

Server-Side Options

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Objectives

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

Agenda

- **Prelim: packages**
- Prelim: library management
- Prelim: function definition expressions
- Baseline
- Java server-side pgmming
- Java server-side pgmming: Spark
- 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

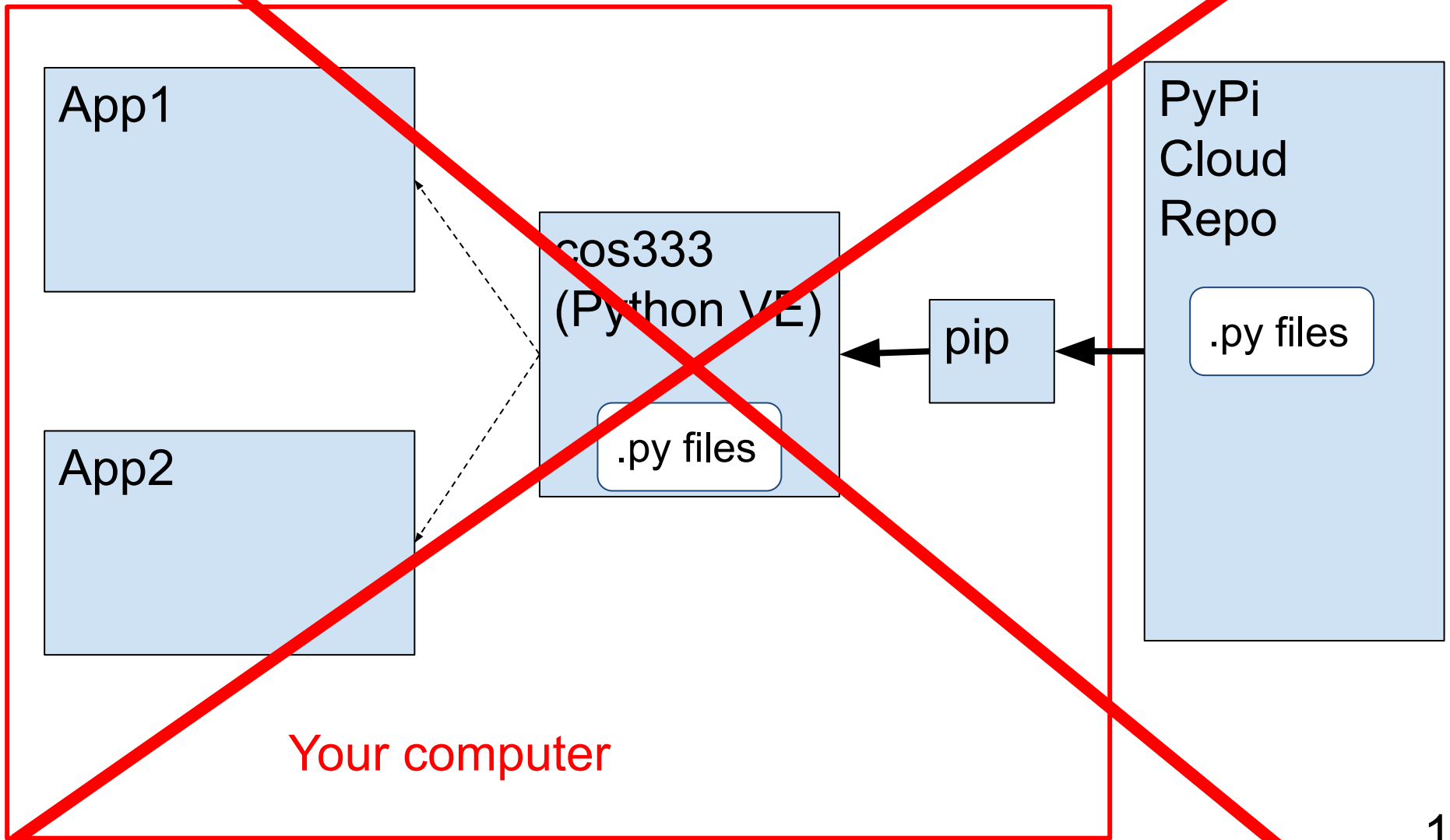
- Prelim: packages
- **Prelim: library management**
- Prelim: function definition expressions
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- Java server-side pgmming
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Library Management

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

Library Management

Python library management (cont.)



Library Management

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

```
activate333
```

```
cd App1ProjectDir
```

```
Install libraries needed by App1
```

```
Run App1
```

```
cd App2ProjectDir
```

