Testing Spring Boot Applications

1. The Spring Boot test ecosystem
2. Writing and running tests on beans
3. Mocking beans
4. Additional Spring Boot test techniques

Demo project: **`demo-testing`**

1. The Spring Boot Test Ecosystem

- Overview
- Spring Boot test dependency
- Defining test cases in Spring Boot
- Understanding `@SpringBootTest`
- Specifying Java config classes for tests
- Specifying properties for tests
- Specifying a web environment for tests

Demo package: **`demo.testing`**

Overview

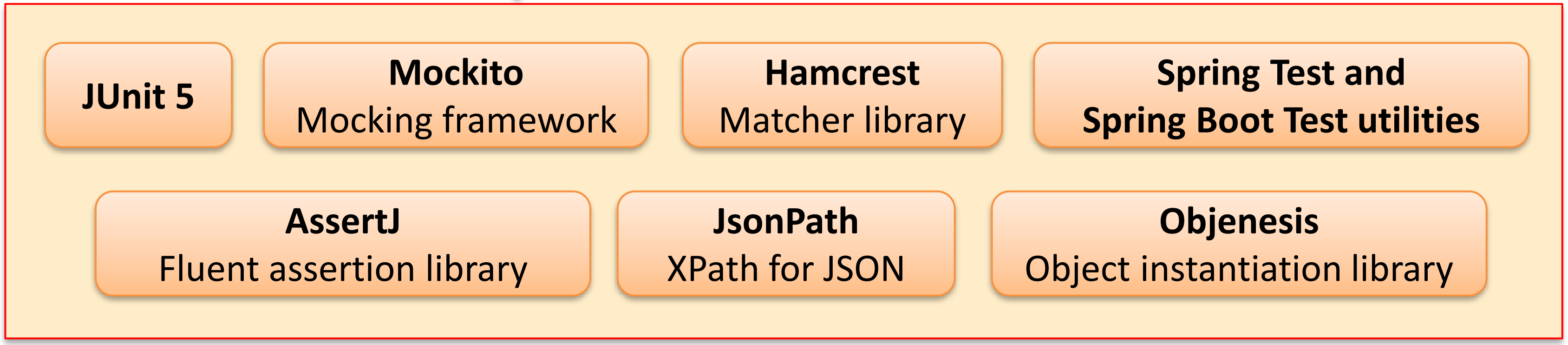
- Spring Boot makes testing easy, in various ways…
- Spring Boot auto-configuration automatically sucks in common test libraries
- Spring Boot automatically makes components available for autowiring into your test cases
- Spring Boot automatically loads application properties, so you can test components with realistic settings

Spring Boot Test Dependency

- When you create a Spring Boot app with Spring Initializr, it has the `spring-boot-starter-test` dependency

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

pom.xml



JUnit 5
Mockito Mocking framework
Hamcrest Matcher library
Spring Test and Spring Boot Test utilities
AssertJ Fluent assertion library
JsonPath XPath for JSON
Objenesis Object instantiation library

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Defining Test Cases in Spring Boot

- Spring Initializr also generates a simple JUnit test case
  - See the `src/test/java` folder in the demo project

```
import org.junit.jupiter.api.Test;
import org.springframework.boot.test.context.SpringBootTest;

@SpringBootTest
class ApplicationTests {

    @Test
    void contextLoads() {
    }
    …
}
```

ApplicationTests.java

- We discuss the details on the following slides…

Understanding @SpringBootTest

```
@SpringBootTest
class ApplicationTests {
    …
}
```

- `@SpringBootTest` automatically loads Java config classes, which presumably define the beans you want to test
  - First it loads inner classes annotated with `@Configuration`
  - If none found, it loads your `@SpringBootApplication` class

- `@SpringBootTest` also loads `application.properties`
  - So the beans are initialized properly when you test them

Specifying Java Config Classes for Tests

- `@SpringBootTest` **has a** `classes` **attribute**
  - Specifies particular Java config classes you want to load
  - Enables you to control which beans are created for your tests

```
@SpringBootTest(classes={MyJavaConfig1.class, MyJavaConfig2.class})
public class ApplicationTests {
      …
}
```

Specifying Properties for Tests

- `@SpringBootTest` **has a** `properties` **attribute**
  - Specifies additional properties you want to use in your tests
  - You specify an array of key=value strings

```
@SpringBootTest(properties={"prop1=value1", "prop2=value2"})
public class ApplicationTests {
    …
}
```

Specifying a Web Environment for Tests

- `@SpringBootTest` has a `webEnvironment` attribute
  - Enables you to configure a web environment for your tests

- To use a mock servlet environment:

```
@SpringBootTest(webEnvironment=SpringBootTest.WebEnvironment.MOCK)
```

