Automating Systematic Edits with Cha-Q search-and-replace

Presenters: Tim Molderez, Nick Nuyts

Cha-Q

Federale Overheidsdienst FINANCIEN

FOD Financiën pilot study

- Calcul IPP project: Simulation personal taxes

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- Calcul IPP project: Simulation personal taxes

- 2987 Java source files; 274883 LOC
- Examined development activity of Sep. 2014 - May 2016 (751 commits)

Introducing fields + usages

```
public class ReportCalcSummary implements Serializable {
...
+ private Long impotReferRegulPosVla;
+ public Long getImpotReferRegulPosVla() {
+   return impotReferRegulPosVla;}
+ public void setImpotReferRegulPosVla(Long impotReferRegulPosVla) {
+   this.impotReferRegulPosVla = impotReferRegulPosVla;}
...
+   .append("impotReferRegulPosVla = ").append(this.impotReferRegulPosVla).append(TAB)
...
+   dto.setImpotReferRegulPosVla(new Long(0));
...
+   if (g8653 > 0) {dto.setImpotReferRegulPosVla(a(dto.getImpotReferRegulPosVla(), g8653));}
...
+   vo.setImpotReferRegulPosVla(dto.getImpotReferRegulPosVla());
...
```

Introducing fields + usages

A new field

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A new field

Its getter

Introducing fields + usages

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A new field

Its getter

Its setter

Introducing fields + usages

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A new field

Its getter

Its setter

Different usages of the field

Systematic edits overview

Type	*# sys. edits*	*avg. instances*
Adding similar call statements	***38***	***53***
Adding/removing similar fields	***33***	***96.26***
Adding similar if cases	***13***	***21.92***
Adding similar test cases	***12***	***51.67***
Generating similar classes	***5***	***8.2***
Formatting changes	***5***	***63.6***
Miscellaneous	***14***	***33.5***
Total	***120***	

Systematic edits overview

Type	*# sys. edits*	*avg. instances*
Adding similar call statements	*38*	*53*
Formatting changes	*5*	*63.6*
Miscellaneous	*14*	*33.5*
Total	*120*	

- ~16% of commits containing systematic edits
- ~7% of commits are systematic edits related to tax law changes → Likely to reoccur

Cha-Q search-and-replace

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- Systematic edits are unavoidable

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- Repetitive and error-prone if done manually

Cha-Q search-and-replace

- Systematic edits are unavoidable
- Repetitive and error-prone if done manually
- Automate it!
  - Only describe the similar change once
  - Tool can apply it to all locations

Example systematic edit

```
public class BreakStatement extends Statement {
    @EntityProperty(value = SimpleName.class)
    private EntityIdentifier label;

    public EntityIdentifier getLabel() {
        return label;
    }

    public void setLabel(EntityIdentifier label) {
        this.label = label;
    }
}
```

Example systematic edit

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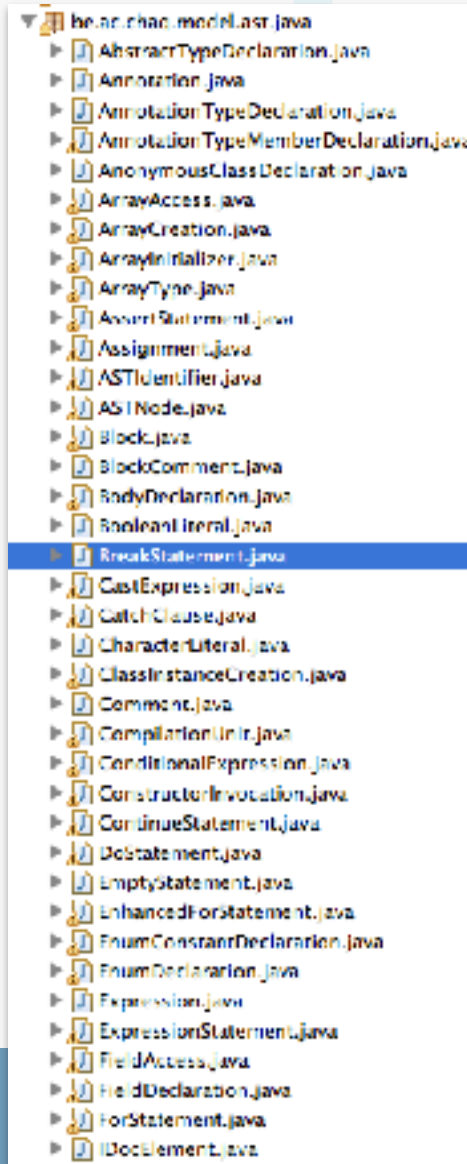

Example systematic edit

A field of type EntityIdentifier

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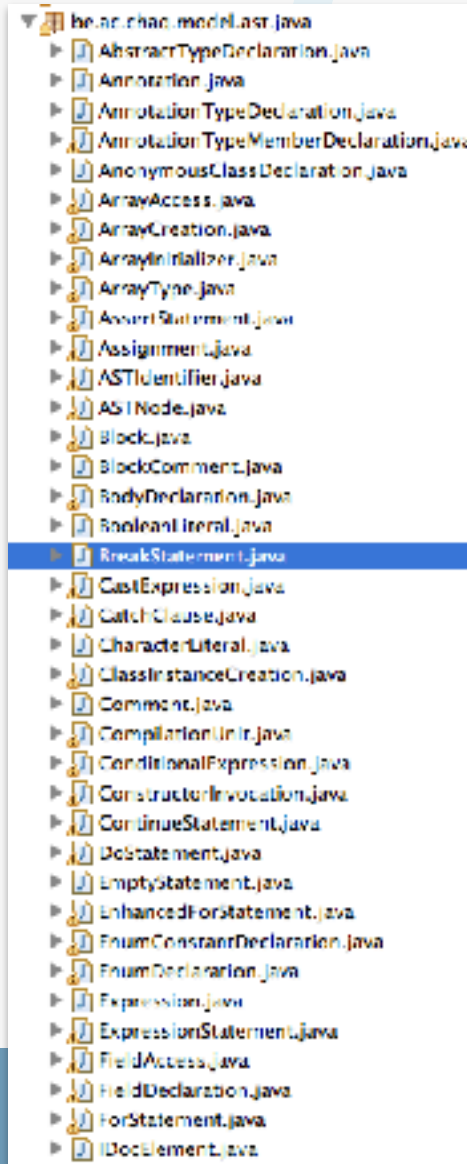

Ex[illegible]edit

An identifier of an entity .. but what kind of entity?

A field of type EntityIdentifier

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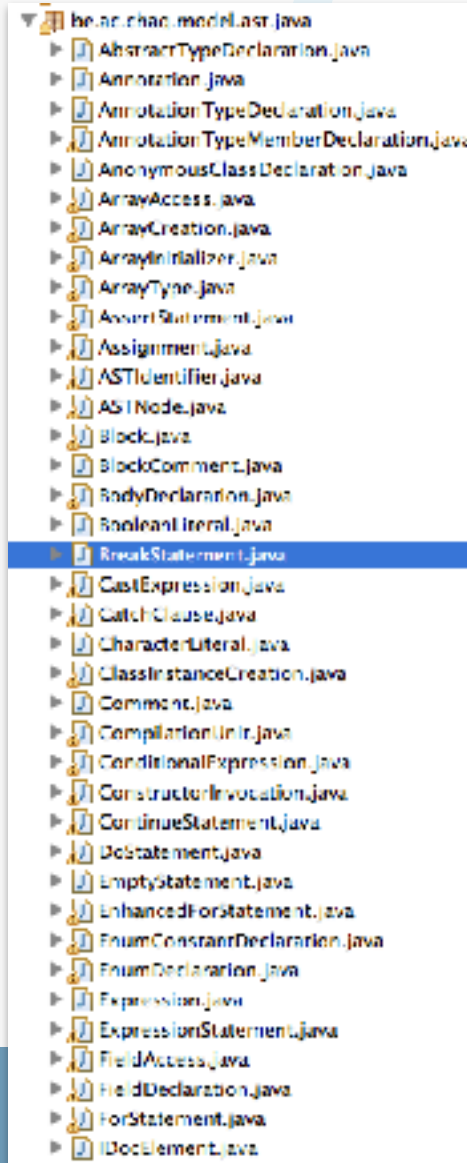

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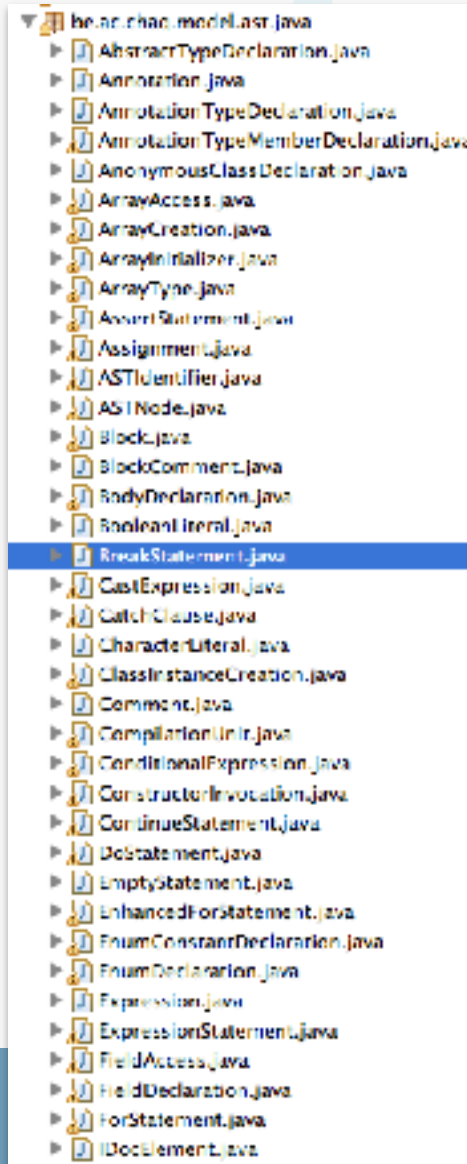

Example: semantic edit

An identifier of an entity .. but what kind of entity?