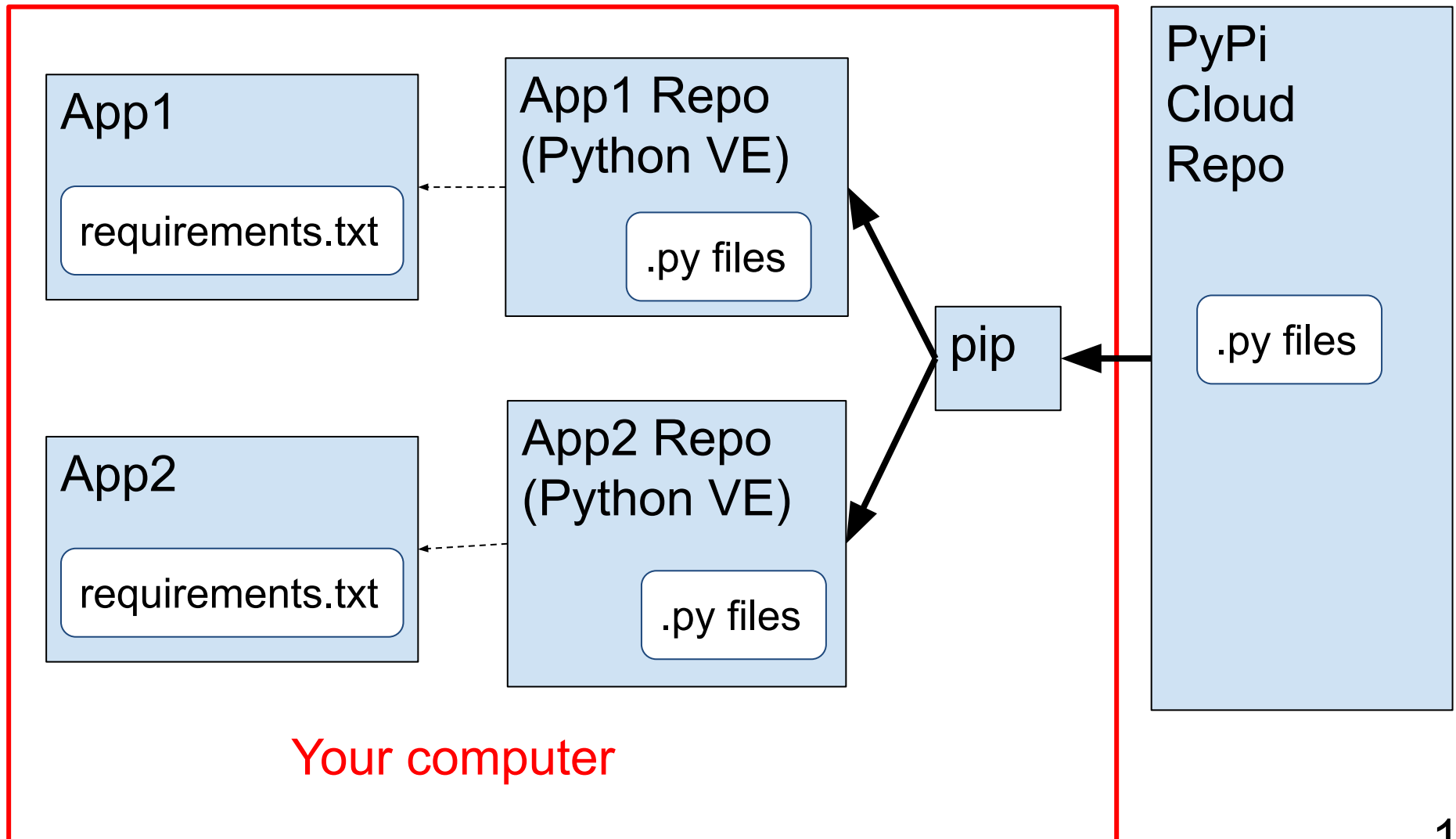
```
Install libraries needed by App2
```

```
Run app2
```

```
deactivate
```

Library Management

Python library management (cont.)



Library Management

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

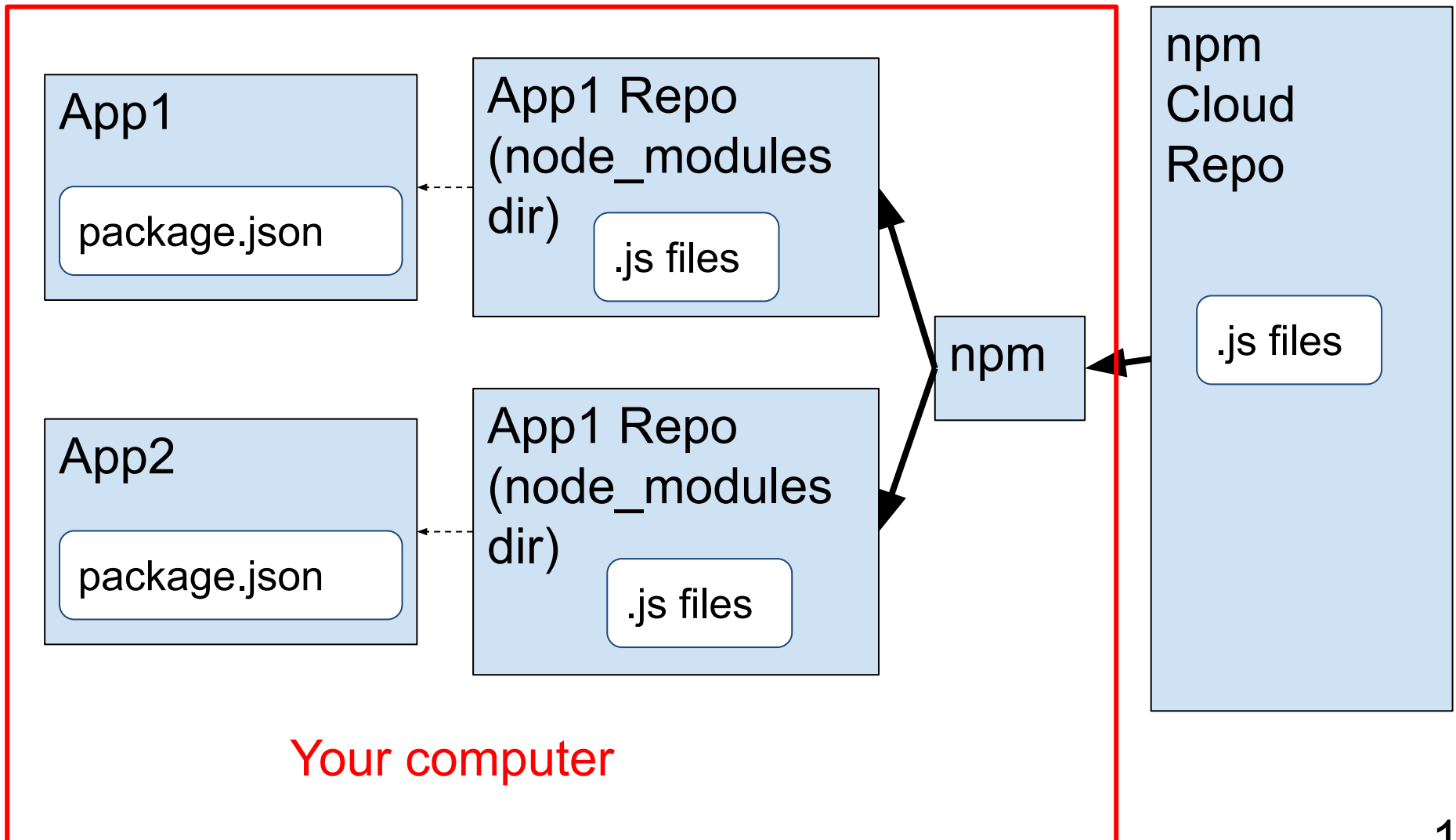
```
Activate Python VE for App1  
cd App1ProjectDir  
pip install -r requirements.txt  
Run App1  
deactivate  
...  
Activate Python VE for App2  
cd App2ProjectDir  
pip install -r requirements.txt  
Run App2  
deactivate
```

