

Server-Side Options

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Princeton University

Objectives

- We will cover:
 - Some server-side options
 - Java: Servlets
 - Java: The Spring web app framework
 - JavaScript: The Express web app framework

Agenda

- **Prelim: packages**
- Prelim: library management
- Baseline
- Java server-side pgmming
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Packages

- **Python packages**
 - A *package* is a named group of modules (and other packages)
 - A *module* is stored in a *file*
 - A *package* is stored in a *directory*

Packages

- **Python packages (cont.)**
 - **Using a Python package**

```
import intmath.euclid
...
intmath.euclid.gcd(x, y)
...
```

Packages

- **Python packages (cont.)**
 - **Defining** a Python package

```
intmath
  __init__.py
  euclid.py
...
```

Packages

- **Java packages**
 - A ***package*** is a named group of classes/interfaces (and other packages)
 - A *class/interface* is stored in a file
 - A *package* is stored in a *directory*

Packages

- **Java packages (cont.)**
 - **Using a Java package**

```
...  
java.lang.Math.sqrt(x) ;  
...
```

```
import java.lang.Math ;  
...  
Math.sqrt(x) ;  
...
```

Packages

- **Java packages (cont.)**
 - **Defining a Java package**

```
// Book.java

package edu.princeton.penny;

// All names defined subsequently are
// in the edu.princeton.penny package.

public class Book { ... }
```

Defines class `edu.princeton.penny.Book`

`Book.java` **must be in** `edu/princeton/penny` directory

Agenda

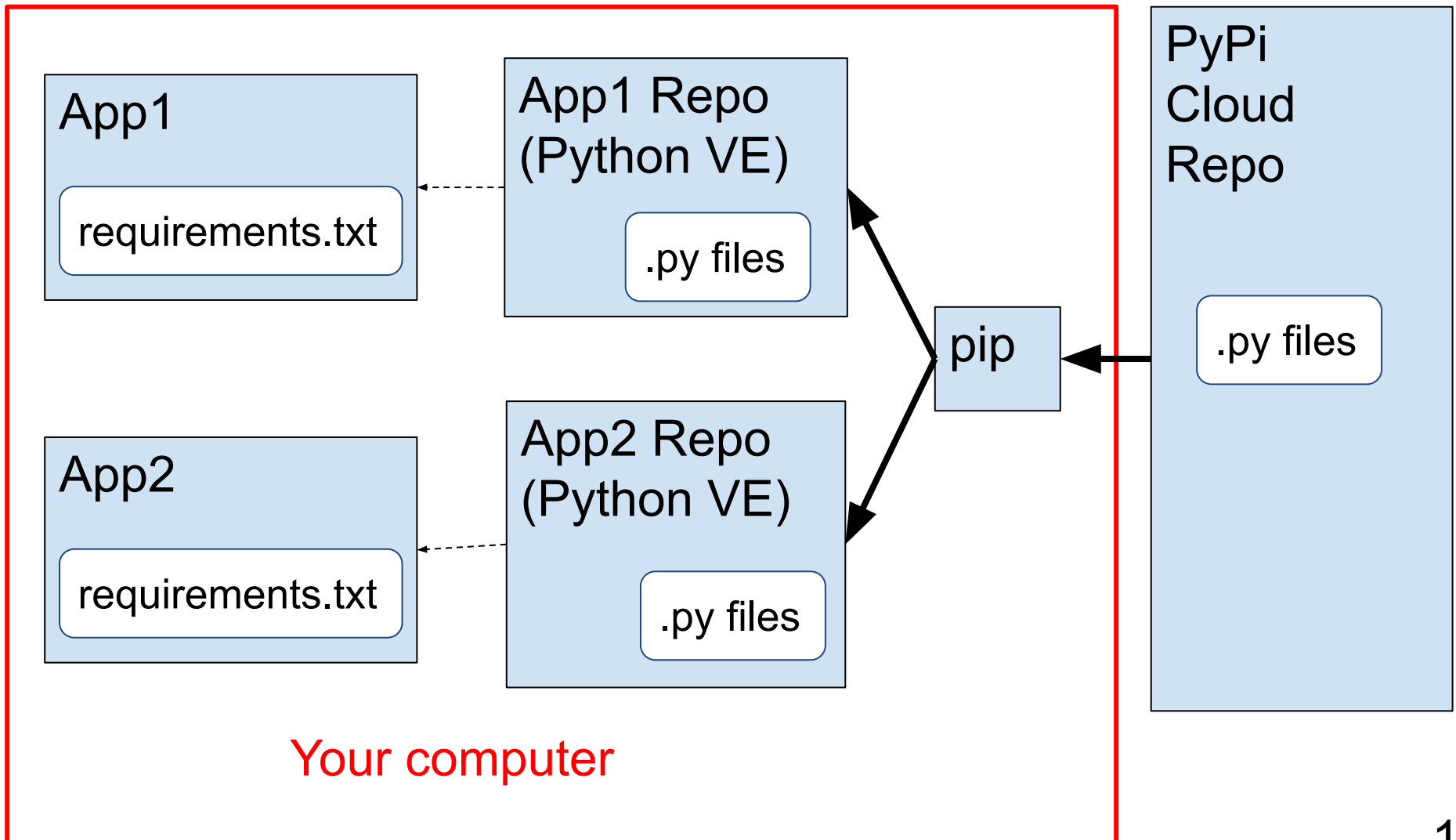
- Prelim: packages
- **Prelim: library management**
- Baseline
- Java server-side pgmming
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Library Management

- **Python** library management
 - **pip** and **PyPi** cloud repo

Library Management

Python library management (cont.)