- To use a real server on the port defined by `server.port`:

```
@SpringBootTest(webEnvironment=SpringBootTest.WebEnvironment.DEFINED_PORT)
```

- To use a real web server on a random port number:

```
@SpringBootTest(webEnvironment=SpringBootTest.WebEnvironment.RANDOM_PORT)
```

2. Writing and Running Tests on Beans

- Defining a bean to test
- Writing a test for a bean
- Running tests

Defining a Bean to Test

- Here's a simple bean to test

```
@Component
public class BankAccountBean {

    private String name;
    private int balance = 0;

    public void deposit(int amount) {
        balance += amount;
    }

    public void withdraw(int amount) {
        if (amount > balance)
           throw new IllegalArgumentException("Insufficient funds");
        balance -= amount;
    }

    // Plus getters, setters, toString(), etc.
}
```

BankAccountBean.java

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Writing a Test for a Bean

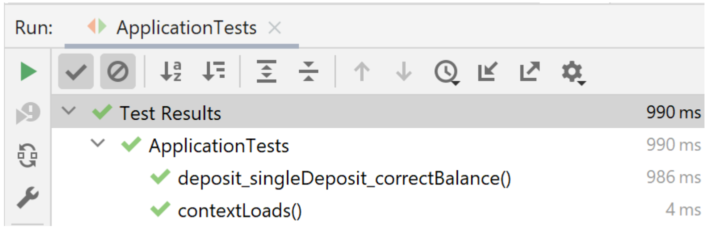
- Here's how we can test the bean
  - Spring loads the application context, as previously discussed
  - So we can autowire the bean into our test case, and then test it

```
import static org.junit.jupiter.api.Assertions.assertEquals;

@SpringBootTest
public class ApplicationTests {

    @Autowired
    BankAccountBean fixture;

    @Test
    public void deposit_singleDeposit_correctBalance() {
        fixture.deposit(100);
        assertEquals(100, fixture.getBalance());
    }
}
```

ApplicationTests.java

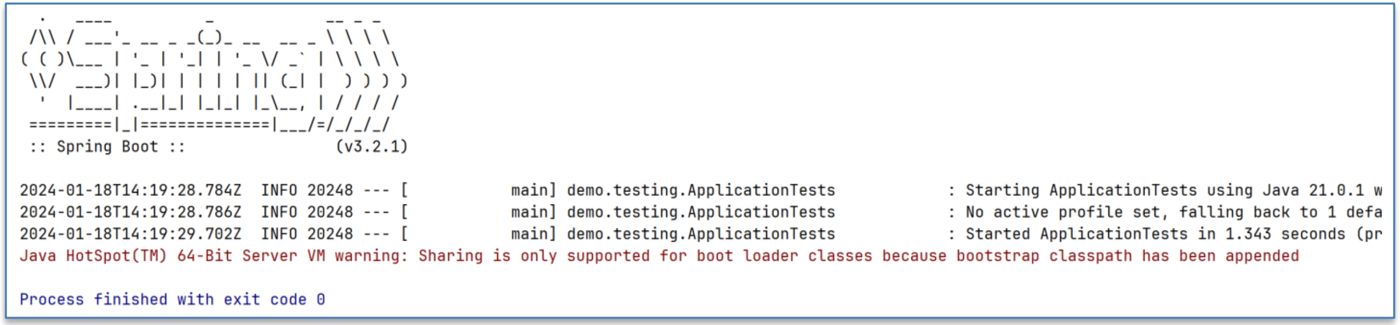
Running Tests

- Run tests as normal
  - See if the tests pass or fail



```
Run:   ApplicationTests
Test Results                                  990 ms
  ApplicationTests                            990 ms
    deposit_singleDeposit_correctBalance()    986 ms
    contextLoads()                              4 ms
```

- Also note the info displayed in the console
  - Indicates the Spring application context has been loaded



```
  .   ____          _            __ _ _
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 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
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 :: Spring Boot ::                (v3.2.1)

2024-01-18T14:19:28.784Z  INFO 20248 --- [           main] demo.testing.ApplicationTests            : Starting ApplicationTests using Java 21.0.1 w
2024-01-18T14:19:28.786Z  INFO 20248 --- [           main] demo.testing.ApplicationTests            : No active profile set, falling back to 1 defa
2024-01-18T14:19:29.702Z  INFO 20248 --- [           main] demo.testing.ApplicationTests            : Started ApplicationTests in 1.343 seconds (pr
Java HotSpot(TM) 64-Bit Server VM warning: Sharing is only supported for boot loader classes because bootstrap classpath has been appended

Process finished with exit code 0
```

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3. Mocking Beans

- Overview
- Java mocking frameworks
- Example bean to test
- Testing the bean using Mockito mocks

Overview

- Object-oriented systems involve lots of interacting objects
    - Unit testing focuses on the behaviour of an isolated object