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  
Run App1
```

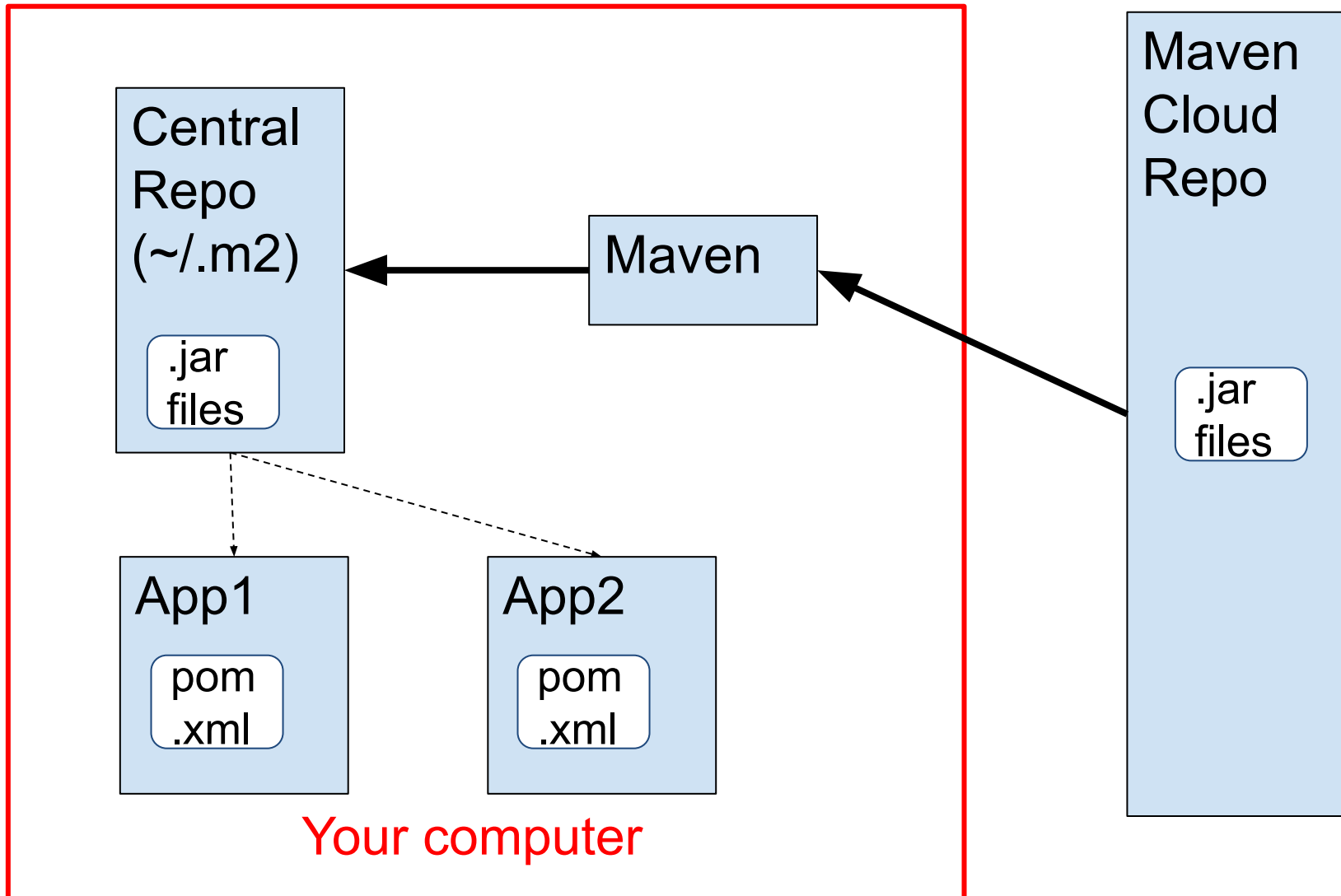
```
cd App2ProjectDir  
npm install  
Run App2
```

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  
Run App1
```

```
cd App2ProjectDir  
mvn compile  
Run App2
```

