

Аннотации, Lombok

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15.05.2019г

Аннотации

- ▶ Нужны для добавления метаданных в классы
 - ▶ Могут потом использоваться во время компиляции или во время выполнения
 - ▶ Активно используются самим компилятором (`@Override`, `@SuppressWarnings`)
- ▶ Могут использоваться для генерации кода во время компиляции (например, Lombok)
- ▶ Полезны во время выполнения вместе с рефлексией (например, JUnit)

Объявление своей аннотации

```
@Target(ElementType.TYPE)
@Retention(RetentionPolicy.RUNTIME)
public @interface Mammal {
    String sound();
    int color();
}
```

Использование

```
@Mammal(color = 0xFFA844, sound = "uuuu")  
class Giraffe {  
}
```

Работа с аннотациями в рантайме

```
@PermissionRequired(User.Permission.USER_MANAGEMENT)
class UserDeleteAction {
    public void invoke(User user) { /* */ }
}
```

```
User user = ...;
Class<?> actionClass = ...;
PermissionRequired permissionRequired =
    actionClass.getAnnotation(PermissionRequired.class);
if (permissionRequired != null)
    if (user != null && user.getPermissions().contains(
        permissionRequired.value())) {
        // ВЫПОЛНИТЬ ДЕЙСТВИЕ
    }
}
```

Процессоры аннотаций

- ▶ Обработывают аннотации во время компиляции
 - ▶ Можно понимать как плагины к компилятору
- ▶ Генерируют код
 - ▶ Который потом подаётся на вход компилятору
- ▶ Появились в Java 6
- ▶ Используются многими библиотеками

API

```
public class MyProcessor extends AbstractProcessor {  
  
    @Override  
    public synchronized void init(ProcessingEnvironment env) { }  
  
    @Override  
    public boolean process(  
        Set<? extends TypeElement> annotations,  
        RoundEnvironment env) { }  
  
    @Override  
    public Set<String> getSupportedAnnotationTypes() { }  
  
    @Override  
    public SourceVersion getSupportedSourceVersion() { }  
}
```

API, с Java 7

```
@SupportedSourceVersion(SourceVersion.latestSupported())
```

```
@SupportedAnnotationTypes({...})
```

```
public class MyProcessor extends AbstractProcessor {
```

```
    @Override
```

```
    public synchronized void init(  
        ProcessingEnvironment env) { }
```

```
    @Override
```

```
    public boolean process(  
        Set<? extends TypeElement> annoations,  
        RoundEnvironment env) { }
```

```
}
```


Регистрация процессора

Надо собрать специальный jar-файл

MyProcessor.jar

- com
 - example
 - MyProcessor.class
- META-INF
 - services
 - javax.annotation.processing.Processor

javax.annotation.processing.Processor содержит полностью квалифицированные имена классов-процессоров через перевод строки

Компиляция кода с процессором

Добавить процессор в classpath (на самом деле, в -processorpath у javac)

```
>javac -cp com.example.annotations.jar;  
    com.example.annotations.processors.jar  
    MyCode.java
```

Пример: фабрика

```
public interface Meal {  
    public float getPrice();  
}  
  
public class MargheritaPizza implements Meal {  
    @Override public float getPrice() {  
        return 6.0f;  
    }  
}  
  
public class CalzonePizza implements Meal {  
    @Override public float getPrice() {  
        return 8.5f;  
    }  
}  
  
public class Tiramisu implements Meal {  
    @Override public float getPrice() {  
        return 4.5f;  
    }  
}
```

Основной класс

```
public class PizzaStore {  
  
    private MealFactory factory = new MealFactory();  
  
    public Meal order(String mealName) {  
        return factory.create(mealName);  
    }  
  
    public static void main(String[] args) throws IOException {  
        var pizzaStore = new PizzaStore();  
        Meal meal = pizzaStore.order(readConsole());  
        System.out.println("Bill: " + meal.getPrice());  
    }  
}
```

Фабрика

```
public class MealFactory {  
  
    public Meal create(String id) {  
        if (id == null) {  
            throw new IllegalArgumentException("id is null!");  
        } else if ("Calzone".equals(id)) {  
            return new CalzonePizza();  
        } else if ("Tiramisu".equals(id)) {  
            return new Tiramisu();  
        } else if ("Margherita".equals(id)) {  
            return new MargheritaPizza();  
        }  
  
        throw new IllegalArgumentException("Unknown id = " + id);  
    }  
}
```