A field of type EntityIdentifier

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public class BreakStatement extends Statement {
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```
public class BreakStatement extends Statement {
    @EntityProperty(value = SimpleName.class)
    private EntityIdentifier<SimpleName> label;

    public EntityIdentifier<SimpleName> getLabel() {
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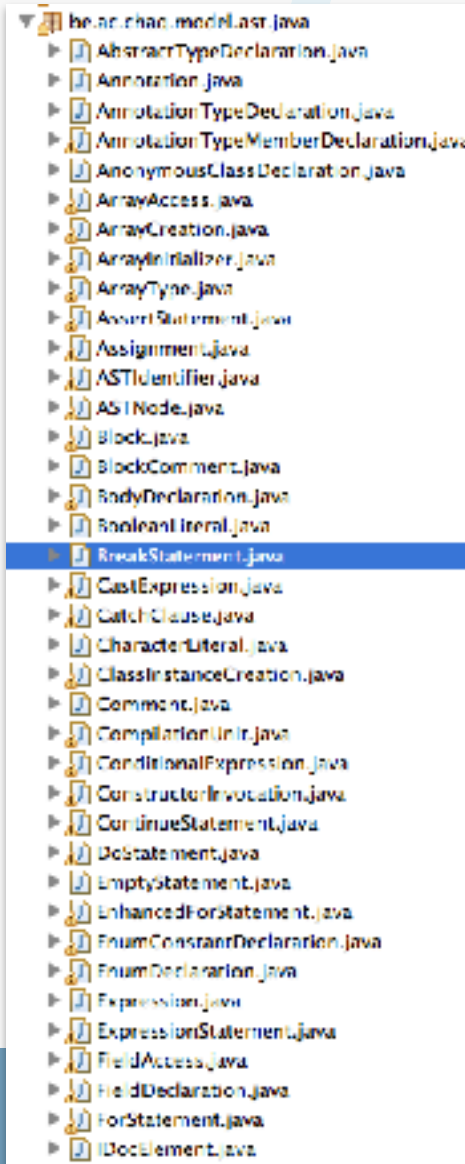

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```

Used as type parameter

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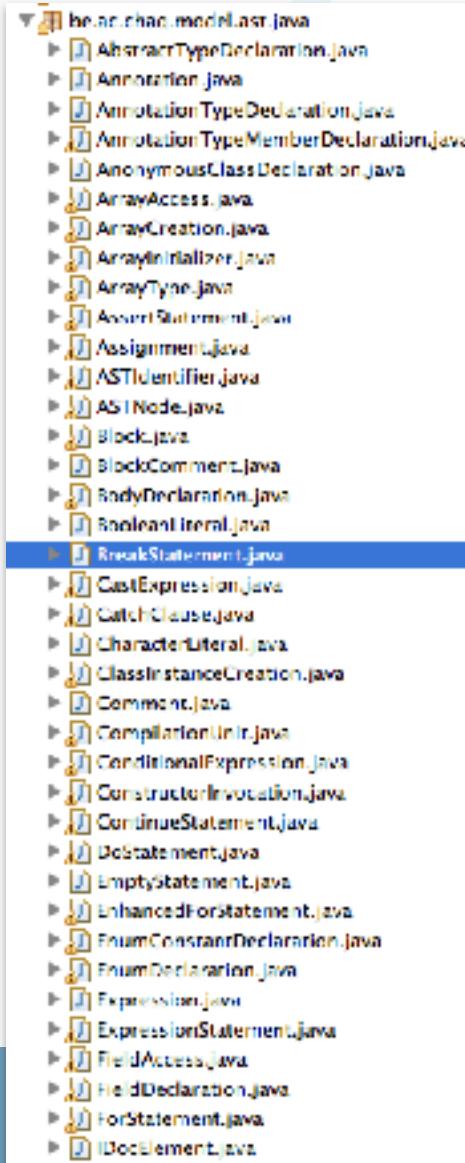
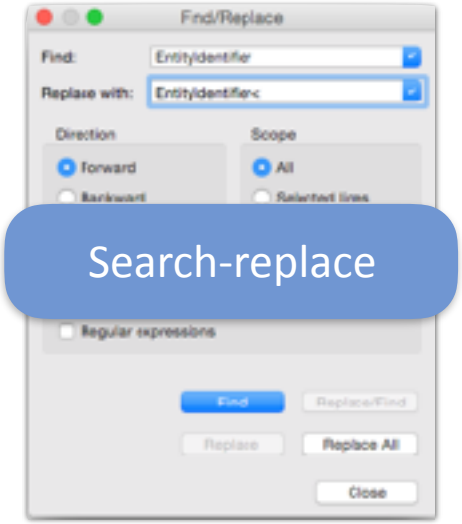
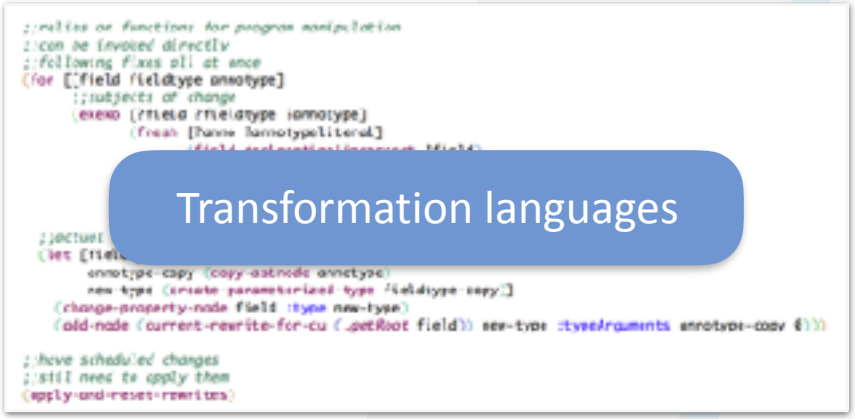