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

	On Your Computer	
	One specific repo for each app?	One central repo for all apps?
Python/ pip	yes	not really
JavaScript/ npm	yes	not really
Java/ maven	no	yes

Agenda

- Prelim: packages
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- **Prelim: function definition expressions**
- Baseline
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- Java server-side pgmming: Spark
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Function Def Exprs

In JavaScript

With a function definition **statement**:

```
function compareLengths(word1, word2) {  
    return word1.length - word2.length;  
}  
...  
words.sort(compareLengths);  
...
```

With a function definition **expression**:

```
...  
words.sort(  
    function(word1, word2) {  
        return word1.length - word2.length;  
    }  
);  
...
```

Function Def Exprs

In **JavaScript**

With an **arrow** function definition **expression**:

```
...  
words.sort(  
    (word1,word2) => word1.length-word2.length) ;  
...
```

Arrow functions are a syntactic shortcut

Function Def Exprs

In **Python**

Lambda Expressions



Alonzo
Church

Function Def Exprs

- In **Python**

```
lambda param1, param2 ...: expression
```

- The keyword `lambda`
- (optionally) Parameters separated by commas
- A colon
- A single expression that uses the parameters

Function Def Exprs

In Python

Without a lambda expression:

```
def compare_lengths(word1, word2):  
    return len(word1) - len(word2)  
...  
words.sort(compare_lengths)  
...
```

With a lambda expression:

```
...  
words.sort(  
    lambda word1, word2: len(word1) - len(word2) )  
...
```

Function Def Exprs

- In **Java**:
 - *Java lambda expressions*
 - New to Java SE 8

Function Def Exprs

In Java

Without a lambda expression:

```
class LengthComparator implements Comparator<String>
{
    public int compare(String word1, String word2)
    {
        return word1.length() - word2.length();
    }
}

...
String[] words;
...
Arrays.sort(words, new LengthComparator());
...
```

Function Def Exprs

In Java

With a lambda expression:

```
...  
String[] words;  
...  
Arrays.sort(words,  
    (String word1, String word2) ->  
        word1.length() - word2.length() );  
...
```

Function Def Exprs

In **Java**

With a lambda expression:

```
...  
String[] words;  
...  
Arrays.sort(words,  
    (word1, word2) -> word1.length() - word2.length()  
);  
...
```

Sometimes can omit parameter types

Function Def Exprs

- In **Java**
 - ***Functional interface***
 - An interface that declares a single method
 - It's OK to use a lambda expression in lieu of **an object of a class that implements a functional interface**

Function Def Exprs

- In **Java**
 - Java lambda expression observations
 - Function def expressions in a language that doesn't have functions!
 - Handy!
 - Inelegant?

Agenda

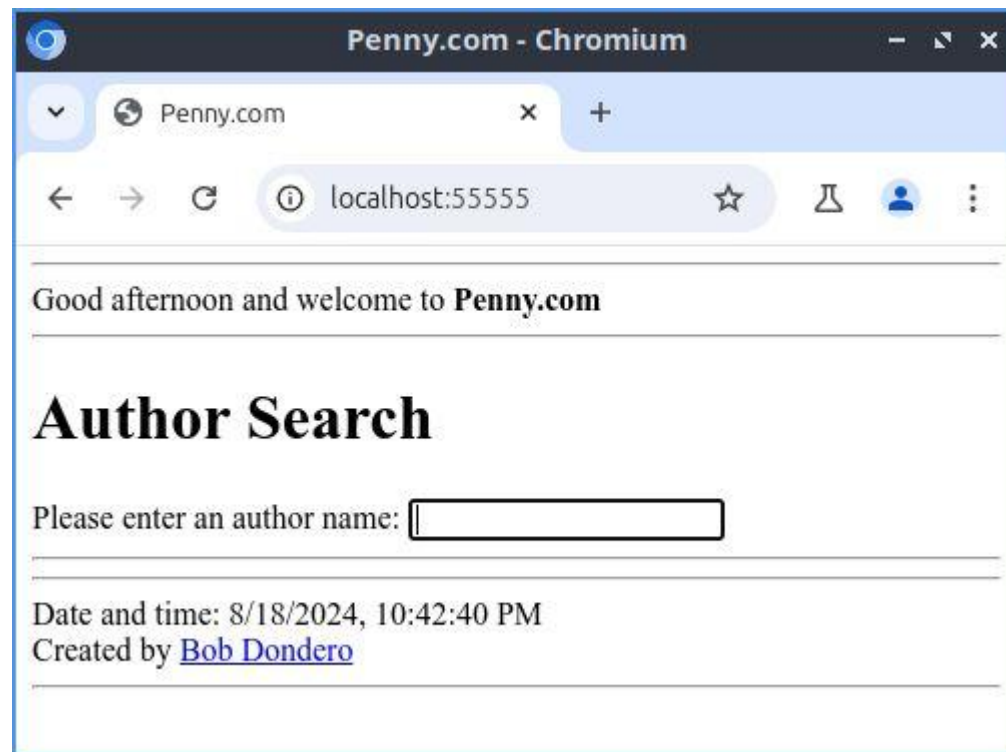
- Prelim: packages
- Prelim: library management
- Prelim: function definition expressions
- **Baseline**
- Java server-side pgmming
- Java server-side pgmming: Spark
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Baseline