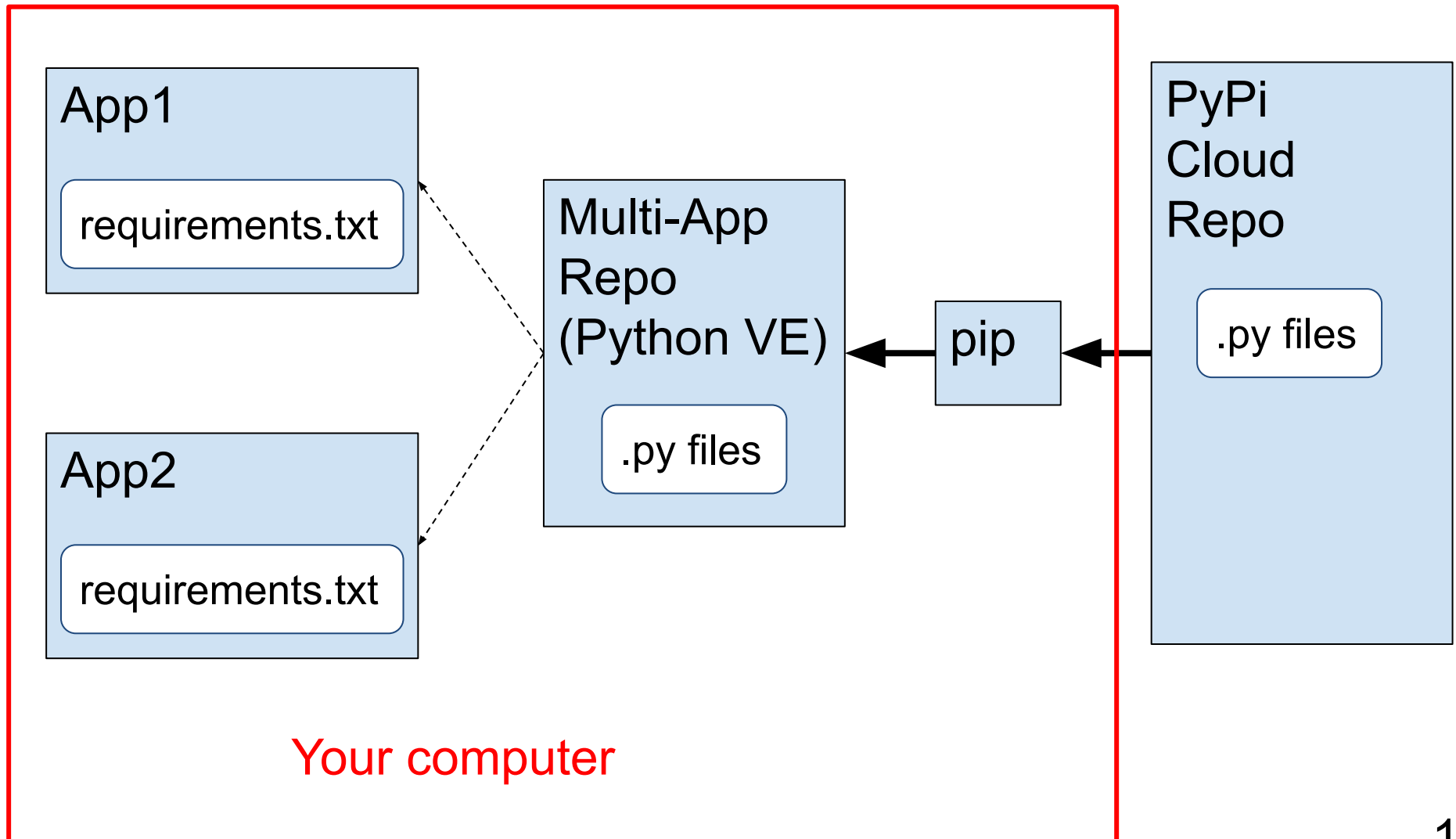
Library Management

- **Python** library management (cont.)

```
(Activate Python VE for App1)
cd App1ProjectDir
pip install -r requirements.txt
...
deactivate
...
(Activate Python VE for App2)
cd App2ProjectDir
pip install -r requirements.txt
...
deactivate
```

Library Management

Python library management (cont.)



Library Management

- **Python** library management (cont.)

```
(Activate Python VE for App1 and App2)
```

```
cd App1ProjectDir
```

```
pip install -r requirements.txt
```

```
cd App2ProjectDir
```

```
pip install -r requirements.txt
```

