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Leveraging Spring Boot Starters and Auto-configuration

Discovering how starters and auto-configuration simplifies Spring application development

Objectives

After completing this lesson, you should be able to

- Utilize Spring Boot Starters to configure a project's dependencies
- Utilize auto-configuration to simplify project configuration and initialization
- Describe the behavior of various configuration elements, such as *@SpringBootApplication*
- Override default configuration

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Four Key Boot Features Used in Last Lab

- Starters
  - Configure dependencies quickly
- Auto-configuration
  - Opinionated defaults enable rapid bootstrapping of project
- Configuration properties
  - One mechanism for tailoring configuration
- **`CommandLineRunner & ApplicationRunner`**
  - Easy way to invoke logic after ApplicationContext is loaded

We will explore these features in-depth in this section

Agenda

- **Starters and BOMs**
- Auto-Configuration
- Configuration Properties
- Overriding Configuration
- Running an Application
- Bonus
  - Advanced Properties
  - Fine Tuning Logging
  - YAML for Configuration

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Spring Boot Needs Dependencies

- Spring Boot relies on analyzing the classpath
  - If you forget a dependency, Spring Boot can't configure it
  - Spring Boot parent and starters make it much easier
  - A dependency management tool is recommended
- Spring Boot works with Maven, Gradle, Ant/Ivy
  - *Our content here will only show Maven*

Spring Boot Parent POM

- Defines key versions of dependencies and Maven plugins
  - Uses a **`dependencyManagement`** section internally

```
<parent>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-parent</artifactId>
  <version>2.1.3.RELEASE</version>
</parent>
```

Defines properties for dependencies, for example:
`${spring.version} = 5.1.5.RELEASE`

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Spring Boot “*Starter*” Dependencies

- Easy way to bring in multiple coordinated dependencies
  - Including *“Transitive”* Dependencies

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter</artifactId>
  </dependency>
</dependencies>
```

Version not needed!
Defined by parent

Resolves ~ 16 JARs!

spring-boot-.jar* *spring-core-*.jar*
spring-context-.jar* *spring-aop-*.jar*
spring-beans-.jar* *aopalliance-*.jar*
...

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Test "*Starter*" Dependencies

- Common test libraries

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
  </dependency>
</dependencies>
```

Resolves
spring-test-.jar*
junit-.jar*
mockito-.jar*
…

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Available Starter POMs

- Not essential but *strongly* recommended for getting started
- Coordinated dependencies for common Java enterprise frameworks
  - Pick the starters you need in your project
- To name a few:
  - **`spring-boot-starter-jdbc`**
  - **`spring-boot-starter-data-jpa`**
  - **`spring-boot-starter-web`**
  - **`spring-boot-starter-batch`**

See: Spring Boot Reference, Starter POMs
https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#using-boot-starter

Spring Boot Developer Tools

- A set of tools to help make Spring Boot development easier
  - Automatic restart - any time a class file changes (on re-compile)
  - Additional features supporting remote application execution from IDE, global devtool settings
- Note the pattern for artifactId is different

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
  </dependency>
</dependencies>
```

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Spring Boot @SpringBootApplication

- @SpringBootApplicaiton somehow enables auto-configuration - How?

```
@SpringBootApplication
(scanBasePackages="example.config")
public class Application {
   ...
}
```