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

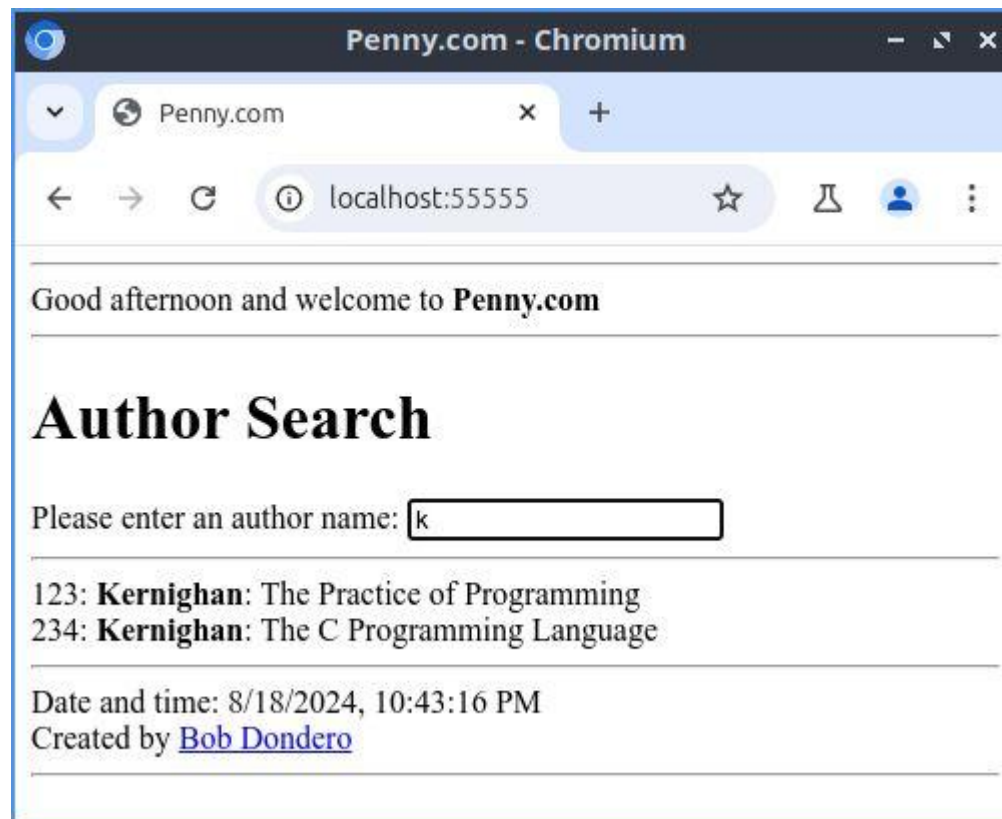
Baseline

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



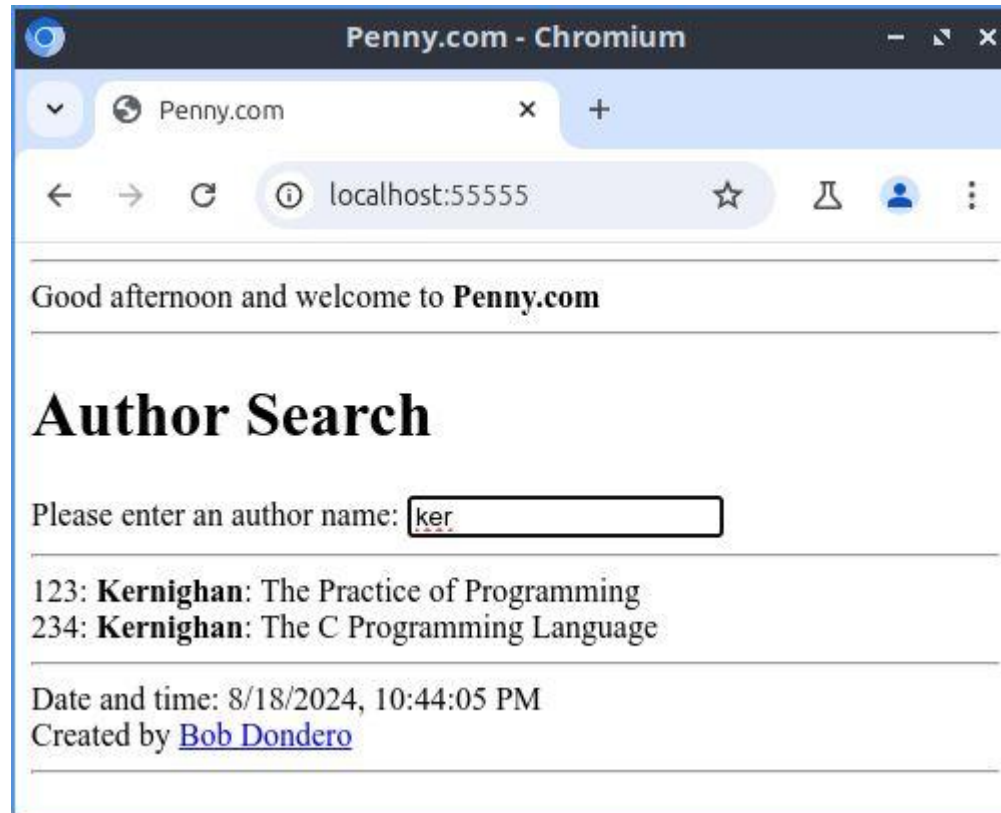
Baseline

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



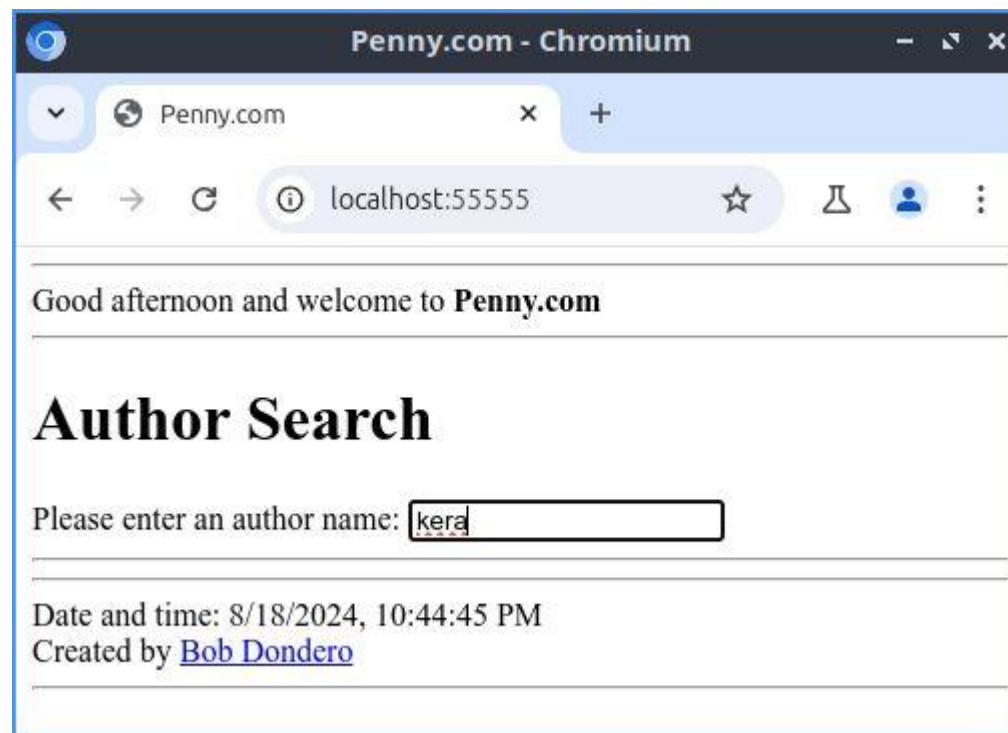
Baseline

- 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**

Agenda

- Prelim: packages
- Prelim: library management
- Prelim: function definition expressions
- Baseline
- **Java server-side pgmming**