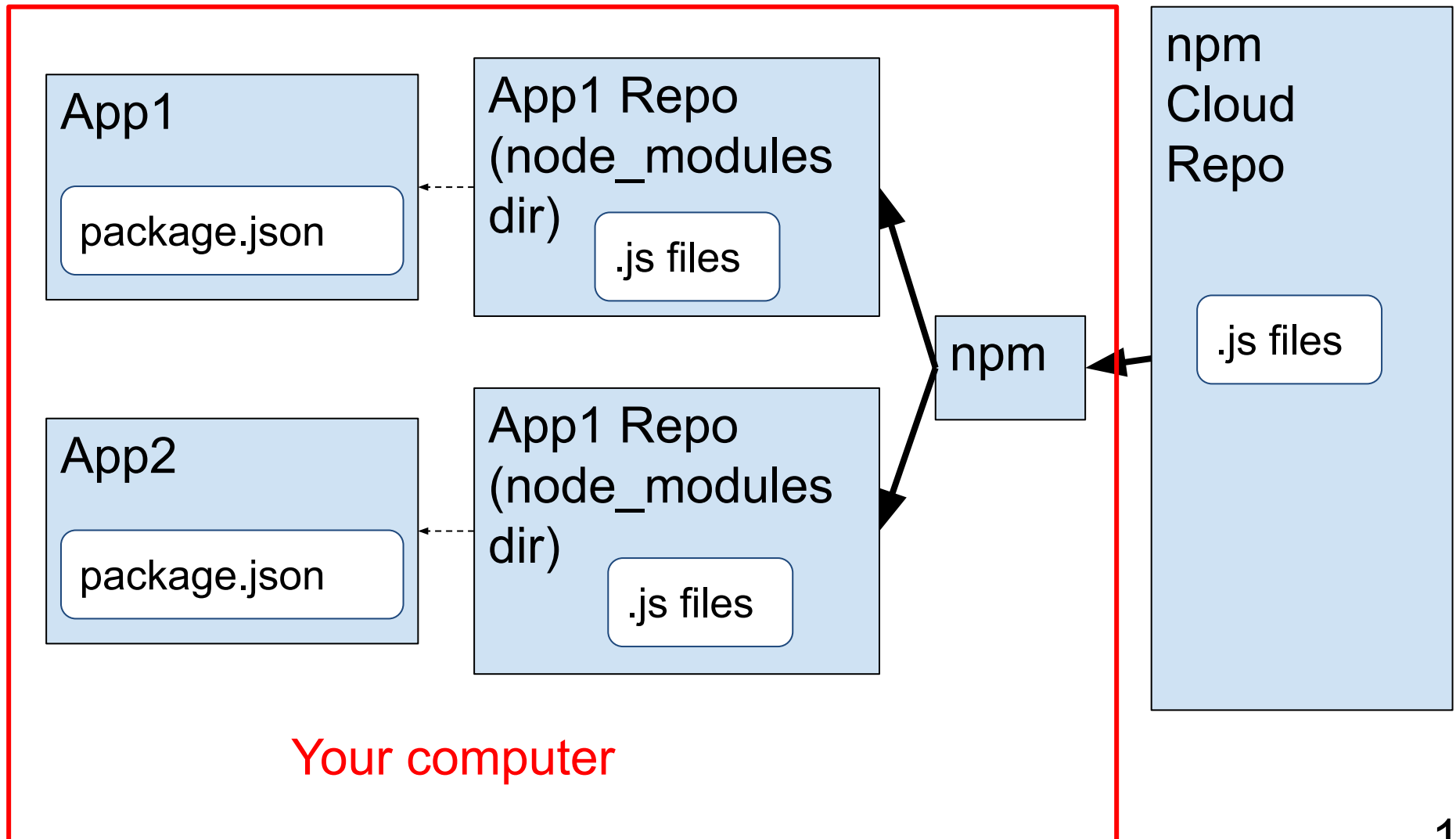
```
deactivate
```

Library Management

- **JavaScript** library management
 - **npm** and **npm cloud repo**

Library Management

JavaScript library management (cont.)



Library Management

- **JavaScript** library management (cont.)

```
cd App1ProjectDir  
npm install
```

