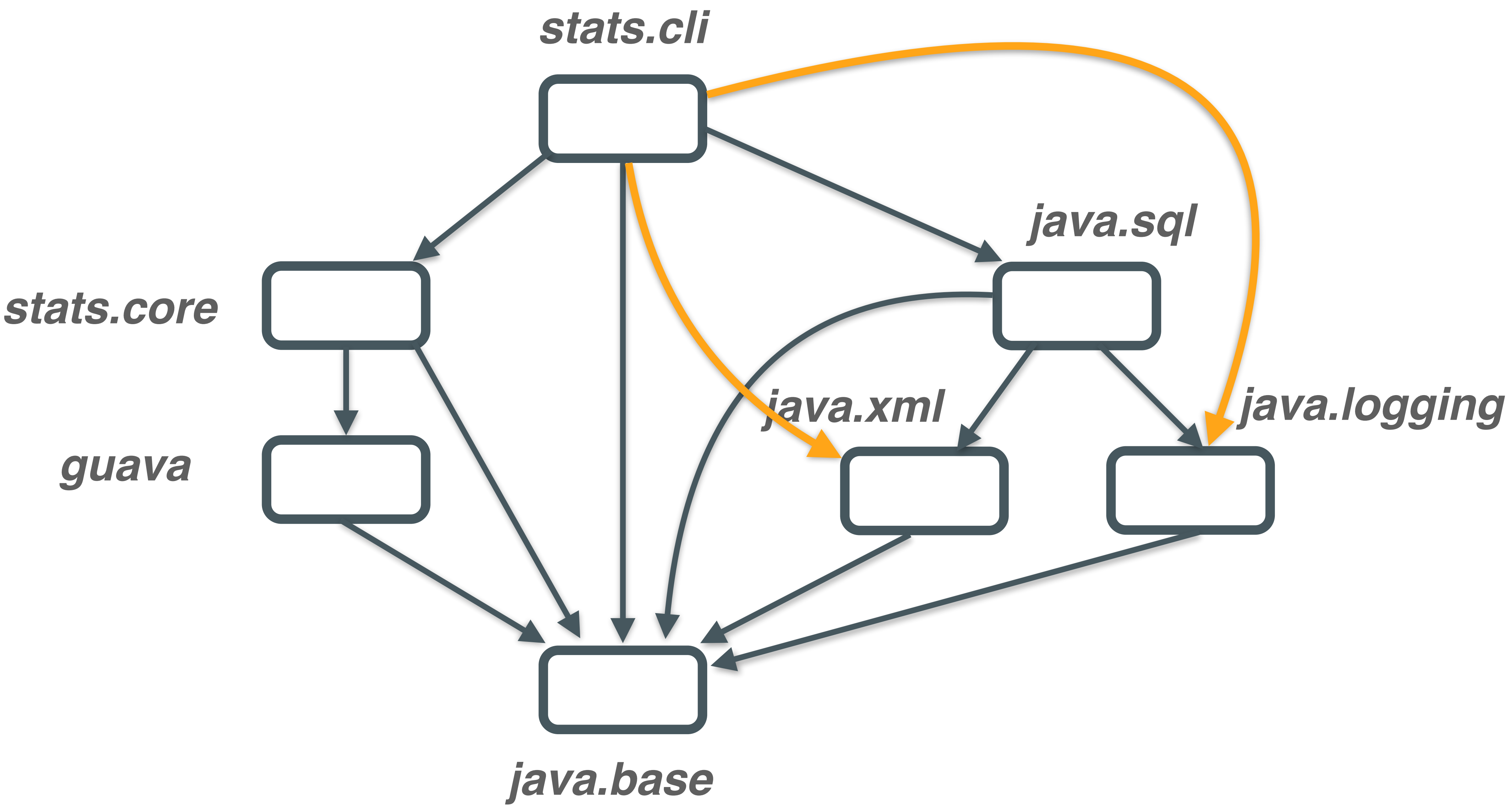

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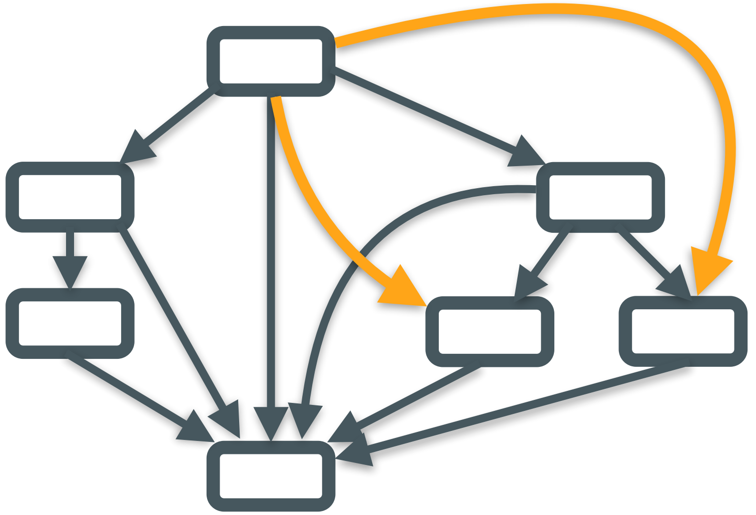
$ java **-Xdiag:resolver** -p mods -m stats.cli/stats.cli.Main

```
[Resolve] Root module stats.cli located
[Resolve]   (file:///d/mods/stats.cli/)
[Resolve] Module stats.core located, required by stats.cli
[Resolve]   (file:///d/mods/stats.core/)
[Resolve] Module java.base located, required by stats.cli
[Resolve]   (jrt:/java.base)
[Resolve] Module java.sql located, required by stats.cli
[Resolve]   (jrt:/java.sql)
[Resolve] Module guava located, required by stats.core
[Resolve]   (file:///d/mlib/guava.jar)
[Resolve] Module java.logging located, required by java.sql
[Resolve]   (jrt:/java.logging)
[Resolve] Module java.xml located, required by java.sql
[Resolve]   (jrt:/java.xml)
[Resolve] Resolve completed
[Resolve]   stats.cli
[Resolve]   stats.core
[Resolve]   guava
[Resolve]   java.base
[Resolve]   java.logging
[Resolve]   java.sql
[Resolve]   java.xml
Welcome to the Stats CLI
```



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Packaging as modular JAR

```
mods/stats.cli/module-info.class
mods/stats.cli/com/acme/stats/cli/Main.class
:
```

stats-cli.jar

```
module-info.class
com/acme/stats/cli/Main.class:
```

```
$ jar --create --file mlib/stats-cli.jar \
   --main-class com.acme.stats.cli.Main \
    -C mods/stats.cli .
```

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```
$ jar --file mlib/stats-cli.jar --print-module-descriptor

stats.cli
  requires stats.core
  requires mandated java.base
  requires java.sql
  main-class p.Main
```

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```
$ java -p mlib:mods -m stats.cli
Welcome to the Stats CLI
>
```