- We can use a mocking framework to create a "mock" of other objects that we use
    - Specify what methods you expect to be called on a mock object
    - Specify what you want the methods to return

Java Mocking Frameworks

- There are various Java mocking frameworks available:
  - Mockito
  - jMock
  - EasyMock
  - Mock Objects
  - etc…
- The `spring-boot-starter-test` dependency automatically includes the Mockito library
  - To use an alternative mocking framework, add the appropriate dependency to your pom file

Example Bean to Test

- Here's an example bean that we're going to test
  - Note that it has an autowired `BARepository` dependency

```
@Component
public class BAServiceBean {

    private BARepository repo;

    @Autowired
    public BAServiceBean(BARepository repo) {
        this.repo = repo;
    }

    public void depositIntoAccount(int id, int amount) {
        BankAccountBean acc = repo.getById(id);
        acc.deposit(amount);
        repo.update(id, acc);
    }
}
```

BAServiceBean.java

```
public interface BARepository {
    …
}
```

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Testing the Bean using Mockito Mocks (1 of 2)

- Spring Boot has a `@MockBean` annotation
  - Tells Mockito to create a mock bean in the application context

```
@SpringBootTest
public class BAServiceBeanTests {

    @MockBean
    private BARepository mockRepo;

    @Autowired
    BAServiceBean service;

    …
}
```

BAServiceBeanTest.java

Spring Boot will create a mock instance of `BARepository` in the application context

Spring Boot will inject the `BARepository` mock bean into the `BAServiceBean` bean

Testing the Bean using Mockito Mocks (2 of 2)

- You can now write tests as follows:

```
@SpringBootTest
public class BAServiceBeanTests {

    …

    @Test
    public void testDeposit() {
        BankAccountBean acc = new BankAccountBean();
        when(mockRepo.getById(anyInt())).thenReturn(acc);

        service.depositIntoAccount(1234, 100);
        assertEquals(acc.getBalance(), 100);

        verify(mockRepo).getById(eq(1234));
        verify(mockRepo).update(eq(1234), refEq(acc));
    }
}
```

BAServiceBeanTest.java

Specify return value for mocked methods

Verify mocked methods were called as expected

4. Additional Spring Boot Test Techniques

- Testing Spring Data repositories
- Testing REST controllers

Testing Spring Data Repositories (1 of 2)

- Earlier in the course we discussed Spring Data repositories
  - Define an interface that extends `CrudRepository`
  - Define query methods, which Spring automatically implements

```
public interface EmployeeRepository extends CrudRepository<Employee, Long> {

    List<Employee> findsByRegion(String region);

    @Query("select e from Employee e where e.dosh >= ?1 and e.dosh <= ?2")
    List<Employee> findInSalaryRange(double from, double to);

    Page<Employee> findByDoshGreaterThan(double sal, Pageable pageable);
}
```

- How can you test these repositories?
  - See next slide…

Testing Spring Data Repositories (2 of 2)

- Spring Boot makes it easy to test Spring Data repositories
  - Define a test class and annotate with `@DataJpaTest`
  - Use a `TestEntityManager` to prepare database state

```
@DataJpaTest  // Configures in-mem db, and does JPA-related config only.
public class EmployeeRepositoryTest {

    @Autowired
    private TestEntityManager em;  // Has some additional test-related APIs.

    @Autowired
    private EmployeeRepository repository;

    @Test
    public void testFindByRegion() {
        em.persist(new Employee(-1, "John Smith", 25000, "London"));
        em.persist(new Employee(-1, "Jane Evans", 30000, "Dublin"));
        List<Employee> emps = repository.findByRegion("London");
        assertEquals(1, emps.size());
    }
}
```

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Testing REST Controllers

- Spring Boot makes it easy to test REST controllers
  - In `@SpringBootTest`, set the `webEnvironment` property
  - Inject a `TestRestTemplate`, a test-friendly version of `RestTemplate` that doesn't throw exceptions for server errors

```
@SpringBootTest(webEnvironment=SpringBootTest.WebEnvironment.RANDOM_PORT)
public class SomeRestControllerTests {

    @Autowired
    private TestRestTemplate restTemplate;

    @Test
    public void testGetAllProducts() {

        ResponseEntity<List<Product>> responseEntity = restTemplate.exchange(
                "/full/products", HttpMethod.GET, null,
                new ParameterizedTypeReference<List<Product>>() {});

        List<Product> responseBody = responseEntity.getBody();
        assertEquals(HttpStatus.OK, responseEntity.getStatusCode());
        assertEquals(4, responseBody.size());   // Let's say we expect 4 products.
    }}
```

Summary

- The Spring Boot test ecosystem
- Writing and running tests on beans
- Mocking beans
- Additional Spring Boot test techniques