Аннотация @Factory

```
@Target(ElementType.TYPE)
@Retention(RetentionPolicy.CLASS)
public @interface Factory {
```

```
    /** The name of the factory */
```

```
    Class type();
```

```
    /** The identifier for determining which item should be instantiated */
```

```
    String id();
```

```
}
```

Пиццы

```
@Factory(id = "Margherita", type = Meal.class)
public class MargheritaPizza implements Meal {
    @Override public float getPrice() {
        return 6f;
    }
}
```

```
@Factory(id = "Calzone", type = Meal.class)
public class CalzonePizza implements Meal {
    @Override public float getPrice() {
        return 8.5f;
    }
}
```

Самое интересное: процессор

```

@Service(Processor.class)
public class FactoryProcessor extends AbstractProcessor {
    private Types typeUtils;
    private Elements elementUtils;
    private Filer filer;
    private Messenger messenger;
    private Map<String, FactoryGroupedClasses> factoryClasses
        = new LinkedHashMap<String, FactoryGroupedClasses>();
    @Override
    public synchronized void init(ProcessingEnvironment processingEnv) {
        super.init(processingEnv);
        typeUtils = processingEnv.getTypeUtils();
        elementUtils = processingEnv.getElementUtils();
        filer = processingEnv.getFiler();
        messenger = processingEnv.getMessager();
    }
    @Override
    public Set<String> getSupportedAnnotationTypes() {
        Set<String> annotations = new LinkedHashSet<String>();
        annotations.add(Factory.class.getName());
        return annotations;
    }
    ...
}

```


Элементы

```
package com.example; // PackageElement
```

```
public class Foo { // TypeElement
```

```
    private int a; // VariableElement
```

```
    private Foo other; // VariableElement
```

```
    public Foo () {} // ExecutableElement
```

```
    public void setA ( // ExecutableElement
```

```
        int newA // VariableElement
```

```
    ) {}
```

```
}
```

Пример работы с элементами

```
TypeElement fooClass = ...;  
for (Element e : fooClass.getEnclosedElements()) {  
    Element parent = e.getEnclosingElement();  
}
```

Вернёмся к процессору

```
@AutoService(Processor.class)
```

```
public class FactoryProcessor extends AbstractProcessor {
```

```
...
```

```
@Override
```

```
public boolean process(
```

```
    Set<? extends TypeElement> annotations,
```

```
    RoundEnvironment roundEnv) {
```

```
    // Iterate over all @Factory annotated elements
```

```
    for (Element annotatedElement
```

```
        : roundEnv.getElementsAnnotatedWith(Factory.class)) {
```

```
        ...
```

```
    }
```

```
}
```

```
...
```

```
}
```

FactoryAnnotatedClass

```

public class FactoryAnnotatedClass {
    private TypeElement annotatedClassElement;
    private String qualifiedSuperClassName;
    private String simpleTypeName;
    private String id;
    public FactoryAnnotatedClass(TypeElement classElement)
        throws IllegalArgumentException {
        this.annotatedClassElement = classElement;
        Factory annotation = classElement.getAnnotation(Factory.class);
        id = annotation.id();
        if (StringUtils.isEmpty(id)) {
            throw new IllegalArgumentException(
                String.format("id() in @%s for class %s is null or empty! that's not allowed",
                    Factory.class.getSimpleName(), classElement.getQualifiedName().toString()));
        }
        ...
    }
}

```

FactoryAnnotatedClass (2)

```
public class FactoryAnnotatedClass {  
    public FactoryAnnotatedClass(TypeElement classElement)  
        throws IllegalArgumentException {  
        ...  
        try {  
            Class<?> clazz = annotation.type();  
            qualifiedSuperClassName = clazz.getCanonicalName();  
            simpleTypeName = clazz.getSimpleName();  
        } catch (MirroredTypeException mte) {  
            DeclaredType classTypeMirror = (DeclaredType) mte.getTypeMirror();  
            TypeElement classTypeElement = (TypeElement) classTypeMirror.asElement();  
            qualifiedSuperClassName = classTypeElement.getQualifiedName().toString();  
            simpleTypeName = classTypeElement.getSimpleName().toString();  
        }  
    }  
}
```

FactoryGroupedClasses

```

public class FactoryGroupedClasses {
    private String qualifiedClassName;
    private Map<String, FactoryAnnotatedClass> itemsMap =
        new LinkedHashMap<String, FactoryAnnotatedClass>();
    public FactoryGroupedClasses(String qualifiedClassName) {
        this.qualifiedClassName = qualifiedClassName;
    }
    public void add(FactoryAnnotatedClass toInsert) throws IdAlreadyUsedException {
        FactoryAnnotatedClass existing = itemsMap.get(toInsert.getId());
        if (existing != null) {
            throw new IdAlreadyUsedException(existing);
        }
        itemsMap.put(toInsert.getId(), toInsert);
    }
    public void generateCode(Elements elementUtils, Filer filer) throws IOException {
        ...
    }
}