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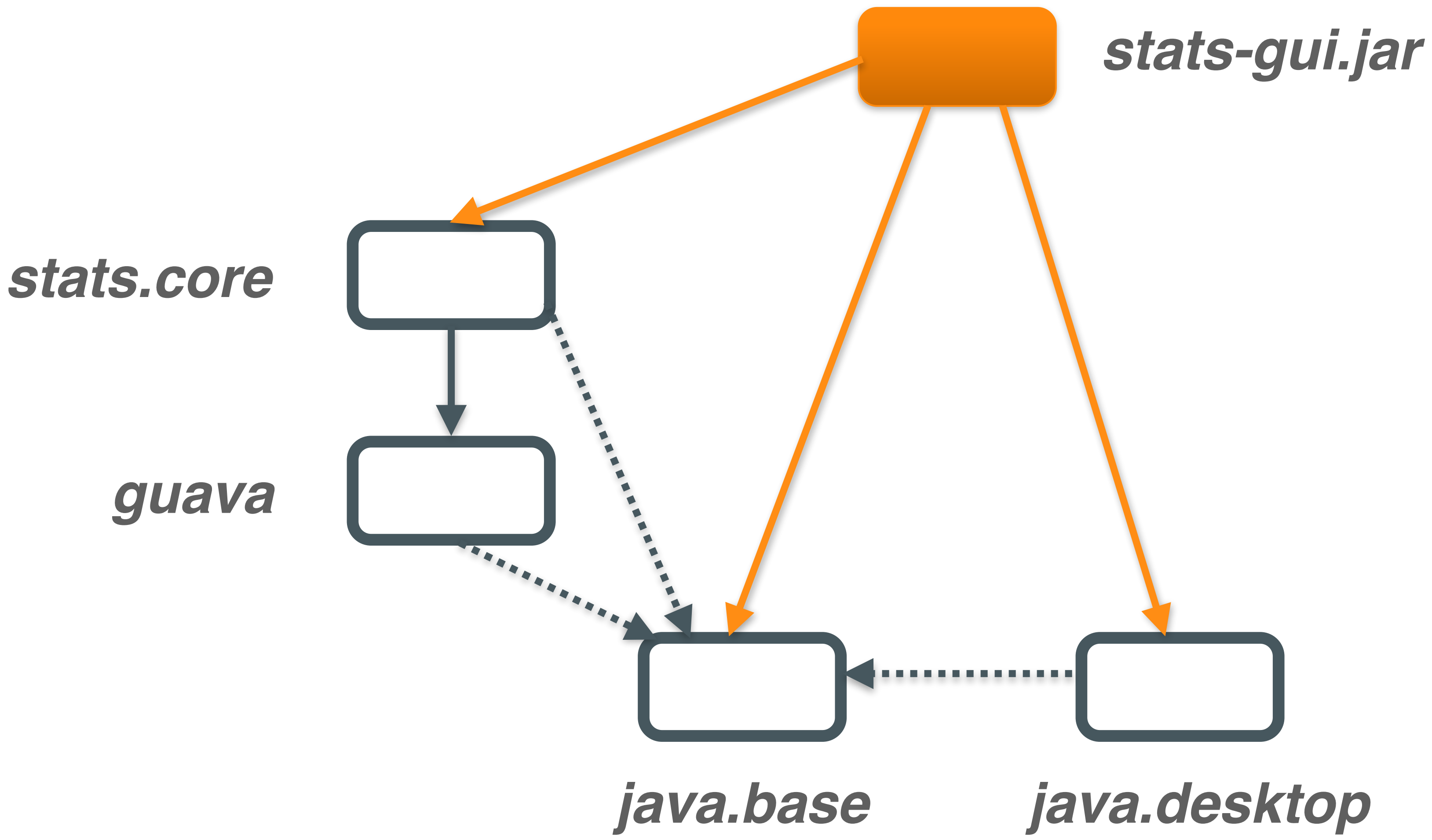
Using the module path and class path together



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Using the module path and class path together

```
$ java -p mlib --add-modules stats.core -jar stats-gui.jar
```

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Linking

```
$ jlink --module-path $JDKMODS:mlib:mods --add-modules stats.cli \
    --output myimage

$ myimage/bin/java -list-modules
java.base@9
java.logging@9
java.sql@9
java.xml@9
stats.cli
stats.core
guava
```

Wrap-up

- Introduced basic concepts
- Introduced basic command lines to compile, package and run

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Other sessions, mostly this room

- Prepare for JDK 9: Tues @ 2.30pm
- Advanced Modular Development: Mon @ 5.30pm, Wed @ 4.30pm
- Modules and Services, Tues @ 11.00am, Thur @ 2.30pm
- Project Jigsaw: Under The Hood: Tues @ 4pm
- Project Jigsaw Hack Session: Wed @ 8.30am

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More Information

OpenJDK Project Jigsaw

- http://openjdk.java.net/projects/jigsaw/
- mailto:jigsaw-dev@openjdk.java.net

Early Access Builds

- https://jdk9.java.net/jigsaw/

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