- Java server-side pgmming: Spark
- JavaScript server-side pgmming
- 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

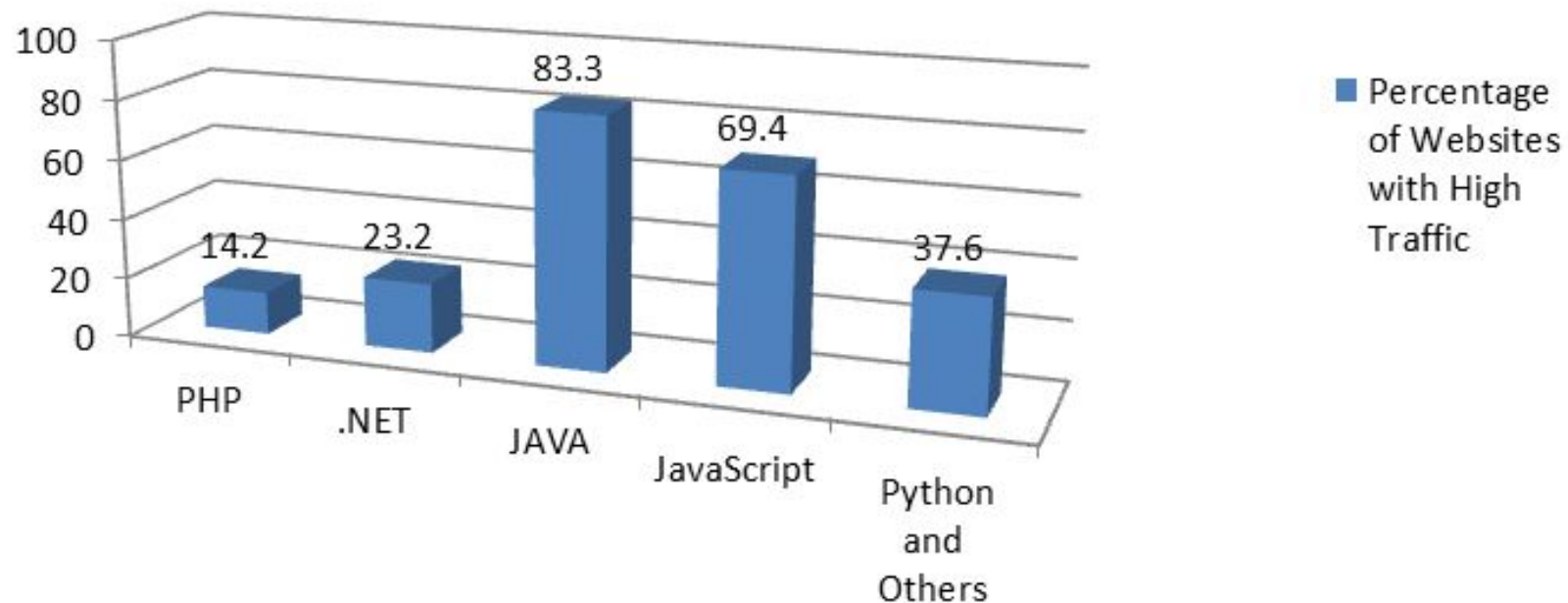
Website	Front End	Back End
Google	JavaScript	C, C++, Go, Java , Python, Node
Facebook	JavaScript TypeScript Flow	Hack, HHVM, Python, C++, Java , Erlang, D, Haskell
YouTube	JavaScript TypeScript	Python, C, C++, Java , Go
Yahoo	JavaScript	PHP
Etsy	JavaScript	PHP
Amazon	JavaScript	Java , C++, Perl
Wikipedia	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/>