```
@SpringBootConfiguration
@ComponentScan("example.config")
@EnableAutoConfiguration
 public class Application {
      ...
 }
```

@SpringBootConfiguration simply extends **@Configuration** – see **@SpringBootTest** for why.

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Spring Boot @EnableAutoConfiguration

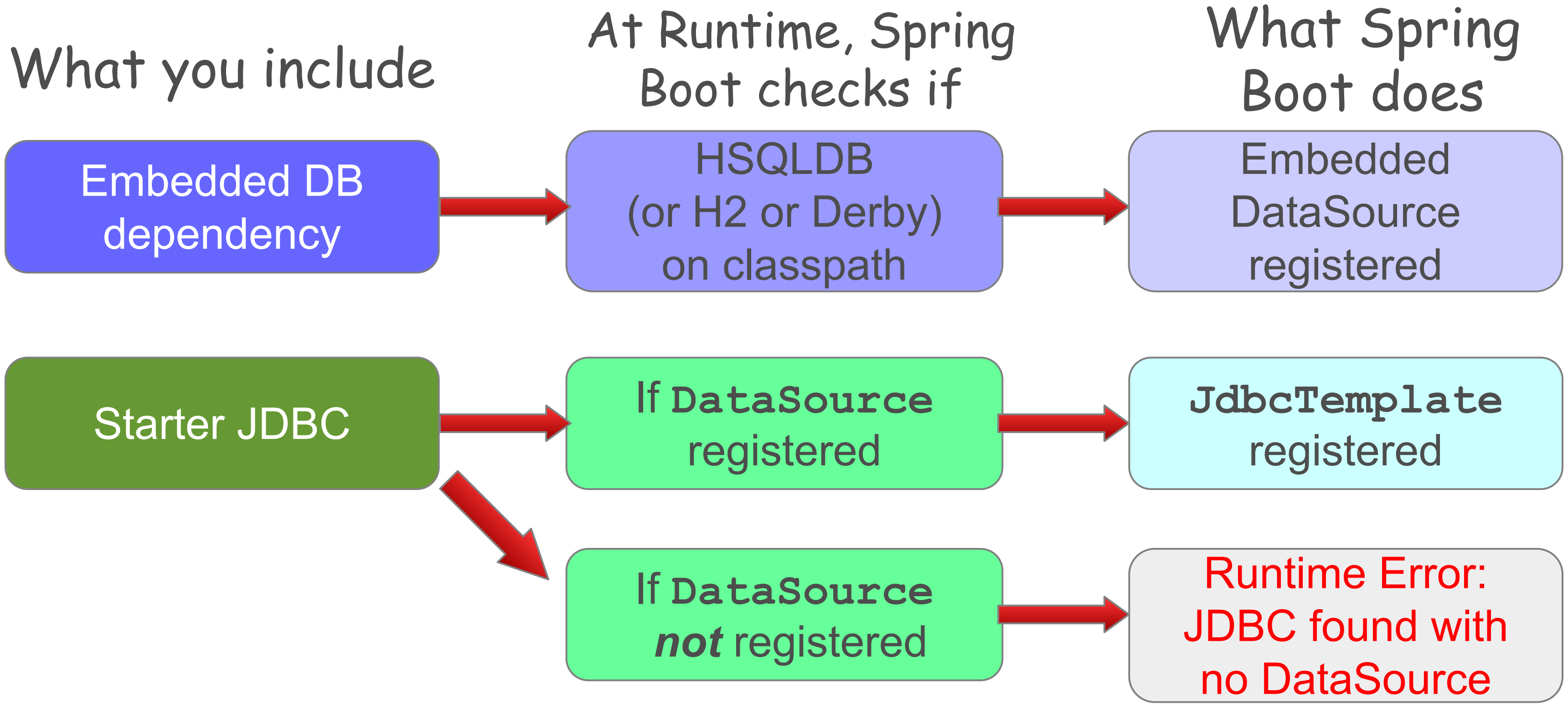
- `@EnableAutoConfiguration` annotation on a Spring Java configuration class
  - Spring Boot automatically creates the beans it thinks you need
  - Usually based on classpath contents, can be easily overridden