State of the art: 2 extremes



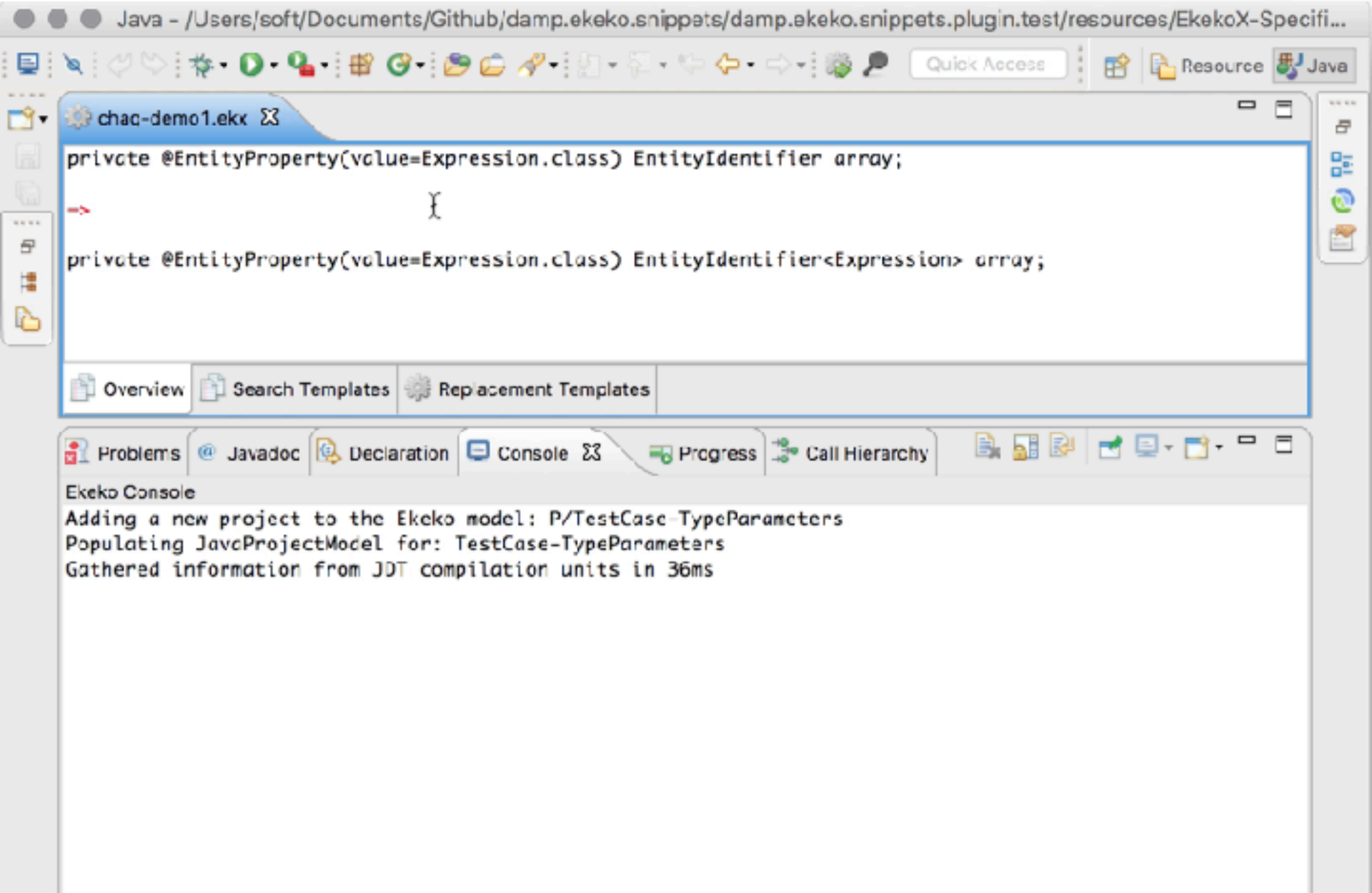
Search-replace



Transformation languages

Cha-Q search-and-replace

Demo 1



Cha-Q search-and-replace

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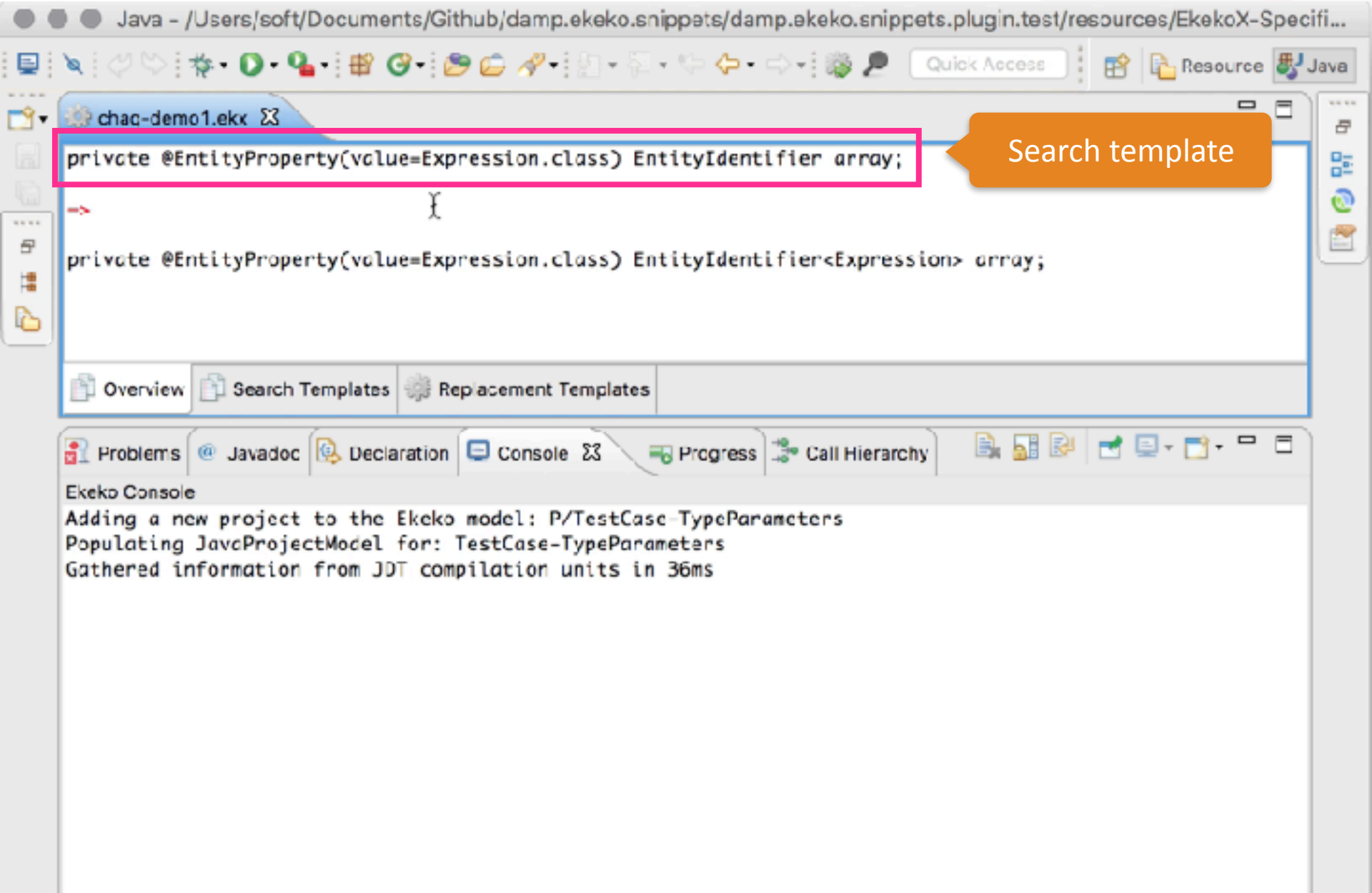

Cha-Q search-and-replace

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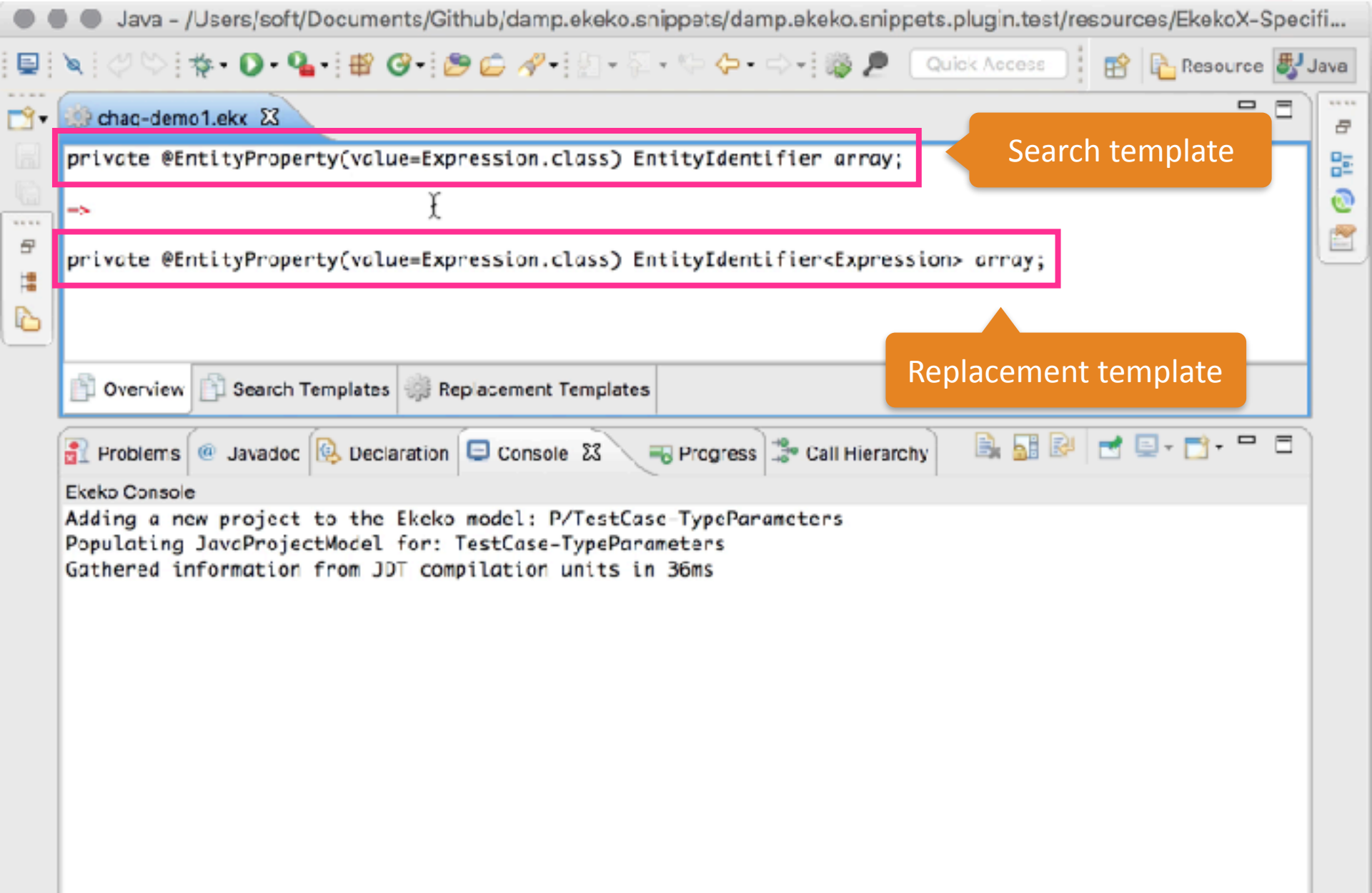