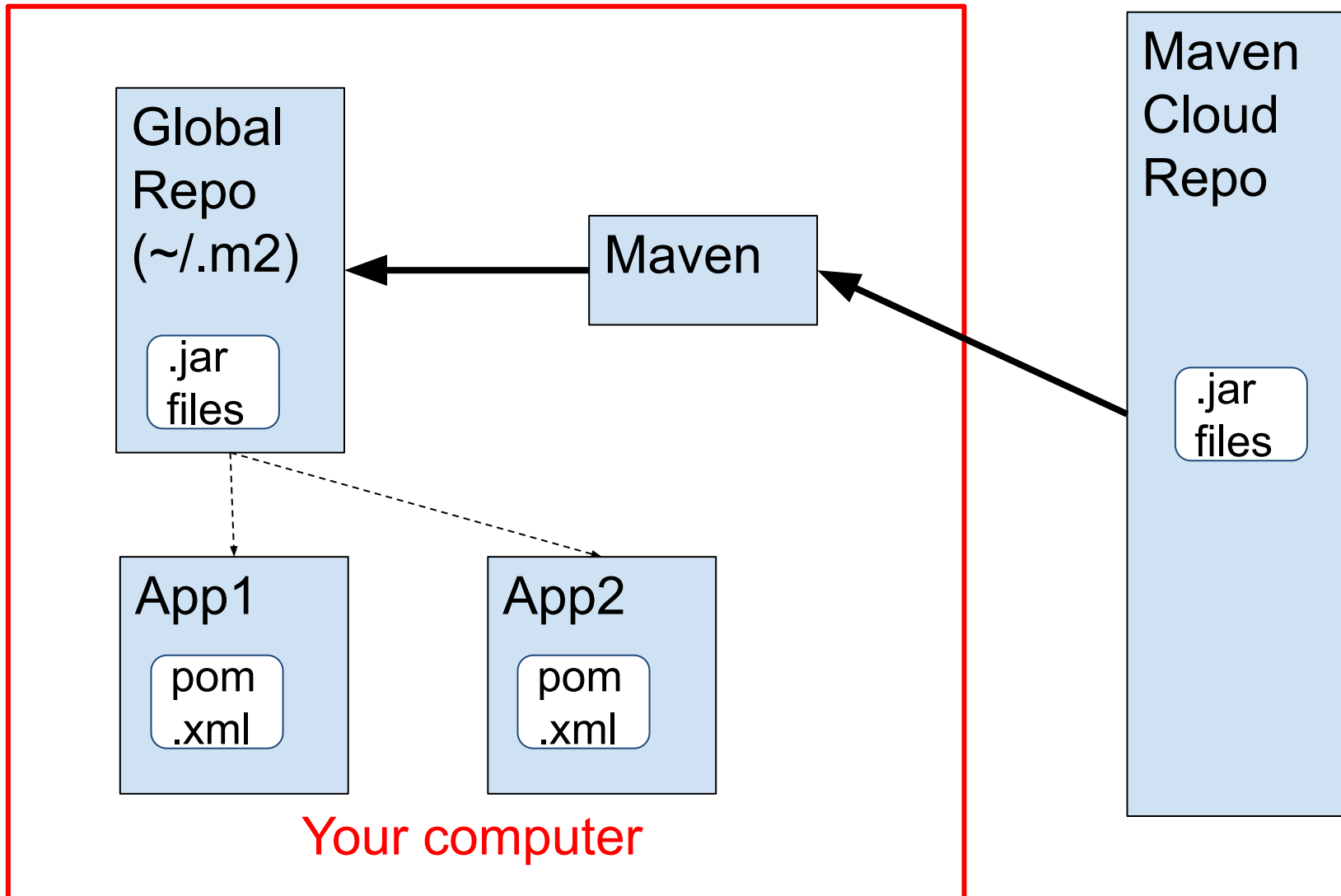
```
cd App2ProjectDir  
npm install
```

Library Management

- **Java** library management
 - *Maven* and Maven cloud repo
 - Others: *Gradle*, *Ant*
- Maven is a:
 - Library management tool
 - Build tool
 - C : make
 - Java : Maven

Library Management

Java library management (cont.)



Library Management

- **Java** library management (cont.)

```
cd App1ProjectDir  
mvn compile
```

```
cd App2ProjectDir  
mvn compile
```

Library Management

- Installing Maven
 - Mac:
 - `brew install maven`
 - MS Windows
 - <https://maven.apache.org/guides/getting-started/windows-prerequisites.html>
 - Linux
 - Use your package mgr

Library Management

	App Repos?	Multi-App Repos?	Global Repo?
Python/ pip	yes (not enforced)	yes (bad idea *)	not really
JavaScript/ npm	yes	no	not really
Java/ maven	no	no	yes

* But I do it routinely!

Agenda

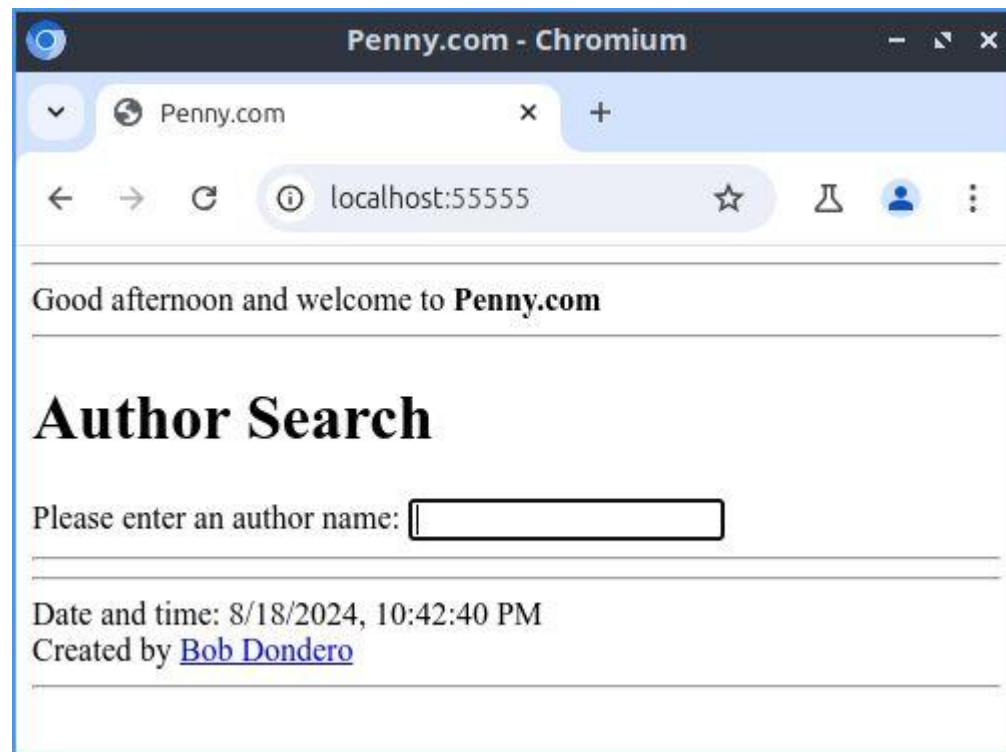
- Prelim: packages
- Prelim: library management
- **Baseline**
- Java server-side pgmming
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Baseline

- See **PennyFlaskSpa** app
 - (Same as PennyAjax4 app)