```
@SpringBootConfiguration
@ComponentScan
@EnableAutoConfiguration
public class Application {
   public static void main(String[] args) {
            SpringApplication.run(Application.class, args);
      }
}
```

No packages specified = scan current package and all sub-packages

`SpringApplication` is actually a Spring Boot class

Auto-Configuration: Examples



What you include
At Runtime, Spring Boot checks if
What Spring Boot does
Embedded DB dependency
HSQLDB (or H2 or Derby) on classpath
Embedded DataSource registered
Starter JDBC
If DataSource registered
JdbcTemplate registered
If DataSource *not* registered
Runtime Error: JDBC found with no DataSource

Auto-Configuration Factories

- ***@EnableAutoConfiguration*** reads the ***spring-boot-autoconfigure/META-INF/spring.factories***

- The ***spring.factories*** file contains a list of auto-configuration classes (****AutoConfiguration***) that have all the logic to be executed accordingly to the dependencies that an application has in the classpath

- Auto-configuration classes in the ***spring.factories*** file get processed after application defined configuration classes are processed

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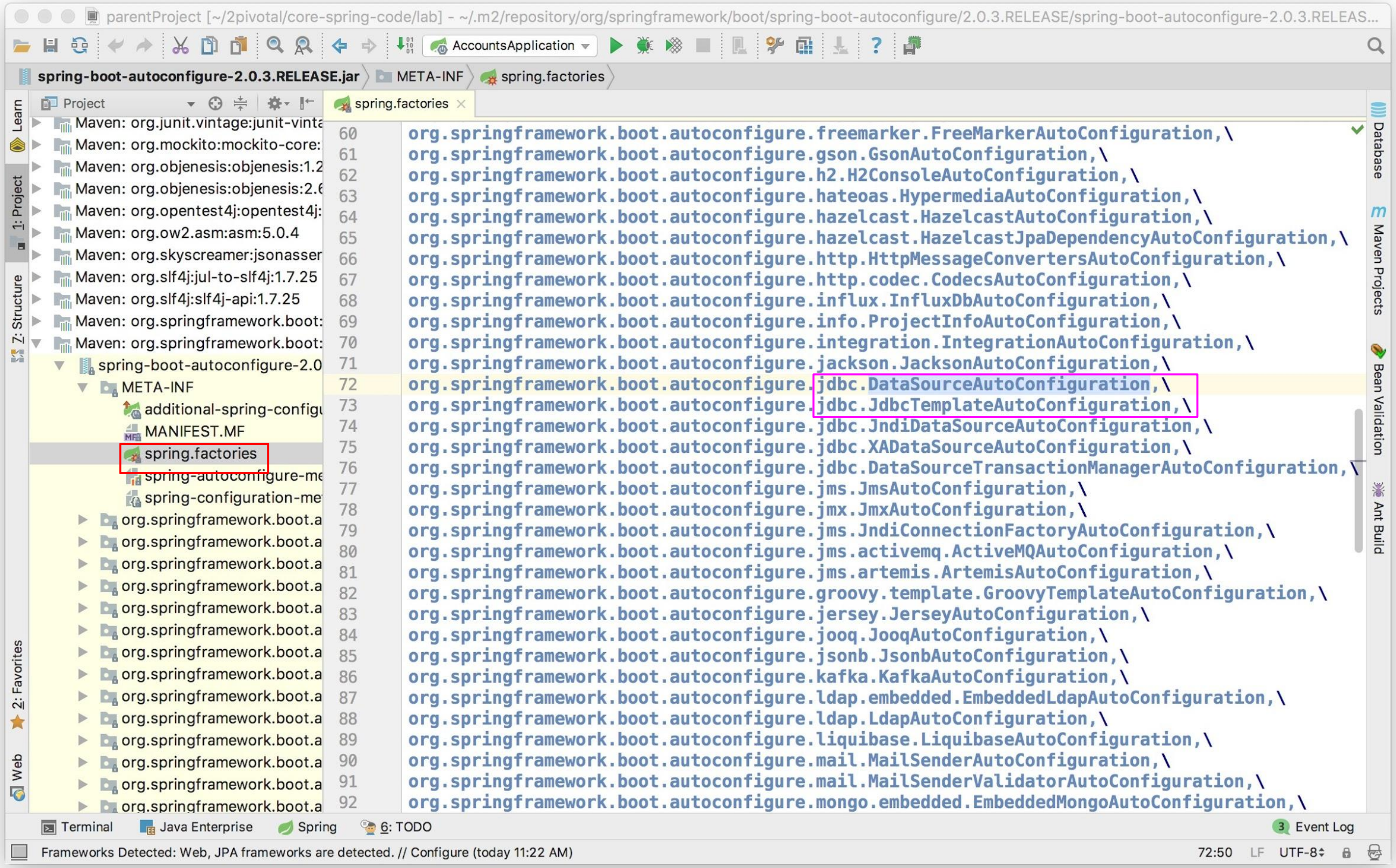
Exploring Auto-configuration classes in *spring.factories*


parentProject [~/2pivotal/core-spring-code/lab] - ~/.m2/repository/org/springframework/boot/spring-boot-autoconfigure/2.0.3.RELEASE/spring-boot-autoconfigure-2.0.3.RELEAS...
AccountsApplication
spring-boot-autoconfigure-2.0.3.RELEASE.jar
META-INF
spring.factories
Project
Maven: org.junit.vintage:junit-vinta
Maven: org.mockito:mockito-core:
Maven: org.objenesis:objenesis:1.2
Maven: org.objenesis:objenesis:2.6
Maven: org.opentest4j:opentest4j:
Maven: org.ow2.asm:asm:5.0.4
Maven: org.skyscreamer:jsonasser
Maven: org.slf4j:jul-to-slf4j:1.7.25
Maven: org.slf4j:slf4j-api:1.7.25
Maven: org.springframework.boot:
Maven: org.springframework.boot:
spring-boot-autoconfigure-2.0
META-INF
additional-spring-configu
MANIFEST.MF
spring.factories
spring-autoconfigure-me
spring-configuration-me
org.springframework.boot.a
Learn
1: Project
7: Structure
2: Favorites
Web
Database
Maven Projects
Bean Validation
Ant Build
Terminal
Java Enterprise
Spring
6: TODO
Event Log

