Subscribe to DeepL Pro to translate larger documents.
Visit www.DeepL.com/pro for more information.

Object-Oriented Programming

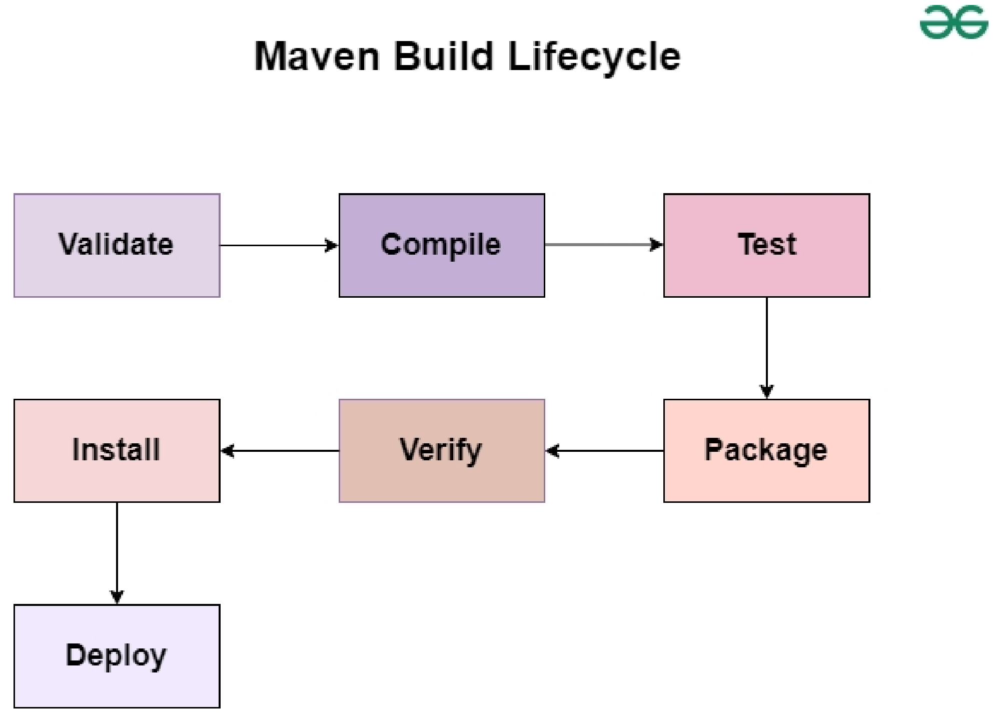
10. Lecture

LS 2025/2026

Author: Juraj Petrík

Lifecycle

- mvn clean: deletes the target directory.
- mvn compile: compiles source code.
- mvn test: runs unit tests.
- mvn package: creates JAR/WAR file.
- mvn install: installs artifact in local repository.
- mvn dependency:tree: shows dependency hierarchy.



pom.xml

```
• <project>
•   <modelVersion>4.0.0</modelVersion>
•   <groupId>com.example</groupId>
•   <artifactId>my-app</artifactId>
•   <version>1.0.0</version>
•
•   <dependencies>
•     <dependency>
•       <groupId>junit</groupId>
•       <artifactId>junit</artifactId>
•       <version>4.12</version>
•       <scope>test</scope>
•     </dependency>
•   </dependencies>
• </project>
```

Maven

-
  ```
  mvn archetype:generate -DgroupId=com.mycompany.app -DartifactId=my-app -DarchetypeArtifactId=maven-archetype-quickstart -DarchetypeVersion=1.5 -DinteractiveMode=false
  ```

Maven phases

- All "previous" phases are also executed, i.e. during mvn compile:
    1. validate
    2. generate-sources
    3. process-sources
    4. generate-resources
    5. process-resources
    6. compile

Maven repositories

- Local
- Central - https://mvnrepository.com/
- Remote

Maven dependencies

- Direct vs transitive

```
<dependency>
   <groupId>org.junit.jupiter</groupId>
   <artifactId>junit-jupiter-api</artifactId>
   <version>5.12.2</version>
   <scope>test</scope>
</dependency>
```

```
<dependency>
   <groupId>com.google.code.gson</groupId>
   <artifactId>gson</artifactId>
   <version>2.13.0</version>
</dependency>
```

SOLID

- Single Responsibility Principle
- Open-Closed Principle
- Liskov Substitution Principle
- Interface Segregation Principle
- Dependency Inversion Principle