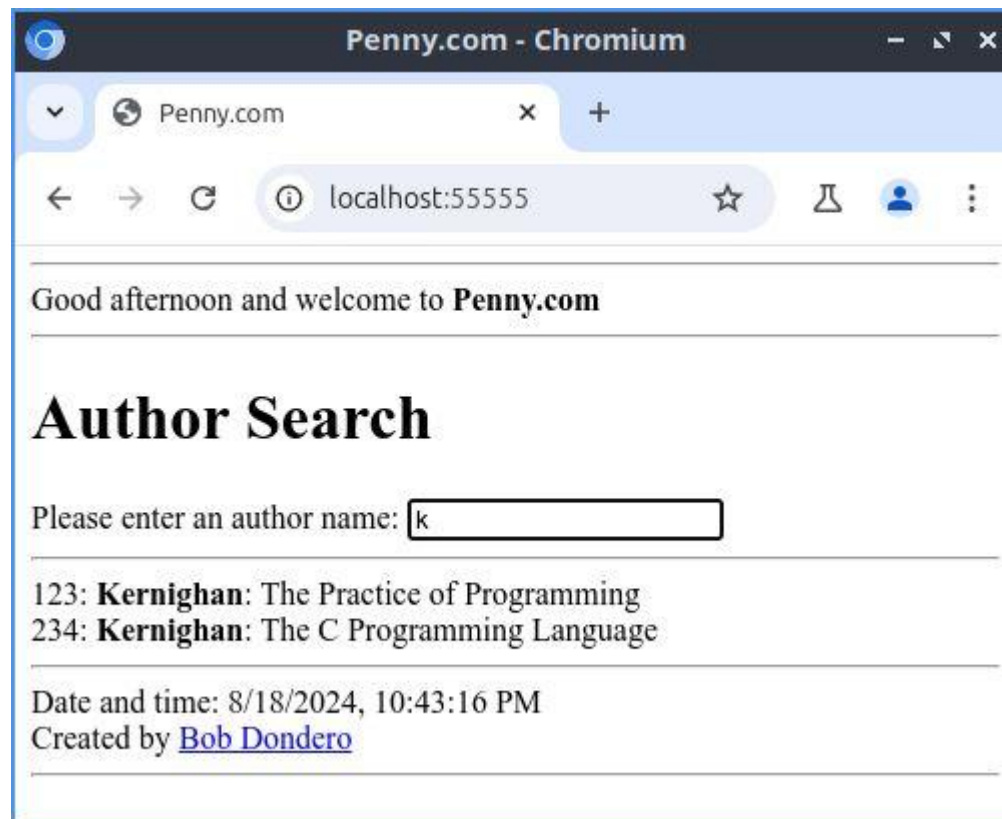
Baseline

- See **PennyFlaskSpa** app (cont.)



Baseline

- See PennyFlaskSpa app (cont.)



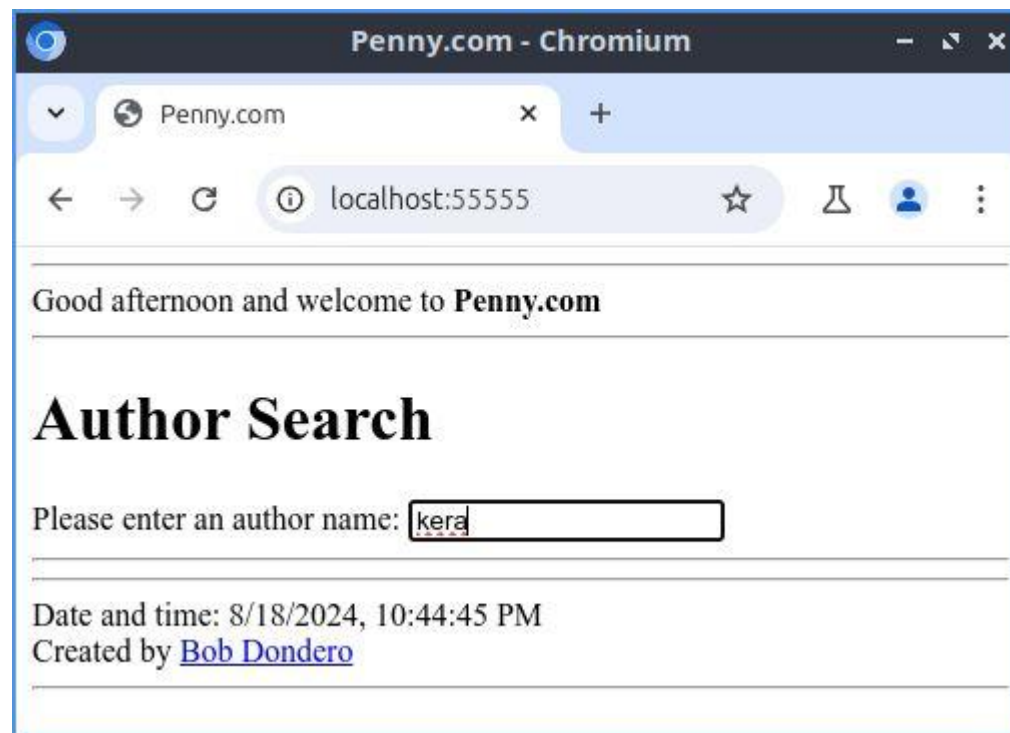
Baseline

- See PennyFlaskSpa app (cont.)



Baseline

- See PennyFlaskSpa app (cont.)



Baseline

- See **PennyFlaskSpa** app (cont.)
 - **runserver.py**
 - penny.sql, penny.sqlite
 - **database.py**
 - **penny.py**
 - **index.html**

Baseline

So far:

Client	Browser + HTML + JavaScript
Server	Python + Flask

Agenda

- Prelim: packages
- Prelim: library management
- Baseline
- **Java server-side pgmming**
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
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- JavaScript server-side pgmming: Express

Java Server-Side Web Pgmming

- **Question:** Why study Java server-side web programming?
- **Answer 1:** Help you better understand server-side web programming
- **Answer 2:** Give you a sense of how Java is used in the “real world”

Java Server-Side Web Pgmming

- **Question:** Why study Java server-side web programming (cont.)?
- **Answer 3:** Show realistic use of some advanced features of Java
- **Answer 4:** Popular and important...