```
org.springframework.boot.autoconfigure.freemarker.FreeMarkerAutoConfiguration,\
org.springframework.boot.autoconfigure.gson.GsonAutoConfiguration,\
org.springframework.boot.autoconfigure.h2.H2ConsoleAutoConfiguration,\
org.springframework.boot.autoconfigure.hateoas.HypermediaAutoConfiguration,\
org.springframework.boot.autoconfigure.hazelcast.HazelcastAutoConfiguration,\
org.springframework.boot.autoconfigure.hazelcast.HazelcastJpaDependencyAutoConfiguration,\
org.springframework.boot.autoconfigure.http.HttpMessageConvertersAutoConfiguration,\
org.springframework.boot.autoconfigure.http.codec.CodecsAutoConfiguration,\
org.springframework.boot.autoconfigure.influx.InfluxDbAutoConfiguration,\
org.springframework.boot.autoconfigure.info.ProjectInfoAutoConfiguration,\
org.springframework.boot.autoconfigure.integration.IntegrationAutoConfiguration,\
org.springframework.boot.autoconfigure.jackson.JacksonAutoConfiguration,\
org.springframework.boot.autoconfigure.jdbc.DataSourceAutoConfiguration,\
org.springframework.boot.autoconfigure.jdbc.JdbcTemplateAutoConfiguration,\
org.springframework.boot.autoconfigure.jdbc.JndiDataSourceAutoConfiguration,\
org.springframework.boot.autoconfigure.jdbc.XADataSourceAutoConfiguration,\
org.springframework.boot.autoconfigure.jdbc.DataSourceTransactionManagerAutoConfiguration,\
org.springframework.boot.autoconfigure.jms.JmsAutoConfiguration,\
org.springframework.boot.autoconfigure.jmx.JmxAutoConfiguration,\
org.springframework.boot.autoconfigure.jms.JndiConnectionFactoryAutoConfiguration,\
org.springframework.boot.autoconfigure.jms.activemq.ActiveMQAutoConfiguration,\
org.springframework.boot.autoconfigure.jms.artemis.ArtemisAutoConfiguration,\
org.springframework.boot.autoconfigure.groovy.template.GroovyTemplateAutoConfiguration,\
org.springframework.boot.autoconfigure.jersey.JerseyAutoConfiguration,\
org.springframework.boot.autoconfigure.jooq.JooqAutoConfiguration,\
org.springframework.boot.autoconfigure.jsonb.JsonbAutoConfiguration,\
org.springframework.boot.autoconfigure.kafka.KafkaAutoConfiguration,\
org.springframework.boot.autoconfigure.ldap.embedded.EmbeddedLdapAutoConfiguration,\
org.springframework.boot.autoconfigure.ldap.LdapAutoConfiguration,\
org.springframework.boot.autoconfigure.liquibase.LiquibaseAutoConfiguration,\
org.springframework.boot.autoconfigure.mail.MailSenderAutoConfiguration,\
org.springframework.boot.autoconfigure.mail.MailSenderValidatorAutoConfiguration,\
org.springframework.boot.autoconfigure.mongo.embedded.EmbeddedMongoAutoConfiguration,\
```

Frameworks Detected: Web, JPA frameworks are detected. // Configure (today 11:22 AM)   72:50 LF UTF-8

How Does Auto-Configuration Work?

- Extensive use of *pre-written* **`@Configuration`** classes
- Configuration of beans based on on
  - The contents of the classpath
  - Properties you have set
  - Beans already defined (or not defined)

- **`@Profile`** is an example of conditional configuration
  - Spring Boot takes this idea to the next level

@Conditional Annotations

- Allow conditional bean creation
  - Only create if other beans exist (or don't exist)

```
@Bean
@ConditionalOnBean(name={"dataSource"})
public JdbcTemplate jdbcTemplate(DataSource dataSource) {
   return new JdbcTemplate(dataSource);
}
```

  - Or by type: `@ConditionalOnBean(DataSource.class)`
- Many others:
  - @ConditionalOnClass, @ConditionalOnProperty, ...
    @ConditionalOnMissingBean, @ConditionalOnMissingClass

Leverages @Conditional added in Spring 4.0

What are Auto-Configuration Classes?

- Pre-written Spring configurations
  - `org.springframework.boot.autoconfigure` package
  - See `spring-boot-autoconfigure` JAR file
    - Best place to check what they exactly do