Single Responsibility Principle

- A class should solve and be responsible for one thing, not "everything."

```
class Employee {
	private String name; private
	String position;

	public void saveToDatabase(Employee employee) {
	}

	public void calculateTax(Employee employee) {
	}

	public void generateReport(Employee employee) {
	}
}
```

```
class Employee {
	private String name;
	private String position;
}

class EmployeeRepository {
	public void save(Employee employee) {
	}
}

class TaxCalculator {
	public double calculateTax(Employee employee) {
	}
}

class ReportGenerator {
	public void generateReport(Employee employee) {
	}
}
```

Open-Closed Principle

- Open for extension, but closed for modification

```
class Shape {
      private String type;

      public double calculateArea() { if
            (type.equals("circle")) {
            } else if (type.equals("rectangle")) {
            }
      }
}
```

```
interface Shape {
      double calculateArea();
}

class Circle implements Shape { private
      double radius;

      @Override
      public double calculateArea() { return
            Math.PI * radius * radius;
      }
}
```

```
class Rectangle implements Shape { private
      double width;
      private double height;

      @Override
      public double calculateArea() {
            return width * height;
      }
}

class Triangle implements Shape { private
      double base;
      private double height;

      @Override
      public double calculateArea() { return
            0.5 * base * height;
      }
}
```

Liskov Substitution Principle

- Superclass objects should be interchangeable with subclass (superclass) objects without fatal consequences for the application.

```
class Bird {
      public void fly() {
            System.out.println("Flying");
      }
}

class Ostrich extends Bird { @Override
      public void fly() {
            throw new
UnsupportedOperationException("Ostriches can't fly!");
      }
}

  public class Main {
          public static void makeBirdFly(Bird bird) {
            bird.fly();   //   exception!

      }
}
```

```
 class Bird {
}

class FlyingBird extends Bird { public
      void fly() {
            System.out.println("Flying");
      }
}

class Ostrich extends Bird {
}

class Sparrow extends FlyingBird {
      @Override
      public void fly() {
            System.out.println("Sparrow flying");
      }
}

public class Main {
      public static void makeBirdFly(FlyingBird bird) {
            bird.fly();
      }
```

Interface Segregation Principle

- The client should not be forced to depend on interfaces it does not use

```
interface Worker {
        void work();
        void eat(); void
        sleep();
}

class HumanWorker implements Worker {
        public void work() {} public
        void eat() {} public void
        sleep() {}
}

class RobotWorker implements Worker {
        public void work() {}
        public void eat() {}
        public void sleep() {}
}
```

```
  interface Workable {
        void work();
}

interface Eatable { void
        eat();
}

  interface Sleepable {
         void sleep();
}

class HumanWorker implements Workable, Eatable, Sleepable { public void
        work() {}
        public void eat() {}
        public void sleep() {}
}

class RobotWorker implements Workable { public
        void work() {}
}
```

Dependency Inversion Principle

- High-level modules should not depend on low-level ones. Implement abstraction.

```
class LightBulb {
	public void turnOn() {} public
	void turnOff() {}
}

class Switch {
	private LightBulb bulb;

	public Switch() {
		this.bulb = new LightBulb();
	}

	public void operate() {
	}
}
```

```
interface Switchable {
	void turnOn(); void
	turnOff();
}

class LightBulb implements Switchable { public
	void turnOn() {}
	public void turnOff() {}
}

class Fan implements Switchable {
	public void turnOn() {} public
	void turnOff() {}
}

class Switch {
	private Switchable device;

	public Switch(Switchable device) {
		this.device = device;

	public void operate() {
	}
}
```

```
Switch lightSwitch = new Switch(new LightBulb());
Switch fanSwitch = new Switch(new Fan());
```

Other important principles

DRY (Don't Repeat Yourself)

- We do not duplicate code

```
class OrderProcessor {
       public void processDomesticOrder(Order order) {
              validate(order); calculateDomesticTax(order);
              saveToDatabase(order);
              sendEmail(order, "domestic");
       }
       public void processInternationalOrder(Order order)
{
              validate(order);
              calculateInternationalTax(order);
              saveToDatabase(order);
              sendEmail(order, "international");
       }
}
```

```
class OrderProcessor {
       public void processOrder(Order order, TaxCalculator taxCalculator, String type)
{
              validate(order);
              taxCalculator.calculateTax(order);
              saveToDatabase(order); sendEmail(order,
              type);
       }
}
```