Java Server-Side Web Pgmming

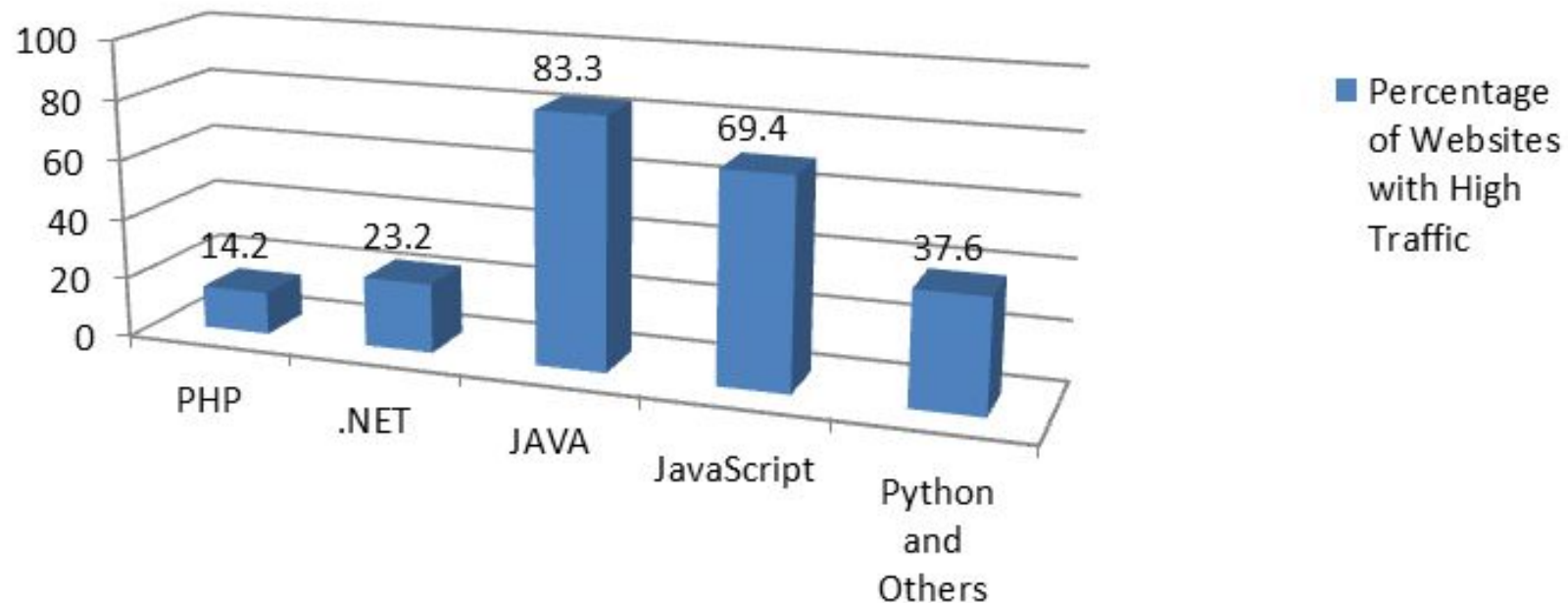
Website	Front End	Back End
Google	JavaScript	C, C++, Go, Java , Python, Node
Facebook	JavaScript TypeScript Flow	Hack, HHVM, Python, C++, Java , Erlang, D, Haskell
YouTube	JavaScript TypeScript	Python, C, C++, Java , Go
Yahoo	JavaScript	PHP
Etsy	JavaScript	PHP
Amazon	JavaScript	Java , C++, Perl
Wikipedia	JavaScript	PHP
Fandom	JavaScript	PHP
X	JavaScript	C++, Java , Scala, Ruby
Bing	JavaScript	C++, C#
eBay	JavaScript	Java , JavaScript, Scala

<https://en.wikipedia.org/wiki/>

Programming_languages_used_in_most_popular_websites (July 2024)

Java Server-Side Web Pgmming

Programming Language vs High Traffic Websites



-- <http://blog.stoneriverelearning.com/top-5-programming-languages-used-in-web-development/>

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- **Java server-side pgmming: Servlets**
- Java server-side pgmming: Spring
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- JavaScript server-side pgmming: Express

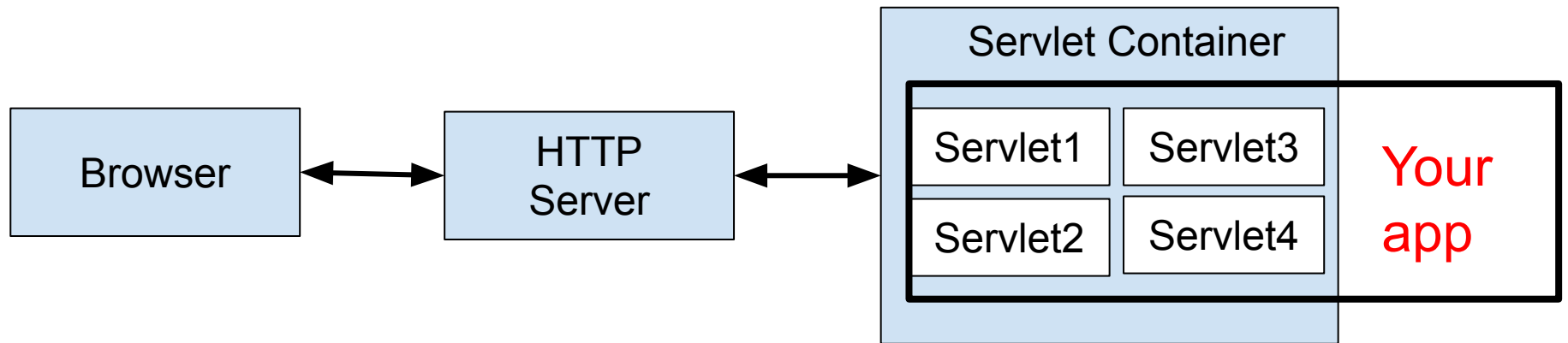
Servlet Programming

- **Question:** How does one do web programming in Java?
- **Answer 1:** Use Servlets
- **Answer 2:** Use a Java web app framework