Agenda

- Prelim: packages
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- Baseline
- Java server-side pgmming
- **Java server-side pgmming: Spark**
- JavaScript server-side pgmming
- JavaScript server-side pgmming: Express

Spark



Per
Wendel

Spark

- Why study Spark?
 - (Instead of some other framework?)
 - Easy to learn
 - Simple
 - Good documentation and tutorial
 - Integrated with **Jetty** server

Spark

- See **PennySparkSpa** app

```
PennySparkSpa\  
  runserver  
  runserver.bat  
  pom.xml  
  src\  
    main\  
      java\  
        edu\  
          princeton\  
            penny\  
              Database.java  
              Penny.java  
    resources\  
      penny.sql  
      penny.sqlite  
    public\  
      index.html
```

Spark

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

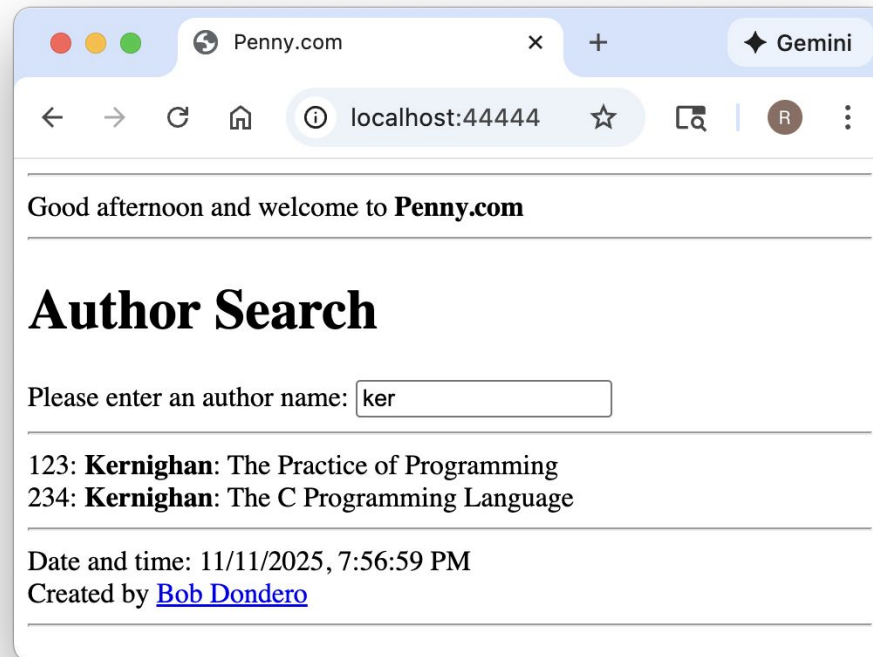
Spark

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

```
$ cd PennySparkSpa  
$ mvn clean  
$ mvn compile  
$ ./runserver 44444
```

Spark

- See PennySparkSpa app (cont.)



Agenda

- Prelim: packages
- Prelim: library management
- Prelim: function definition expressions
- Baseline
- Java server-side pgmming
- Java server-side pgmming: Spark
- **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 (10/20/24)

JavaScript Server Web Pgmming

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

Agenda

- Prelim: packages
- Prelim: library management
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- Baseline
- Java server-side pgmming
- Java server-side pgmming: Spark
- 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:

Framework	GitHub Stars
Django (Python)	85.3K
Laravel (PHP)	82.3K
Spring-Boot (Java)	78.6K
Nest (JavaScript)	72.9K
Flask (Python)	70.5K
Express (JavaScript)	67.9K
Spring (Java)	58.9K
Rails (Ruby)	57.7K
Meteor (JavaScript)	44.7K
Fiber (Go)	38.0K

According
to
GitHub
as
of
10/5/25

Express

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

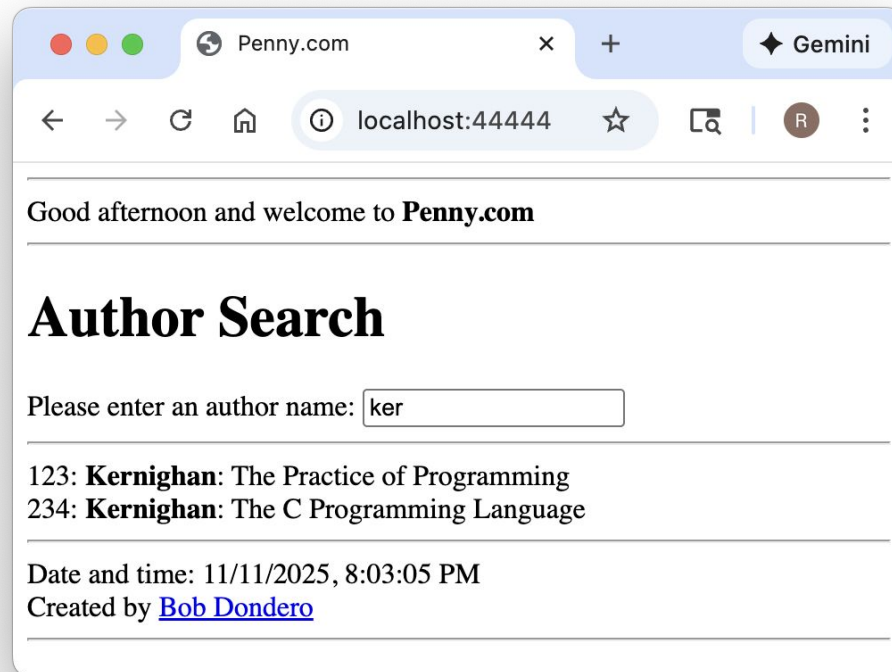
Express

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

```
$ cd PennyExpressSpa
$ npm install
$ node runserver.js 44444
Listening at port 44444
```