```
@Configuration
public class DataSourceAutoConfiguration {
   ...
   @Conditional(...)
   @ConditionalOnMissingBean(DataSource.class, ..)
   @Import({EmbeddedDataSourceConfiguration.class})
   protected static class EmbeddedDatabaseConfiguration { ... }
   ...
}
```

Spring Boot defines many of these configurations. They activate in response to dependencies on the classpath

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- Auto-Configuration
- **Configuration Properties**
- Overriding Configuration
- Running an Application
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  - Advanced Properties
  - Fine Tuning Logging
  - YAML for Configuration

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Configuration Properties
Using *application.properties (or application.yml) file*

- Developers commonly externalize properties to files
  - Easily consumable via **`@PropertySource`**
  - But developers name / locate their files different ways

- Spring Boot looks for **`application.properties`**
  - *Many* properties exist to control auto-configuration
  - Can put *any* properties you need in here
    - Boot will automatically find and load them
  - Available to **`Environment`** and **`@Value`** in usual way

See *Appendix A* of Spring Boot documentation:
http://docs.spring.io/spring-boot/docs/current/reference/html/common-application-properties.html

Example: External Database

- Configuring an *external* database
  - Such as MySQL
  - Make sure project defines JDBC driver dependency

```
spring.datasource.url=jdbc:mysql://localhost/test
spring.datasource.username=dbuser
spring.datasource.password=dbpass
spring.datasource.driver-class-name=com.mysql.jdbc.Driver

spring.datasource.schema=/testdb/schema.sql
spring.datasource.data=/testdb/data.sql
```

Example: Controlling Logging Level

- Boot can control the logging level
  - Just set it in **`application.properties`**
- Works with most logging frameworks
  - Java Util Logging, Logback, Log4J, Log4J2

```
logging.level.org.springframework=DEBUG
logging.level.com.acme.your.code=INFO
```

application.properties

Try to stick to SLF4J in the application.
The *advanced* section covers how to change the logging framework

Where to Define Properties

- Spring Boot properties
  - Use **`application.properties`** (or **`application.yml`**)
    - Read early by Spring Boot since they affect auto-configuration
    - Profile-aware
      - application-dev.properties, application-production.properties
    - Some properties can *only* be set there
      - Such as logging levels

- Your application properties
  - *Can* be in **`application.properties`**
    - But add comments to identify Boot vs custom properties
  - *Or* use your own properties files with **`@PropertySource`**

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Controlling What Spring Boot Does

- There are several options
  - Set some of Spring Boot's properties
  - Define certain beans yourself so Spring Boot won't
  - Explicitly disable some auto-configuration
  - Change dependencies

1. Set some of Spring Boot’s properties

- Spring Boot looks for `application.properties` in these locations (in this order):
  - `/config` sub-directory of the working directory
  - The working directory
  - `config` package in the classpath
  - classpath root
- Creates a *PropertySource* based on these files
- Many, many configuration properties available

See *Appendix A* of Spring Boot documentation:
http://docs.spring.io/spring-boot/docs/current/reference/html/common-application-properties.html

2. Define certain beans yourself

- Normally beans you declare *explicitly* disable any auto-created ones.
  - *Example:* Your own **`DataSource`** stops Spring Boot creating a default **`DataSource`**
  - Bean name typically not relevant
  - Works with Java Config, Component Scanning

```
@Bean
public DataSource dataSource() {
    return new EmbeddedDatabaseBuilder().
                                    setName("RewardsDb").build();
}
```

3. Explicitly disable some auto-configuration

- Can disable some auto-configuration classes
  - If they don't suit your needs
- Via an annotation

```
@EnableAutoConfiguration(exclude=DataSourceAutoConfiguration.class)
public class ApplicationConfiguration {
    ...
}
```

`@SpringBootApplication` also has the *exclude* attribute

- Or use *configuration*

application.properties

```
spring.autoconfigure.exclude=\
    org.springframework.boot.autoconfigure.jdbc.DataSourceAutoConfiguration
```

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4a. Override Dependency Versions

- Spring Boot POMs preselect the versions of dependencies
  - Ensures the versions of all dependencies are consistent
  - Simplifies dependency management in many cases
- Should I override the version of a given dependency?
  - Use default pre-selected version unless there are compelling reasons such as
    - A bug in the given version
    - Compliance
    - Company policies/restrictions

4b. Override Dependency Versions

- Set the appropriate Maven property in your **`pom.xml`**

```
<properties>
    <spring.version>5.0.0.RELEASE</spring.version>
</properties>
```

- Check this POM to know all the properties names
  – https://github.com/spring-projects/spring-boot/blob/master/spring-boot-project/spring-boot-dependencies/pom.xml

This only works if you *inherit* from the parent. You need to redefine the artifact if you directly import the dependency

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4c. Explicitly Substitute Dependencies