Cha-Q search-and-replace

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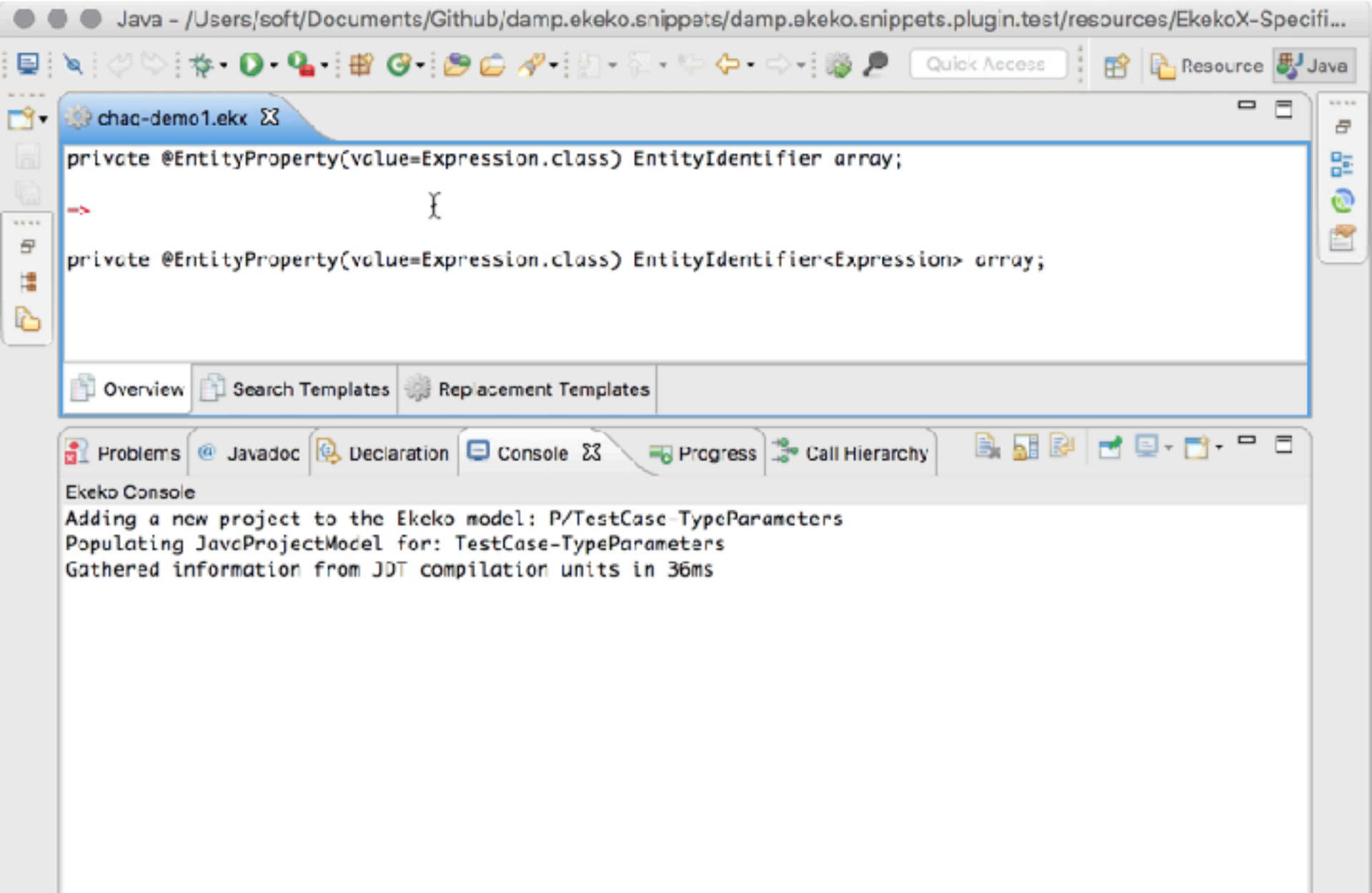