Express

- See PennyExpressSpa app



Commentary

Server Languages	Small Apps	Medium Apps	Large Apps
PHP	✓		
Python		✓	
JavaScript		✓	
Java			✓

Lecture Summary

- In this lecture we covered:
 - Some server-side options
 - Java: The Spark web app framework
 - JavaScript: The Express web app framework
- See also...
 - **Appendix 1:** Java Servlet Programming
 - **Appendix 2:** Java Spring Programming

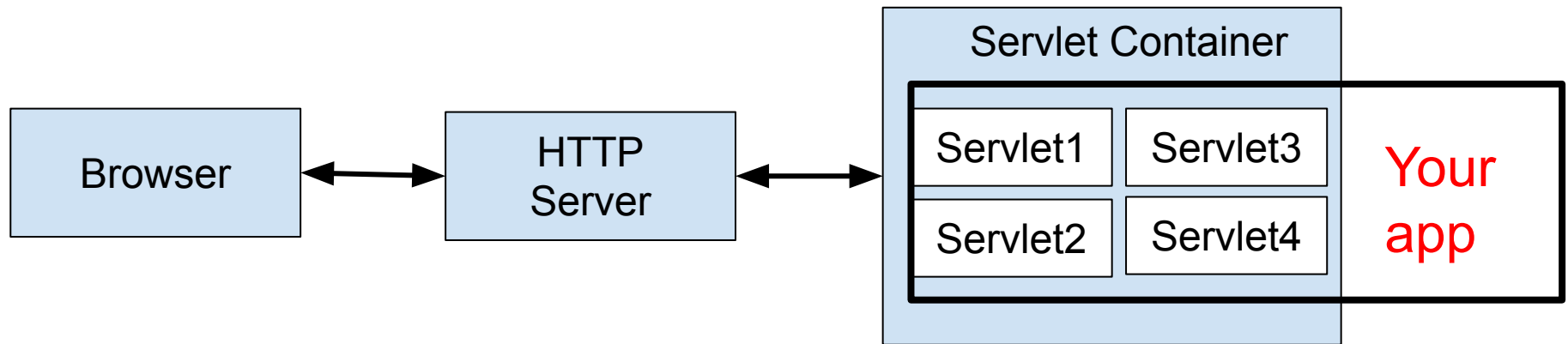
Appendix 1: Java Servlet Programming

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

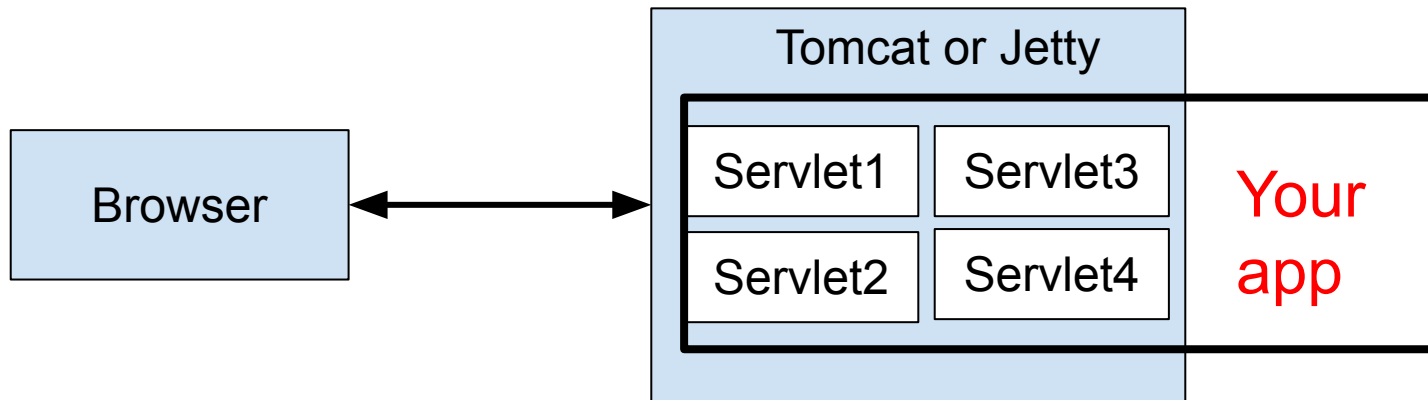


Popular servlet containers:

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:

```
$ mvn clean  
$ mvn compile  
$ ./runserver 55555
```

On MS Windows:

```
C:\>mvn clean  
C:\>maven compile  
C:\>runserver.bat 55555
```

Appendix 2: Java Spring Programming

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:

Framework	GitHub Stars
Django (Python)	85.3K
Laravel (PHP)	82.3K
Spring-Boot (Java)	78.6K
Nest (JavaScript)	72.9K
Flask (Python)	70.5K
Express (JavaScript)	67.9K
Spring (Java)	58.9K
Rails (Ruby)	57.7K
Meteor (JavaScript)	44.7K
Fiber (Go)	38.0K

According
to
GitHub
as
of
10/5/25

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
```