```
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-web</artifactId>
  <exclusions>
    <exclusion>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-tomcat</artifactId>
    </exclusion>
  </exclusions>
</dependency>
<dependency>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-jetty</artifactId>
</dependency>
```

Excludes Tomcat

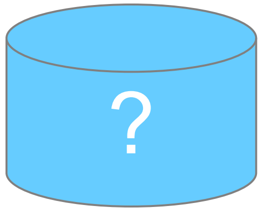
Adds Jetty

Jetty automatically detected and used!

Configuration Example: DataSource (1)

- A common example of how to control or override Spring Boot's default configuration

- Typical customizations
  - Use the predefined properties
  - Change the underlying data source connection pool implementation
  - Define your own DataSource bean (shown earlier)



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Example: DataSource Configuration (2)

- Common properties configurable from properties file

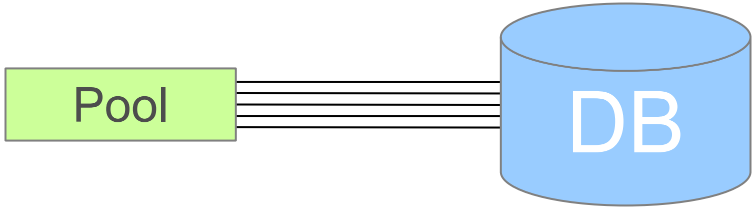
```
spring.datasource.url=                # Connection settings
spring.datasource.username=
spring.datasource.password=
spring.datasource.driver-class-name=

spring.datasource.schema=             # SQL scripts to execute
spring.datasource.data=

spring.datasource.initial-size=       # Connection pool settings
spring.datasource.max-active=
spring.datasource.max-idle=
spring.datasource.min-idle=
```

Example: DataSource Configuration (3)

- Spring Boot creates a pooled **`DataSource`** by default
  - If a known pool dependency is available
    - *spring-boot-starter-jdbc* or *spring-boot-starter-jpa* starters try to pull in *a* connection pool by default
  - *Choices:* Tomcat, HikariCP, Commons DBCP 1 & 2
    - Set **`spring.datasource.type`** to pick a pool explicitly

Default pool:

- Spring Boot 1.x: Tomcat
- Spring Boot 2.x: Hikari



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`CommandLineRunner` and `ApplicationRunner`

- Offers a Spring-style entry point for running applications
  - Avoids having logic in **`main()`** method
- **`CommandLineRunner`**
  - Offers **`run()`** method, handling arguments as an array
- **`ApplicationRunner`**
  - Offers **`run()`** method, handling arguments as **`ApplicationArguments`**
  - A more sophisticated argument handling mechanism

Using `CommandLineRunner`

```
@SpringBootApplication
public class Application {

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }

    @Bean
    CommandLineRunner commandLineRunner(JdbcTemplate jdbcTemplate){
        String QUERY = "SELECT count(*) FROM T_ACCOUNT";

        return args -> System.out.println("Hello, there are "
                + jdbcTemplate.queryForObject(QUERY, Long.class)
                + " accounts");

    }
}
```

Special Spring Bean detected by Boot and invoked before returning from SpringApplication.run()

Fat JARs and the Spring Boot Plugin

- A “fat” JAR is a JAR that also contains all its dependencies
  - Can be run directly using `java -jar` command
- To create
  - Add plugin to your Maven POM or Gradle Build file
  - Build JAR in usual way
    - `gradle assemble` or `mvn package`
  - Creates two JARs

`my-app.jar`	the executable “fat” jar
`my-app.jar.original`	the “usual” jar

Spring Boot Plugin - Maven

- What it does
  - Extend **`package`** goal to create fat JAR
  - Add **`spring-boot:run`** goal to run your application

```
<build>
    <plugins>
        <plugin>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-maven-plugin</artifactId>
        </plugin>
    </plugins>
</build>
```

Spring Boot Plugin - Gradle

- What it does
  - Enable dependency management like Maven
    - Gradle does *not* provide this feature as standard
  - Extend the **`assemble`** task to create fat JAR
  - Add **`bootRun`** goal to run your application