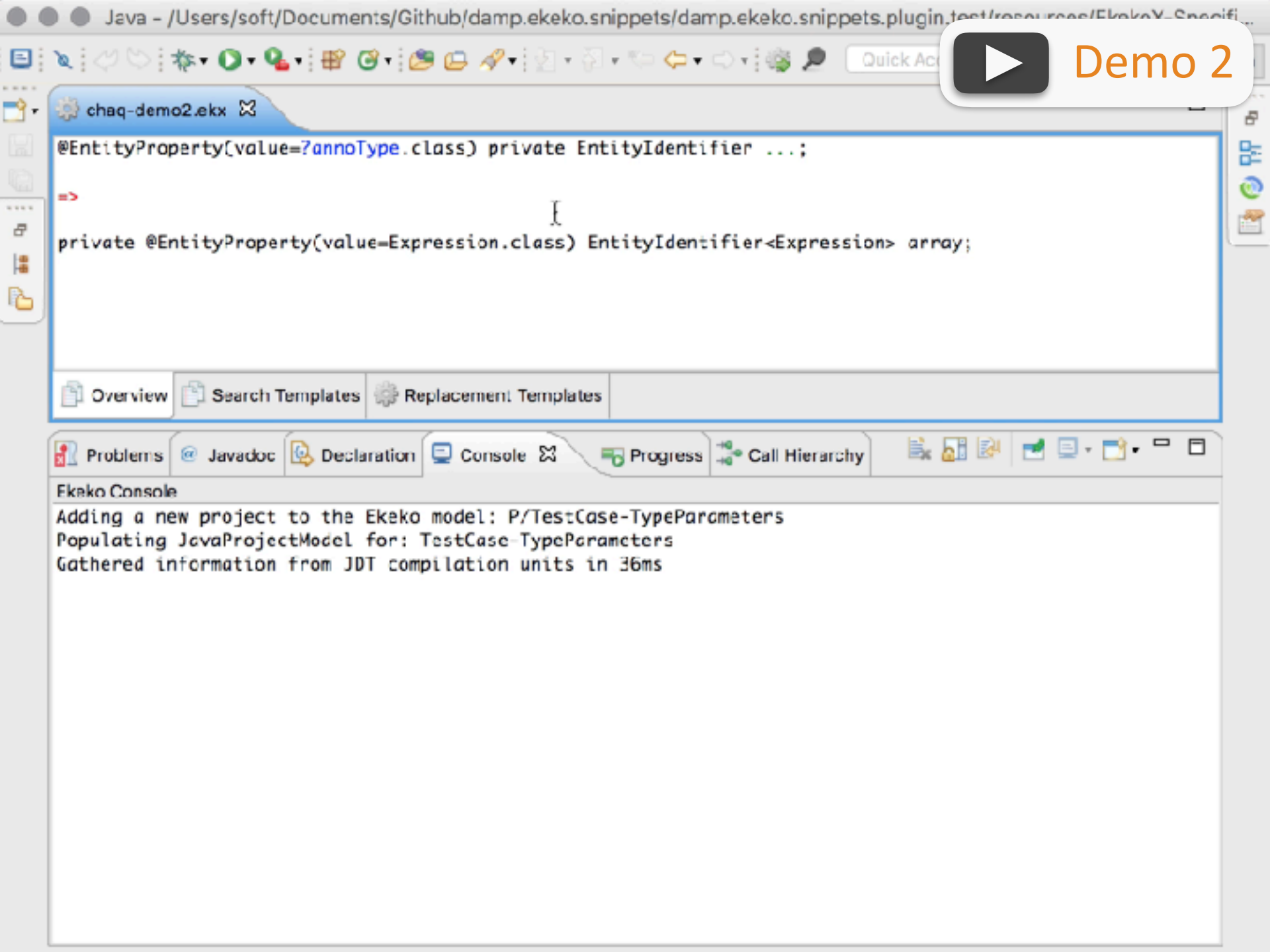
Java - /Users/soft/Documents/Github/damp.ekeko.snippets/damp.ekeko.snippets.plugin.test/resources/EkekoX-Specifi...
Demo 2
chaq-demo2.ekx
@EntityProperty(value=?annoType.class) private EntityIdentifier ...;
=>
private @EntityProperty(value=Expression.class) EntityIdentifier<Expression> array;
Overview
Search Templates
Replacement Templates
Problems
Javadoc
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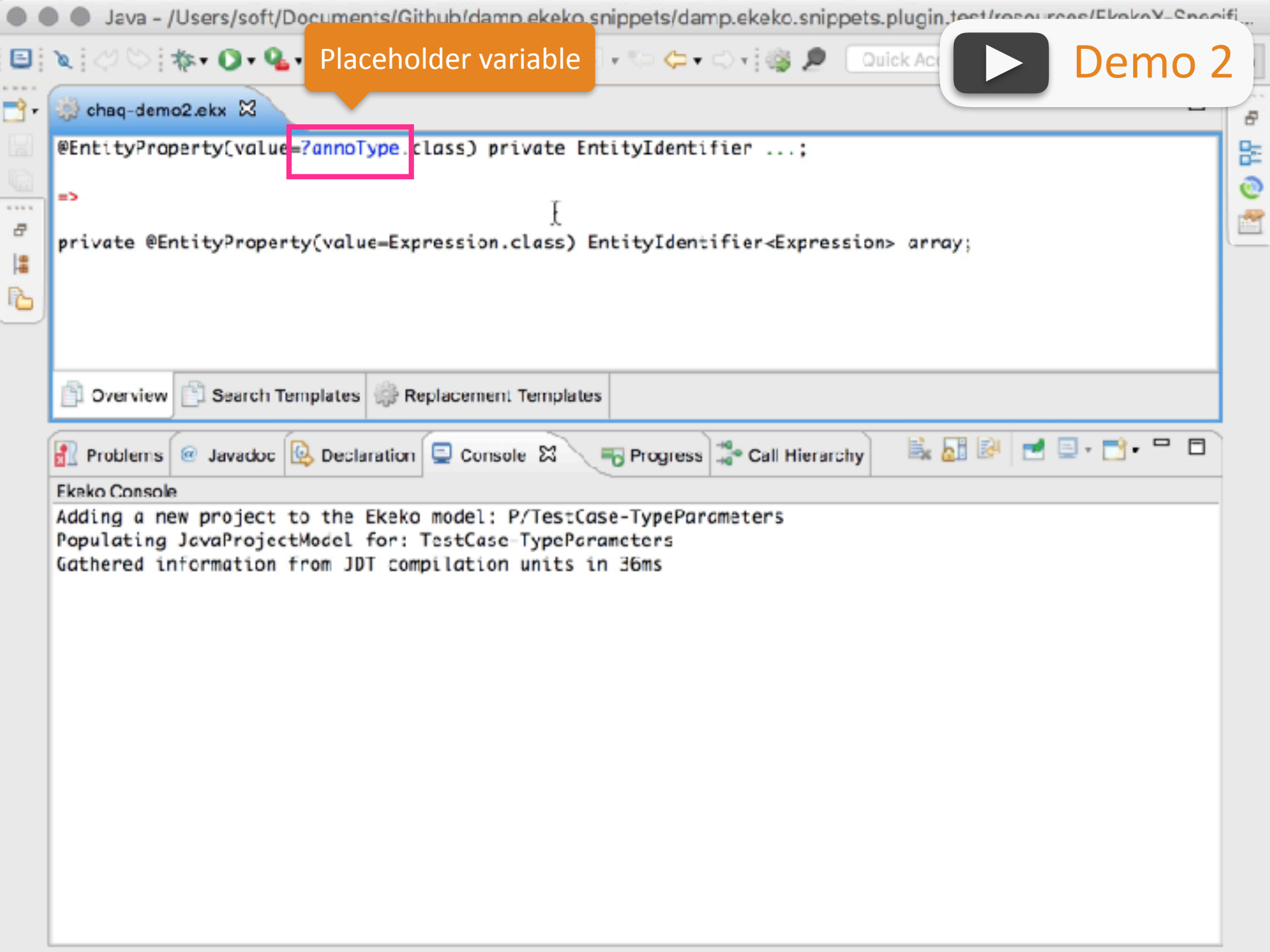
Ekeko Console