Servlet Programming

- **Servlets**
 - “A servlet is a Java technology-based Web component, managed by a **container**, that generates dynamic content.”
 - Servlet specification at:
 - http://download.oracle.com/.../servlet-3_0-final-spec.pdf

Servlet Programming

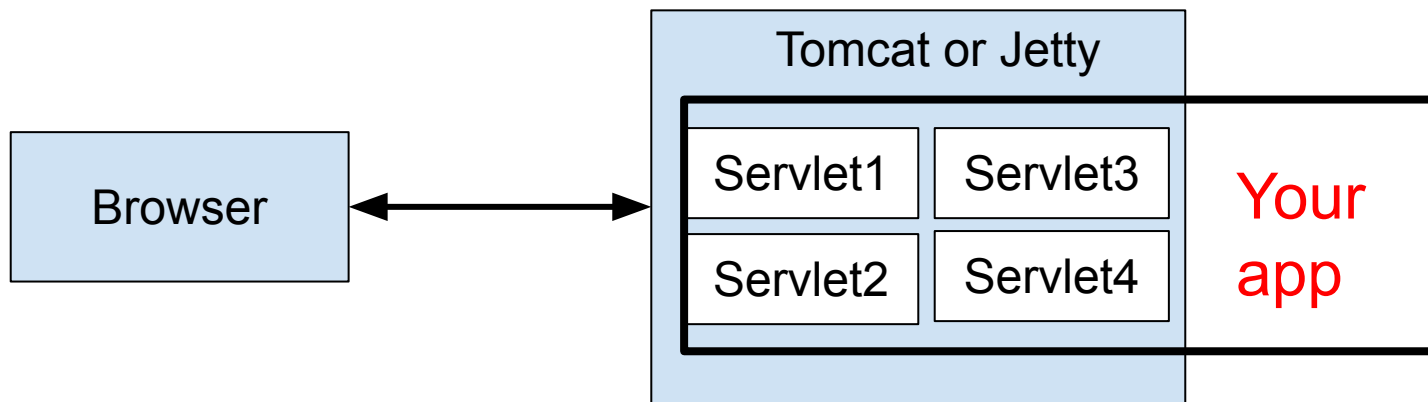


Popular servlet containers:

Apache Tomcat

Eclipse Jetty

Servlet Programming



Tomcat or Jetty can be both servlet container and HTTP server

We'll use that configuration

We'll use Jetty for Servlets, Tomcat for Spring

Servlet Programming

- **Python:**
 - *WSGI specification* connects HTTP server and your Python app
- **Java:**
 - *Servlet specification* connects HTTP server and your Java app

Servlet Programming

```
PennyServletsSpa/  
  runserver  
  runserver.bat  
  pom.xml  
  src/  
    main/  
      java/  
        edu/  
          princeton/  
            penny/  
              Book.java  
              Database.java  
              IndexServlet.java  
              Penny.java  
              SearchResultsServlet.java  
    resources/  
      index.html  
      penny.sql  
      penny.sqlite
```

Servlet Programming

- See **PennyServletsSpa** app (cont.)
 - **runserver, runserver.bat**
 - **pom.xml**
 - **penny.sql, penny.sqlite**
 - **Book.java, Database.java**
 - **IndexServlet.java**
 - **SearchResultsServlet.java**
 - **Penny.java**
 - **index.html**

Servlet Programming

- See **PennyServletsSpa** app

On Linux or Mac:

```
$ ./runserver 55555
```

On MS Windows:

```
C:\>runserver.bat 55555
```

Servlet Programming

So far:

Client	Browser + HTML + JavaScript
Server	Python + Flask Java + Servlets

Agenda

- Prelim: packages
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- Java server-side pgmming
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- **Java server-side pgmming: Spring**
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Spring

- **Question:** How does one do web programming in Java?
- **Answer 1:** Use Servlets
- **Answer 2:** Use a Java web app framework

Spring



Rod
Johnson

Spring

- ***Spring Boot***

- Wikipedia: “Spring Boot is a convention-over-configuration extension for the **Spring** Java platform intended to help minimize configuration concerns while creating Spring-based applications.”

Spring

- Why study Spring / Spring Boot?
 - (Instead of some other framework)

Spring

Some popular server-side web app frameworks:

Rank	Framework	GitHub Stars
1	Laravel (PHP)	74.9K
2	Django (Python)	73.4K
3	Flask (Python)	64.5K
4	Express (JavaScript)	62.0K
5	Ruby on Rails (Ruby)	53.6K
6	Spring (Java)	53.3K
7	Meteor (JavaScript)	43.8K
8	Symfony (PHP)	28.7K

According to GitHub as of 10/4/23

Spring

- See **PennySpringSpa** app (cont.)
 - Browse to <https://start.spring.io/>
 - Complete as shown on following slides, and click *Generate* to download `Penny.zip`

Spring

The screenshot shows the Spring Initializr web application in a browser window. The browser's address bar shows 'start.spring.io'. The page has a sidebar with a hamburger menu and a clock icon. The main content area is divided into sections for Project, Language, Spring Boot, Project Metadata, and Dependencies. The Project section has radio buttons for Gradle - Groovy, Gradle - Kotlin, and Maven (selected). The Language section has radio buttons for Java (selected), Kotlin, and Groovy. The Spring Boot section has radio buttons for 3.5.0 (SNAPSHOT), 3.5.0 (M3), 3.4.5 (SNAPSHOT), 3.4.4 (selected), 3.3.11 (SNAPSHOT), and 3.3.10. The Project Metadata section has input fields for Group (edu.princeton), Artifact (penny), Name (penny), Description (PennySpring Application), and Package name (edu.princeton.penny). The Packaging section has radio buttons for Jar and War (selected). The Java section has radio buttons for 24, 21 (selected), and 17. The Dependencies section has a button 'ADD DEPENDENCIES... ⌘ + B' and the text 'No dependency selected'. At the bottom, there are buttons 'GENERATE ⌘ + ↵', 'EXPLORE CTRL + SPACE', and a button with three dots.