```
plugins {
    id 'org.springframework.boot' version '2.1.3.RELEASE'
}

apply plugin: 'java'
apply plugin: 'io.spring.dependency-management'
```

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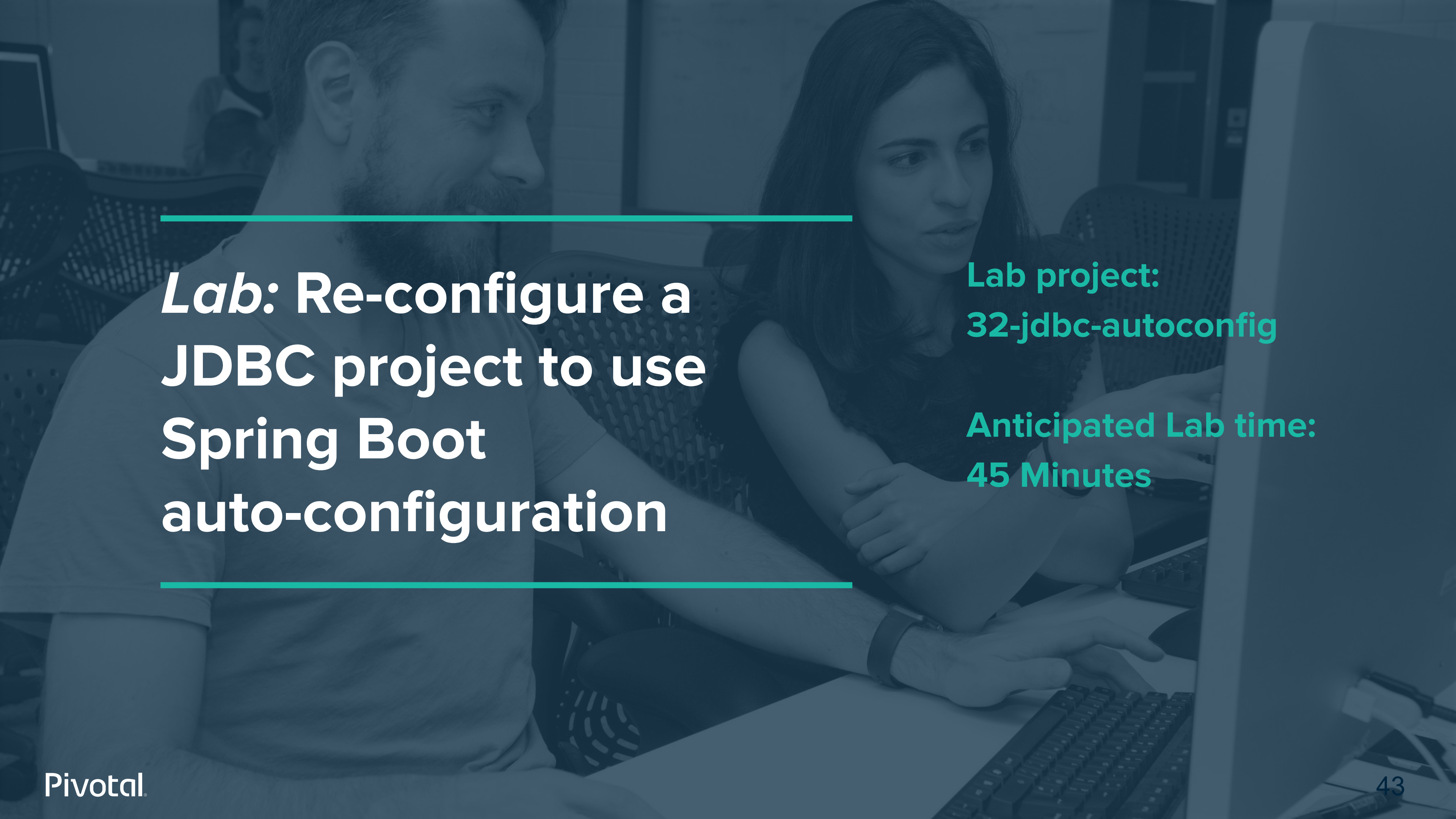
Summary

We’ve discussed starters and auto-configuration:

- How do we get a predefined set of dependencies?
- What is auto-configuration?
- What are configuration properties? Why use them?
- How do you override Spring Boot’s defaults?
- What is the purpose of a **`CommandLineRunner`**?
- What is a “fat” jar?



Lab: Re-configure a JDBC project to use Spring Boot auto-configuration

Lab project:
32-jdbc-autoconfig

Anticipated Lab time:
45 Minutes

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Overriding Properties

Applies to Spring
or Spring Boot

- Order of evaluation of the properties (non-exhaustive)
  - Command line arguments
  - Java system properties
  - OS environment variables
  - Property file(s) – including **`application.properties`**
- Can access any of them using **`@Value`** in the usual way
- *Recommendation:*
  - Use Property files to define defaults
  - Override *externally* using one of the other 3 options

The Problem with Property Placeholders

- Using property placeholders is sometimes cumbersome
  - Many properties, prefix has to be repeated