KISS (Keep It Simple Stupid)

- Simpler code == more readable and easier to maintain

```
public class ComplexTemperatureConverter {
      public double convertTemperature(double value, String
fromUnit, String toUnit) {
            if (fromUnit.equals("Celsius") &&
toUnit.equals("Fahrenheit")) {
                  return (value * 9/5) + 32;
            } else if (fromUnit.equals("Fahrenheit") &&
toUnit.equals("Celsius"))   {
                  return (value - 32) * 5/9;
            } else if (fromUnit.equals("Kelvin") &&
toUnit.equals("Celsius")) {
                  return value - 273.15;
            }
      }
}
```

```
public class TemperatureConverter {
      public double celsiusToFahrenheit(double celsius) { return
            (celsius * 9/5) + 32;
      }

      public double fahrenheitToCelsius(double fahrenheit) { return
            (fahrenheit - 32) * 5/9;
      }
}
```

YAGNI (You Aren't Gonna Need It)

- Don't implement something just because it might be needed in the future

```
interface EmployeeRepository {
	Employee findById(long id);
	List<Employee> findAll(); void
	save(Employee employee); void
	delete(long id);
	// I will need these in the future, for sure!
	List<Employee> findByDepartment(String
department);
	List<Employee> findBySalaryRange(double min, double
max);
}
```

```
interface EmployeeRepository {
	Employee findById(long id);
	List<Employee> findAll(); void
	save(Employee employee);
}
```

Law of Demeter (Principle of Least Knowledge)

- An object communicates only with its closest friends:

1. Each unit should have only limited knowledge about other units: only units "closely" related to the current unit.
2. Each unit should only talk to its friends; don't talk to strangers.
3. Only talk to your immediate friends.

Law of Demeter (Principle of Least Knowledge)

```
class Customer {
      private Wallet wallet;

      public Wallet getWallet() { return
            wallet;
      }
}

class Wallet {
      private   double   money;

      public double getMoney() { return
            money;
      }
}

double   money   =   customer.getWallet().getMoney();
```

```
class Customer {
      private Wallet wallet;

      public double getPayment(double amount) { return
            wallet.subtractMoney(amount);
      }
}

class Wallet {
      private double money;      ;

      public double subtractMoney(double amount) { if
            (money >= amount) {
                  money -= amount; return
                  amount;
            }
            return 0;
      }
}

double money = customer.getPayment(100);
```

Composition Over Inheritance

- If possible, prefer composition over inheritance.
- What if I want a robot dog that can bark but doesn't breathe?

```
class Animal { void
breathe() {}
}

class Mammal extends Animal {
void nurse() {}
}

class Dog extends Mammal {
void bark() {}
}

class Cat extends Mammal {
void meow() {}
}
```

```
interface Breathable {
      void breathe();
}

interface Nursable {
      void nurse();
}

interface Barkable {
      void bark();
}

class Animal implements Breathable {
      public void breathe() {}
}
```

```
class Dog {
      private Breathable breathable; private
      Barkable barkable;

      public Dog(Breathable b, Barkable bark) {
            this.breathable = b;
            this.barkable = bark;
      }

      public void bark() { barkable.bark();
      }
}

class RobotDog {
      private Barkable barkable;

      public RobotDog(Barkable bark) {
            this.barkable = bark;
      }

         public void bark() {
             barkable.bark();
```

Principle of Least Astonishment

- We strive to surprise users (clients) as little as possible (negatively).

```java
class DateUtils {
      public static Date addMonths(Date date, int months) {
            Calendar cal = Calendar.getInstance();
            cal.setTime(date);
            cal.add(Calendar.MONTH, months); return
            cal.getTime();
      }
}
```

```java
class DateUtils {
      public static Date addMonths(Date date, int months) {
            if (date == null) {
                  throw new IllegalArgumentException("Date cannot be null");
            }

            Calendar cal = Calendar.getInstance();
            cal.setTime(date); cal.add(Calendar.MONTH,
            months);

            if (cal.get(Calendar.DAY_OF_MONTH) != date.getDay()) { cal.set(Calendar.DAY_OF_MONTH,
                              Math.min(cal.getActualMaximum(Calendar.DAY_OF_MONTH),     date.getDay()));
            }

              return cal.getTime();
      }
}
```

Quiz time