```

Вернёмся к процессору ещё раз

```

public class FactoryProcessor extends AbstractProcessor {
    @Override
    public boolean process(Set<? extends TypeElement> annotations,
        RoundEnvironment roundEnv) {
        for (Element annotatedElement
            : roundEnv.getElementsAnnotatedWith(Factory.class)) {
            ...
            var typeElement = (TypeElement) annotatedElement;
            try {
                FactoryAnnotatedClass annotatedClass =
                    new FactoryAnnotatedClass(typeElement);
                if (isValidClass(annotatedClass)) {
                    return true;
                }
            } catch (IllegalArgumentException e) {
                error(typeElement, e.getMessage());
                return true;
            }
            ...
        }
    }
}

```

Продолжим

```
try {
    var annotatedClass = new FactoryAnnotatedClass(typeElement);
    if (!isValidClass(annotatedClass)) {
        return true; // Error message printed, exit processing
    }
    // Everything is fine, so try to add
    FactoryGroupedClasses factoryClass =
        factoryClasses.get(annotatedClass.getQualifiedFactoryGroupName());
    if (factoryClass == null) {
        String qualifiedGroupName = annotatedClass.getQualifiedFactoryGroupName();
        factoryClass = new FactoryGroupedClasses(qualifiedGroupName);
        factoryClasses.put(qualifiedGroupName, factoryClass);
    }
    factoryClass.add(annotatedClass);
} catch (IllegalArgumentException e) {
    // @Factory.id() is empty --> printing error message
} catch (IdAlreadyUsedException e) {
    // Already existing
}
```


И генерация кода

@Override

```
public boolean process(Set<? extends TypeElement> annotations,  
    RoundEnvironment roundEnv) {  
    ...  
    try {  
        for (FactoryGroupedClasses factoryClass : factoryClasses.values()) {  
            factoryClass.generateCode(elementUtils, filer);  
        }  
    } catch (IOException e) {  
        error(null, e.getMessage());  
    }  
    return true;  
}
```

Собственно, генерация

```

public class FactoryGroupedClasses {
    private static final String SUFFIX = "Factory";
    private String qualifiedClassName;
    private Map<String, FactoryAnnotatedClass> itemsMap =
        new LinkedHashMap<String, FactoryAnnotatedClass>();
    ...
    public void generateCode(Elements elementUtils, Filer filer) throws IOException {
        TypeElement superClassNames = elementUtils.getTypeElement(qualifiedClassName);
        String factoryClassName = superClassNames.getSimpleName() + SUFFIX;
        JavaFileObject jfo = filer.createSourceFile(qualifiedClassName + SUFFIX);
        Writer writer = jfo.openWriter();
        var jw = new JavaWriter(writer);
        PackageElement pkg = elementUtils.getPackageOf(superClassNames);
        if (!pkg.isUnnamed()) {
            jw.emitPackage(pkg.getQualifiedName().toString());
            jw.emitEmptyLine();
        } else {
            jw.emitPackage("");
        }
    }
}

```

Собственно, генерация (2)

```

jw.beginType(factoryClassName, "class", EnumSet.of(Modifier.PUBLIC));
jw.emitEmptyLine();
jw.beginMethod(qualifiedClassName, "create",
    EnumSet.of(Modifier.PUBLIC), "String", "id");
jw.beginControlFlow("if (id == null)");
jw.emitStatement("throw new IllegalArgumentException(\"id is null!\")");
jw.endControlFlow();
for (FactoryAnnotatedClass item : itemsMap.values()) {
    jw.beginControlFlow("if (\\"" + item.getId() + "\".equals(id))", item.getId());
    jw.emitStatement("return new " + item.getTypeElement().getQualifiedName().toString());
    jw.endControlFlow();
    jw.emitEmptyLine();
}
jw.emitStatement("throw new IllegalArgumentException(\"Unknown id = \" + id)\");
jw.endMethod();
jw.endType();
jw.close();
}
}