Adding a new project to the Ekeko model: P/TestCase-TypeParameters
Populating JavaProjectModel for: TestCase-TypeParameters
Gathered information from JDT compilation units in 36ms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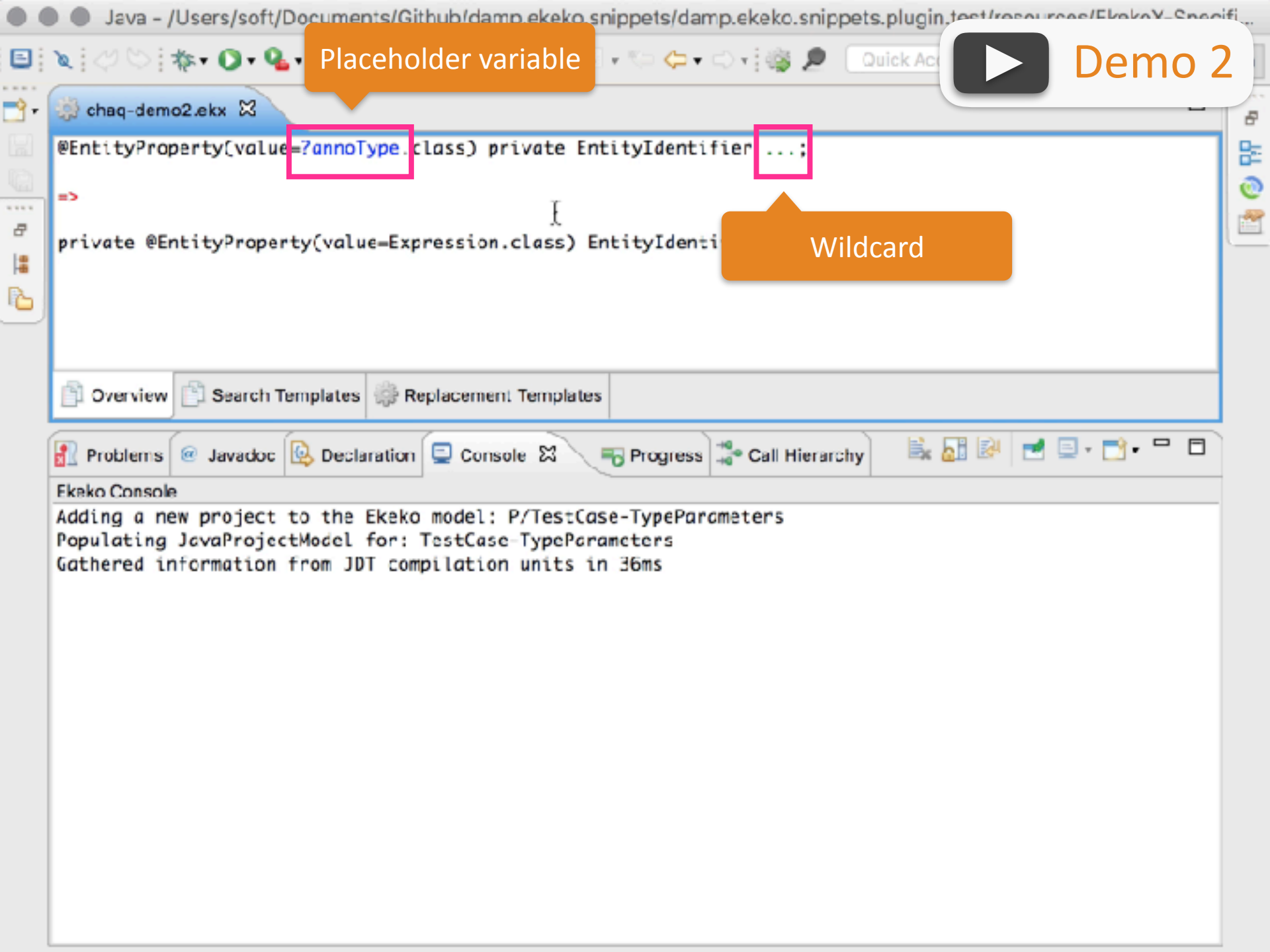
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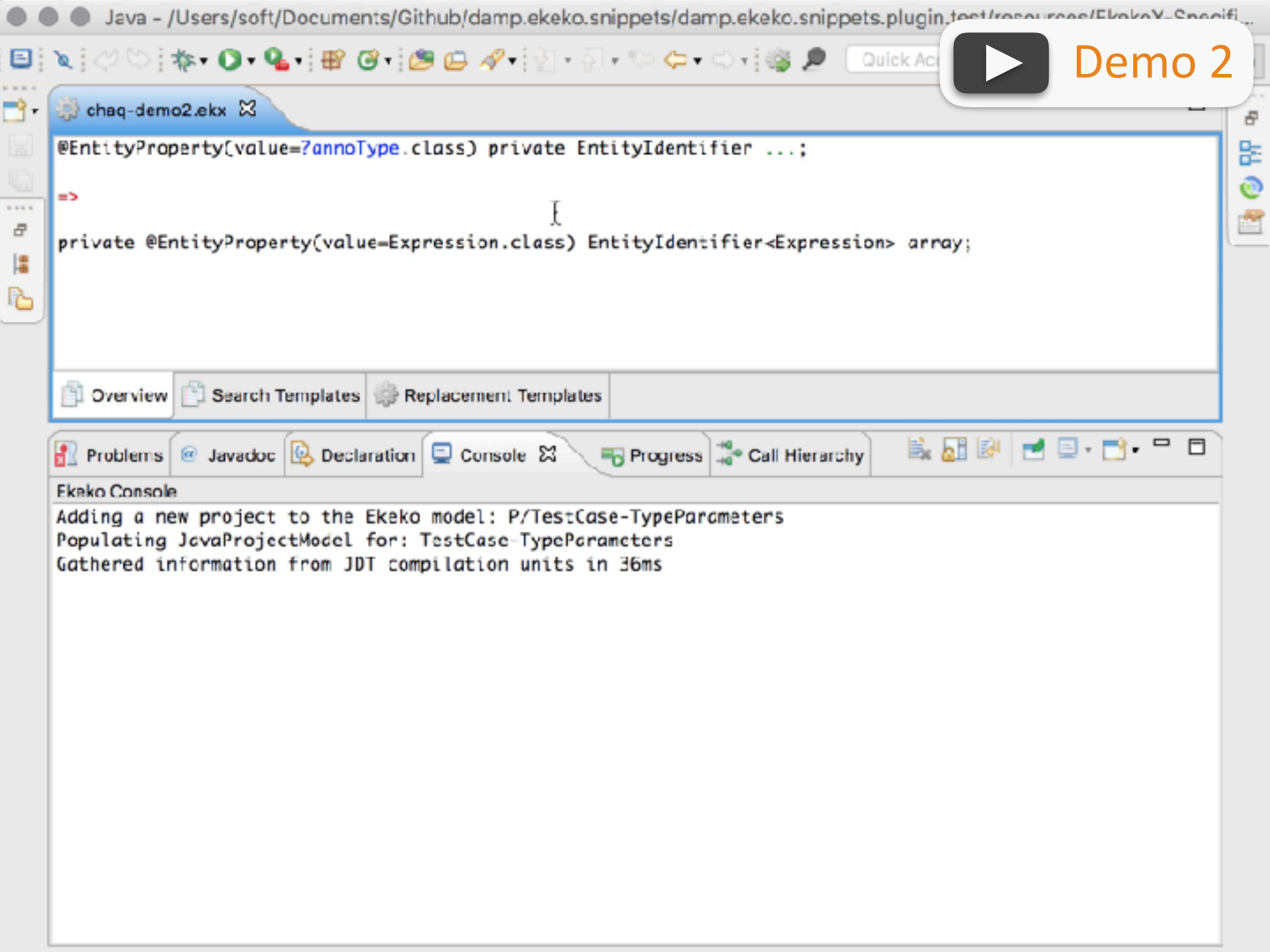
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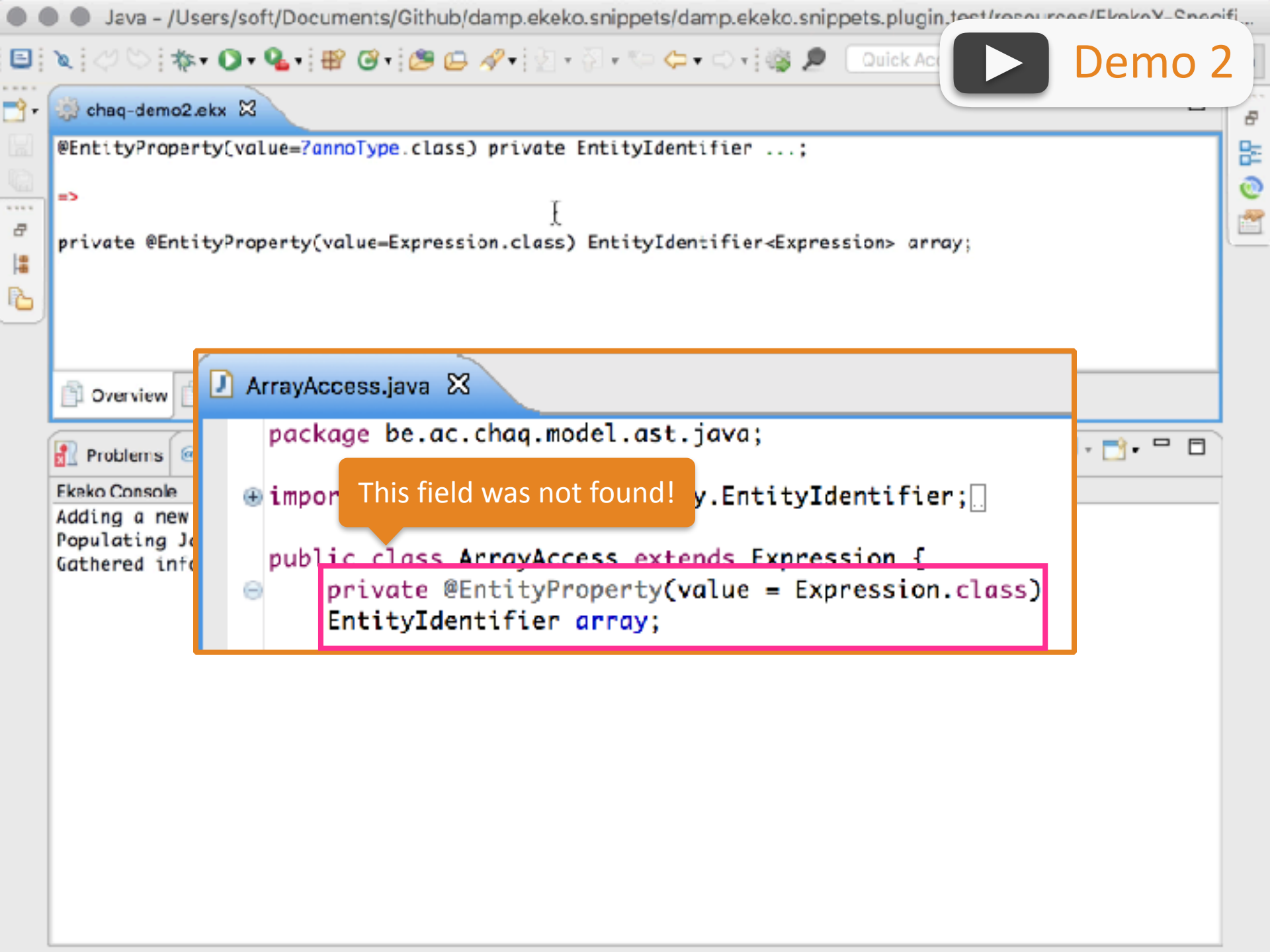
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ArrayAccess.java
package be.ac.chaq.model.ast.java;