Spring Initializr

start.spring.io

CS Department W... COS217 COS333 IntroCsBook IndepWork Princeton Health EmailAddresses Linux Mint Community Forums All Bookmarks

☰

🕒

 **spring initializr**

Project

☐ Gradle - Groovy ☒ Gradle - Kotlin ☒ Maven

Language

☒ Java ☐ Kotlin ☐ Groovy

Spring Boot

☐ 3.5.0 (SNAPSHOT) ☐ 3.5.0 (M3) ☐ 3.4.5 (SNAPSHOT) ☒ 3.4.4 ☐ 3.3.11 (SNAPSHOT) ☐ 3.3.10

Project Metadata

Group

Artifact

Name

Description

Package name

Packaging ☐ Jar ☒ War

Java ☐ 24 ☒ 21 ☐ 17

Dependencies

ADD DEPENDENCIES... ⌘ + B

No dependency selected

 **GENERATE ⌘ + ↵** **EXPLORE CTRL + SPACE** ...

Spring

- See **PennySpringSpa** app (cont.)
 - Unzip `Penny.zip` to generate this directory structure:

Spring

```
Penny
  pom.xml
  src/
    main/
      java/
        edu/
          princeton/
            penny/
              PennyApplication.java
      resources/
        application.properties
    ...
  ...
...
```

A working application

Spring

- See **PennySpringSpa** app (cont.)
 - Edit to create this directory structure:

Spring

```
PennySpringSpa
runserver
runserver.bat
pom.xml
src/
  main/
    java/
      edu/
        princeton/
          penny/
            Book.java
            Database.java
            PennyController.java
            PennyApplication.java
    resources/
      static/
        index.html
        application.properties
        penny.sql
        penny.sqlite
  ...
...
```

Spring

- See **PennySpringSpa** app (cont.)
 - **runserver, runserver.bat**
 - **pom.xml**
 - **application.properties**
 - penny.sql, penny.sqlite
 - Book.java
 - Database.java
 - **PennyController.java**
 - **PennyApplication.java**
 - **index.html**

Spring

- See **PennySpringSpa** app

On Linux or Mac:

```
$ ./runserver
```

On MS Windows:

```
C:\>runserver.bat
```

Spring

- There is much more to Spring
 - Spring website:
 - <https://spring.io/>
 - Spring Boot website:
 - <https://spring.io/projects/spring-boot>

Spring

So far:

Client	Browser + HTML + JavaScript
Server	Python + Flask Java + Servlets Java + Spring

Agenda

- Prelim: packages
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- Java server-side pgmming
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
- **JavaScript server-side pgmming**
- JavaScript server-side pgmming: Express

JavaScript Server Web Pgmming

- Why study JavaScript server-side pgmming?

JavaScript Server Web Pgmming

Website	Front End	Back End
Google	JavaScript	C, C++, Go, Java, Python, Node
Facebook	JavaScript TypeScript Flow	Hack, HHVM, Python, C++, Java, Erlang, D, Haskell
YouTube	JavaScript TypeScript	Python, C, C++, Java, Go
Yahoo	JavaScript	PHP
Etsy	JavaScript	PHP
Amazon	JavaScript	Java, C++, Perl
Wikipedia	JavaScript	PHP
Fandom	JavaScript	PHP
X	JavaScript	C++, Java, Scala, Ruby
Bing	JavaScript	C++, C#
eBay	JavaScript	Java, JavaScript, Scala

<https://en.wikipedia.org/wiki/>

Programming_languages_used_in_most_popular_websites (July 2024)

JavaScript Server Web Pgmming

- Why study server-side JavaScript pgmming (cont.)?
 - Introduces additional aspects of JavaScript
 - Database programming
 - Becoming more popular

Agenda

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- Java server-side pgmming
- Java server-side pgmming: Servlets
- Java server-side pgmming: Spring
- JavaScript server-side pgmming
- **JavaScript server-side pgmming:
Express**

Express

- Why study server-side JavaScript programming using **Express** (instead of some other framework)?

Express

Some popular server-side web app frameworks:

Rank	Framework	GitHub Stars
1	Laravel (PHP)	74.9K
2	Django (Python)	73.4K
3	Flask (Python)	64.5K
4	Express (JavaScript)	62.0K
5	Ruby on Rails (Ruby)	53.6K
6	Spring (Java)	53.3K
7	Meteor (JavaScript)	43.8K
8	Symfony (PHP)	28.7K

According to GitHub as of 10/4/23

Express

- See **PennyExpressSpa** app
 - **runserver.js**
 - **package.json**
 - penny.sql, penny.sqlite
 - **database.js**
 - **penny.js**
 - **index.html**

Express

- See **PennyExpressSpa** app (cont.)

```
$ cd PennyExpressSpa  
$ npm install  
$ node runserver.js 55555  
Listening at port 55555
```

Express

- There is much more to Express
 - Express website:
 - <https://expressjs.com/>

Express

So far:

Client	Browser + HTML + JavaScript
Server	Python + Flask Java + Servlets Java + Spring JavaScript + Express

Commentary

Server Technologies	Small Apps	Medium Apps	Large Apps
PHP	✓		
Python + Flask		✓	
JavaScript + Express		✓	
Java + Spring			✓

Summary

- We have covered:
 - Some server-side options
 - Java: Servlets
 - Java: The Spring web app framework
 - JavaScript: The Express web app framework