```

Полезные ссылки

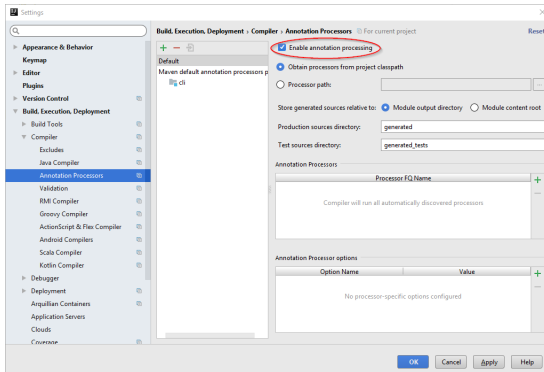
- ▶ <http://hannedorfmann.com/annotation-processing/annotationprocessing101>
- ▶ <https://deors.wordpress.com/2011/10/08/annotation-processors/>

Lombok

- ▶ Очень известная библиотека аннотаций и процессоров, делающая программирование на Java несколько менее неудобным
- ▶ <https://projectlombok.org/>
- ▶ Генерирует boilerplate-код
 - ▶ Геттеры и сеттеры
 - ▶ Конструкторы
 - ▶ Метод toString
 - ▶ Методы equals и hashCode
 - ▶ Всё это сразу
 - ▶ Безопасный synchronized
 - ▶ Строитель (Builder)

Что надо сделать

1. Подключить артефакт `org.projectlombok:lombok` как `compileOnly`-зависимость
2. Включить процессоры аннотаций в IDEA
 - ▶ File -> Settings... -> Build, Execution, Deployment -> Compiler -> Annotation Processors



Геттеры и сеттеры

```
@Getter @Setter private boolean employed = true;  
@Setter(AccessLevel.PROTECTED) private String name;
```

Эквивалентный код:

```
private boolean employed = true;  
private String name;
```

```
public boolean isEmployed() {  
    return employed;  
}
```

```
public void setEmployed(final boolean employed) {  
    this.employed = employed;  
}
```

```
protected void setName(final String name) {  
    this.name = name;  
}
```

@ToString

```
@ToString(callSuper=true,exclude="someExcludedField")
```

```
public class Foo extends Bar {
    private boolean someBoolean = true;
    private String someStringField;
    private float someExcludedField;
}
```

Эквивалентный код:

```
public class Foo extends Bar {
    private boolean someBoolean = true;
    private String someStringField;
    private float someExcludedField;
```

```
@java.lang.Override
```

```
public java.lang.String toString() {
    return "Foo(super=" + super.toString() +
        ", someBoolean=" + someBoolean +
        ", someStringField=" + someStringField + ")";
}
```


@EqualsAndHashCode

```
@EqualsAndHashCode(callSuper=true, exclude={ "address", "city", "state", "zip" })
public class Person extends SentientBeing {
    enum Gender { Male, Female }

    @NonNull private String name;
    @NonNull private Gender gender;

    private String ssn;
    private String address;
    private String city;
    private String state;
    private String zip;
}
```

@Data

```
@Data(staticConstructor="of")
public class Company {
    private final Person founder;
    private String name;
    private List<Person> employees;
}
```

@Synchronized

```
private DateFormat format = new SimpleDateFormat("MM-dd-YYYY");
```

@Synchronized

```
public String synchronizedFormat(Date date) {  
    return format.format(date);  
}
```

Эквивалентный код:

```
private final java.lang.Object $lock = new java.lang.Object[0];  
private DateFormat format = new SimpleDateFormat("MM-dd-YYYY");  
  
public String synchronizedFormat(Date date) {  
    synchronized ($lock) {  
        return format.format(date);  
    }  
}
```

@Builder

```
@Builder
class Example {
    private int foo;
    private final String bar;
}
```

@Builder, эквивалентный код

```

class Example<T> {
    private T foo;
    private final String bar;

    private Example(T foo, String bar) {
        this.foo = foo;
        this.bar = bar;
    }

    public static <T> ExampleBuilder<T> builder() {
        return new ExampleBuilder<T>();
    }

    public static class ExampleBuilder<T> {
        private T foo;
        private String bar;
        private ExampleBuilder() {}
        public ExampleBuilder foo(T foo) {
            this.foo = foo;
            return this;
        }
        public ExampleBuilder bar(String bar) {
            this.bar = bar;
            return this;
        }
        @java.lang.Override public String toString() {
            return "ExampleBuilder(foo = " + foo + ", bar = " + bar + ")";
        }
        public Example build() {
            return new Example(foo, bar);
        }
    }
}

```

@val

```
val x = 10.0;  
val y = new ArrayList<String>();
```

- ▶ Требуется **import lombok.val**;
- ▶ Выводит тип из выражения инициализации
- ▶ Делает переменную **final**