This field was not found!
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public class ArrayAccess extends Expression {
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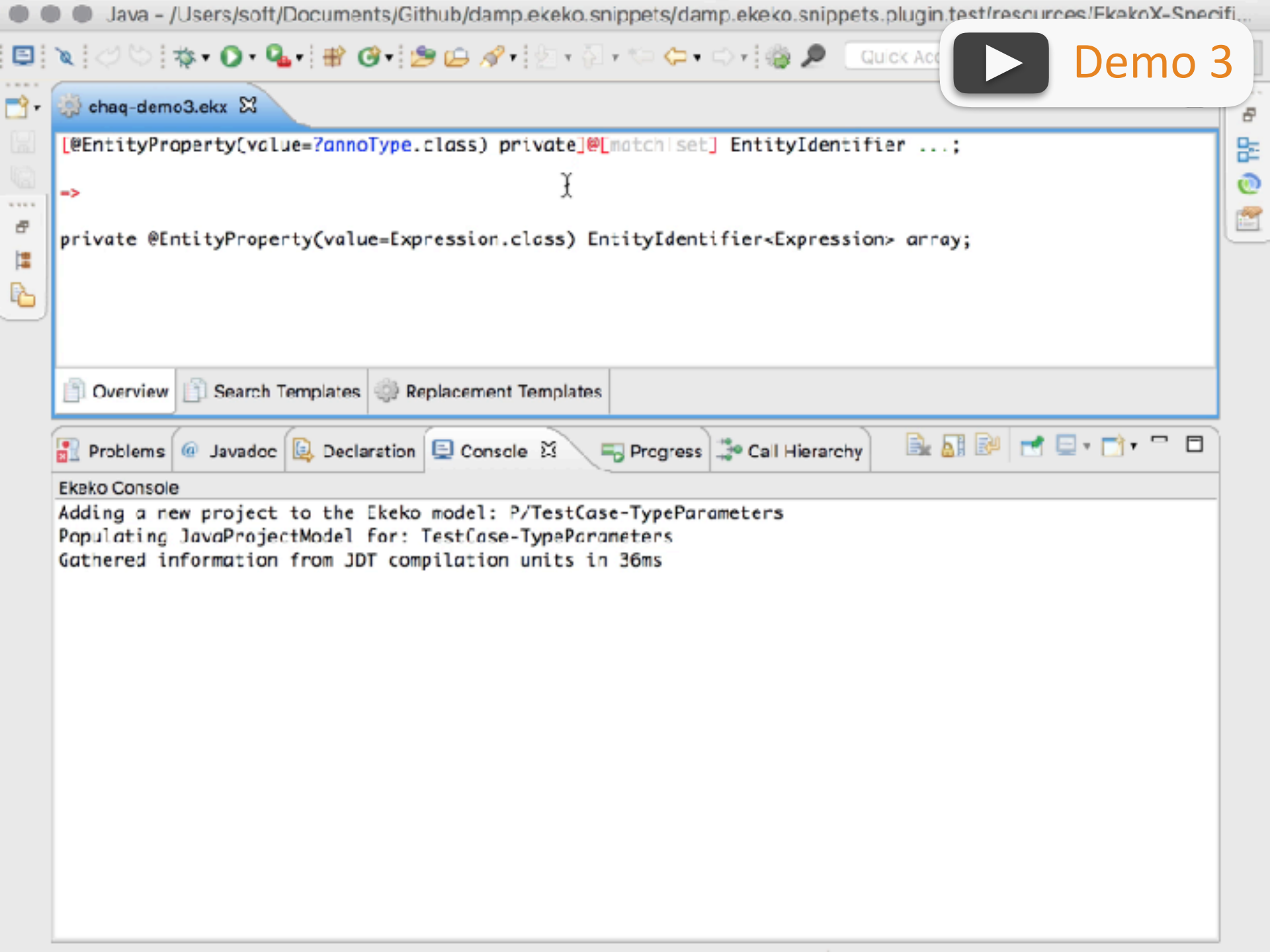
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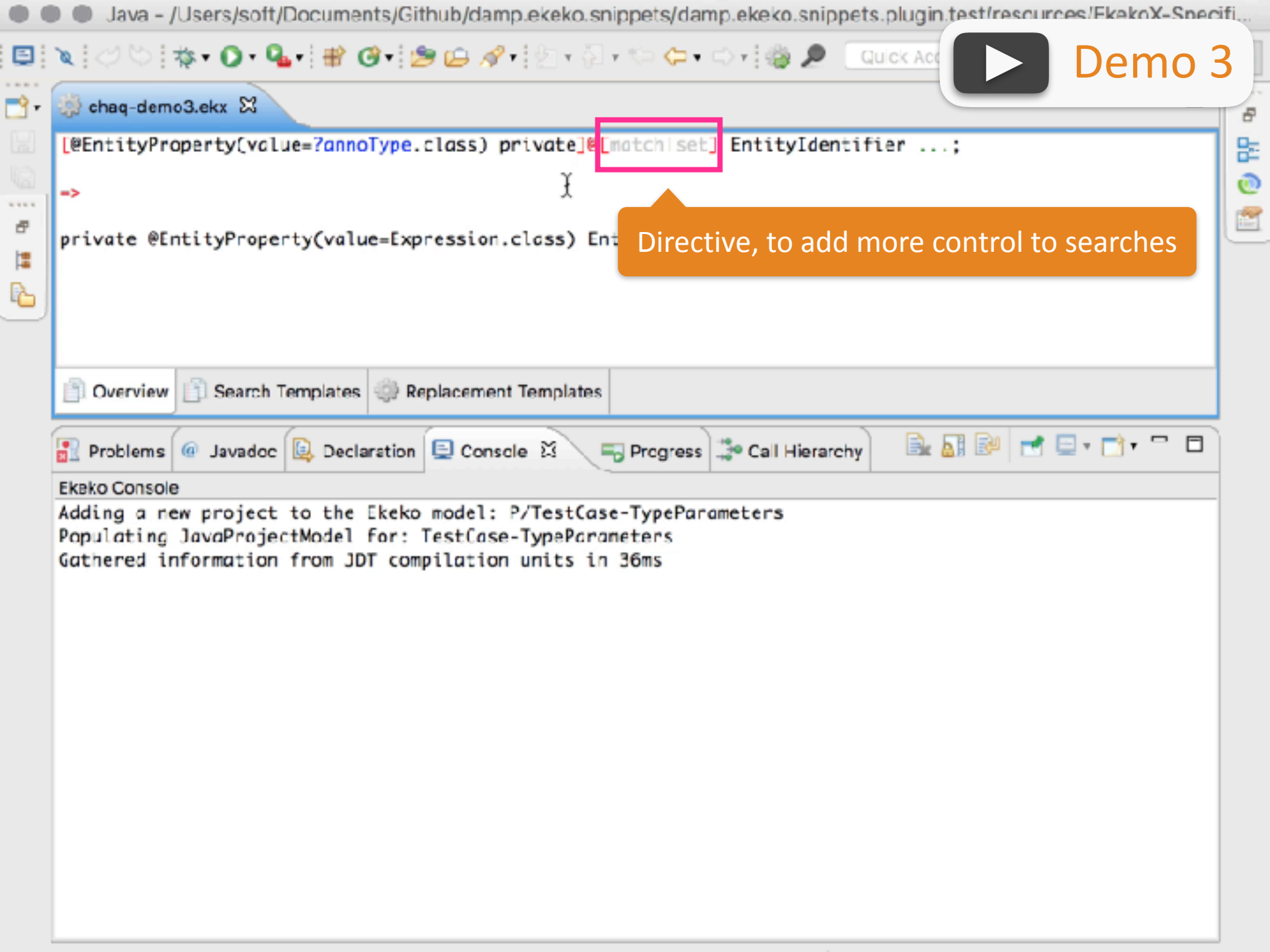
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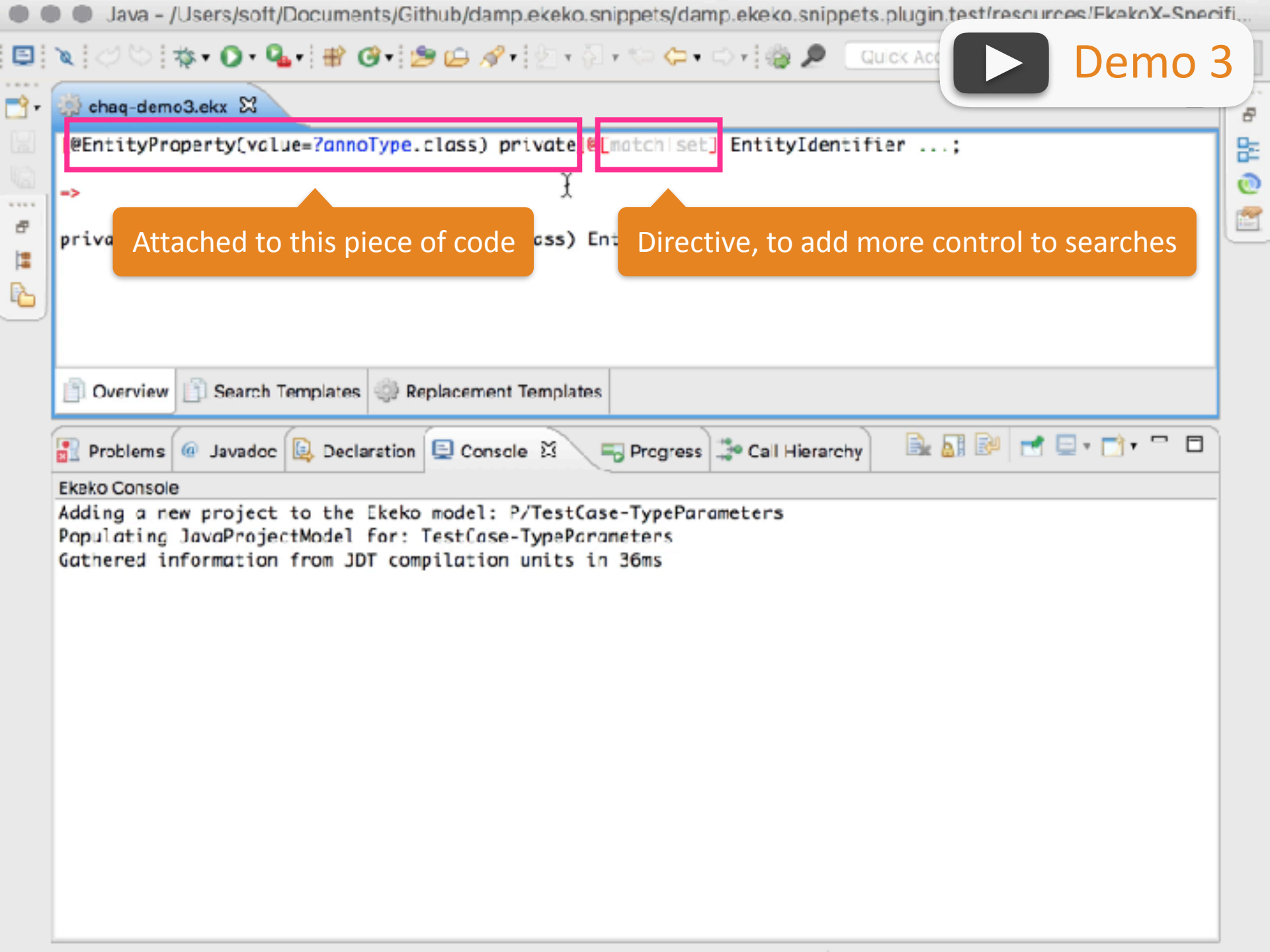
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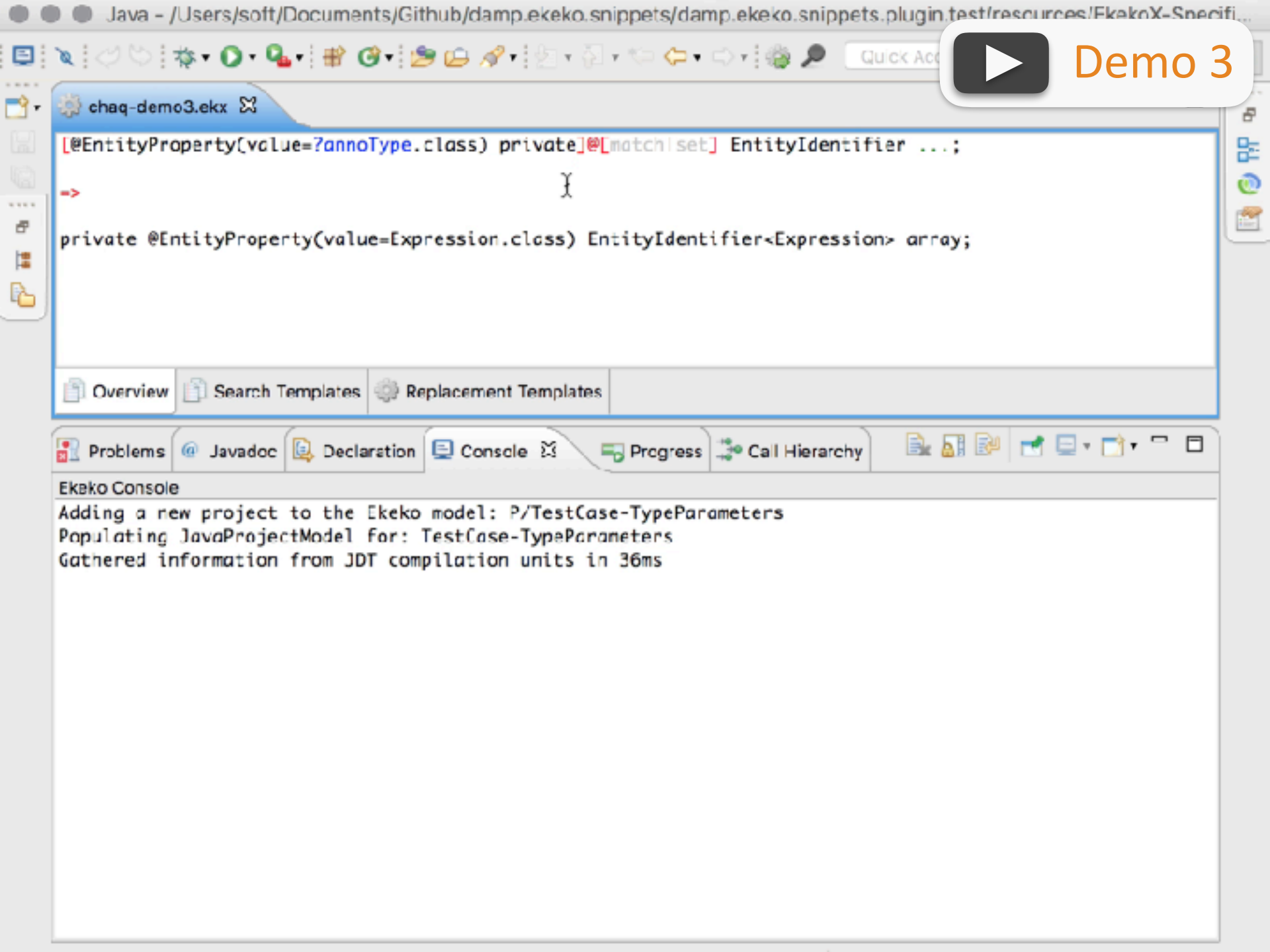