```
@Configuration
public class RewardsClientConfiguration {

    @Value("${rewards.client.host}") String host;
    @Value("${rewards.client.port}") int port;
    @Value("${rewards.client.logdir}") String logdir;
    @Value("${rewards.client.timeout}") int timeout;

    …
}
```

Use @ConfigurationProperties

- `@ConfigurationProperties` on *dedicated* container bean
  - Will hold the externalized properties
  - Avoids repeating the prefix
  - Data-members automatically set from corresponding properties

```
@ConfigurationProperties(prefix="rewards.client")
public class ConnectionSettings {

    private String host;
    private int port;
    private String logdir;
    private int timeout;
    …    // getters/setters
}
```

```
rewards.client.host=192.168.1.42
rewards.client.port=8080
rewards.client.logdir=/logs
rewards.client.timeout=2000
```
example.properties

Use @EnableConfigurationProperties

- *@EnableConfigurationProperties* on configuration class
  - Specify and auto-inject the container bean

```
@Configuration
@EnableConfigurationProperties(ConnectionSettings.class)
public class RewardsClientConfiguration {
    // Spring initialized this automatically
    @Autowired ConnectionSettings connectionSettings;

    @Bean public RewardClient rewardClient() {
        return new RewardClient(
            connectionSettings.getHost(),
            connectionSettings.getPort(), ...
        );
    }
}
```

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Relaxed Property Binding

- Flexible mapping between Java-style properties and environment variables
  - **`path`** equivalent to **`PATH`**
  - **`java.home`** equivalent to **`JAVA_HOME`**
  - Easy overriding of property without changing the name!
- Feature implemented by **`@ConfigurationProperties`**
  - Works for Spring Boot properties

```
@Configuration
class AppConfig {

   @Value("${java.home}")
   String javaInstallDir;
   ...
}
```

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Logging frameworks

- Spring Boot includes by default
  - SLF4J: logging facade
  - Logback: SLF4J implementation
- Best practice: stick to this in your application
  - Use the SLF4J abstraction the application code
- Other logging frameworks are supported
  - Java Util Logging, Log4J, Log4J2

Substituting Logging Libraries

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-websocket</artifactId>
    <exclusions>
        <exclusion>
           <groupId>ch.qos.logback</groupId>
           <artifactId>logback-classic</artifactId>
        </exclusion>
    </exclusions>
</dependency>

<dependency>
    <groupId>org.slf4j</groupId>
    <artifactId>slf4j-log4j12</artifactId>
</dependency>
```

Excludes Logback

Includes Log4J

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Logging Output

- Spring Boot logs by default to the console
- Can also log to rotating files
  - Specify file OR path in application.properties

```
# Use only one of the following properties

#  absolute or relative file to the current directory
logging.file=rewards.log

#  will write to a spring.log file
logging.path=/var/log/rewards
```

Spring Boot can also configure logging by using the appropriate configuration file of the underlying logging framework.

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What is YAML?

- *Yaml Ain't a Markup Language*
  - Recursive acronym
- Created in 2001
- Alternative to .properties files
  - Allows hierarchical configuration
- Java parser for YAML is called SnakeYAML
  - Must be in the classpath
  - Provided by spring-boot-starters

YAML for Properties

- Spring Boot support YAML for Properties
  - An alternative to properties files

```
database.host = localhost
database.user = admin
```

application.properties

equals

```
database:
  host: localhost
  user: admin
```

application.yml

colon

- YAML is convenient for hierarchical configuration data
  - Spring Boot properties are organized in groups

Spring Boot *only* loads **`application.yml`** by default.

Multiple Profiles Inside a Single YAML File

- YAML file can contain configuration for multiple profiles
  - '---' implies a separation between profiles

```
logging.level:
  org.springframework: INFO
---
spring.profiles: development
database:
  host: localhost
  user: dev
---
spring.profiles: production
database:
  host: 198.18.200.9
  user: admin
```

Used for all profiles

“development” profile only

“production” profile only

application.yml

Pivotal

Multiple Profiles – YML vs Properties

```
server:
  port: 9999
---
spring.profiles: development
database:
  host: localhost
  user: dev
---
spring.profiles: production
database:
  host: 198.18.200.9
  user: admin
```

application.yml

```
server.port=9999
```

application.properties

```
database.host=localhost:
database.user=dev
```

application-development.properties

```
database.host=198.18.200.9
database.user=admin
```

application-production.properties