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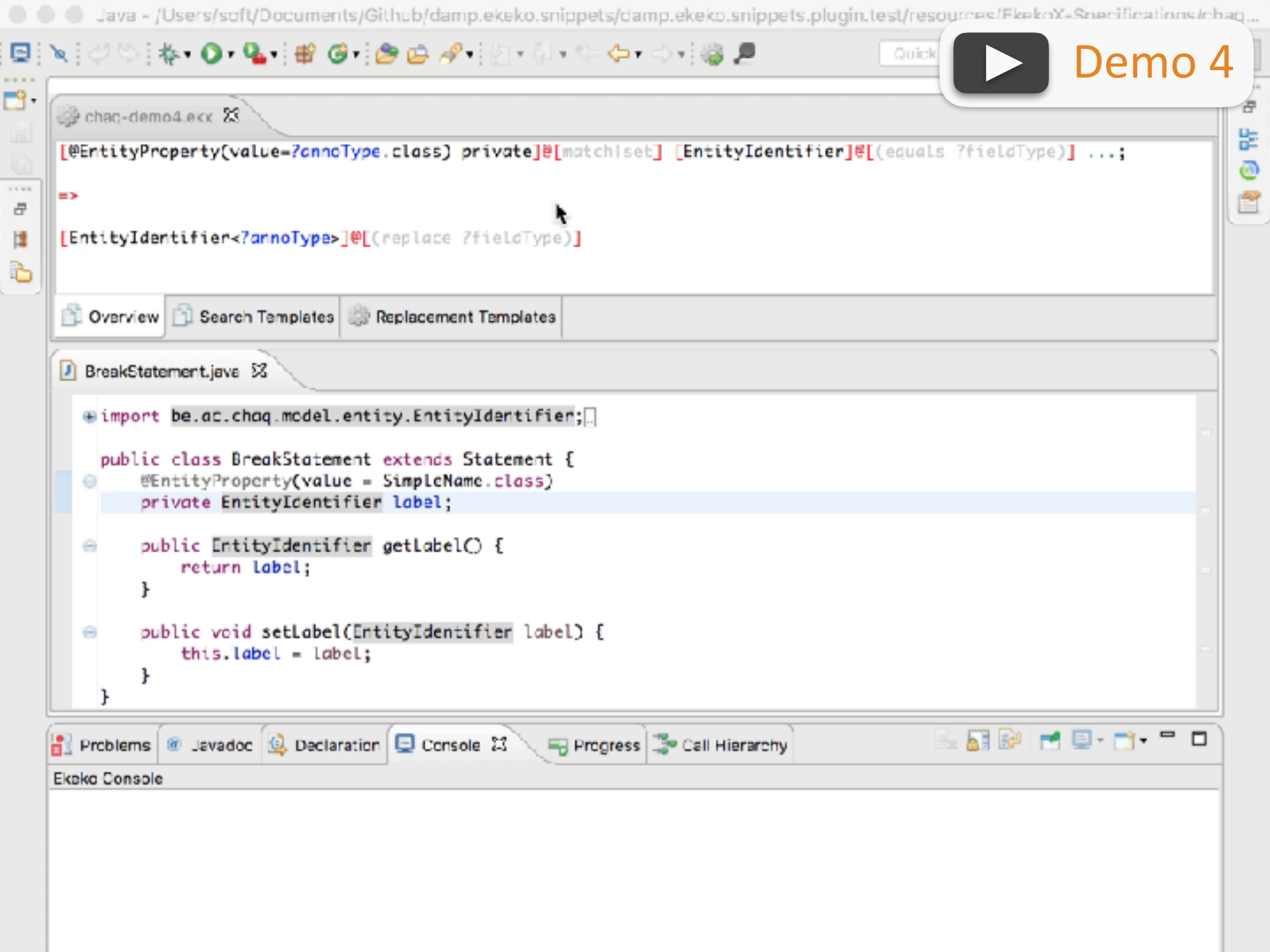
Demo 4
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=>
[EntityIdentifier<?annoType>]@[(replace ?fieldType)]
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BreakStatement.java
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public class BreakStatement extends Statement {
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private EntityIdentifier label;
public EntityIdentifier getLabel() {
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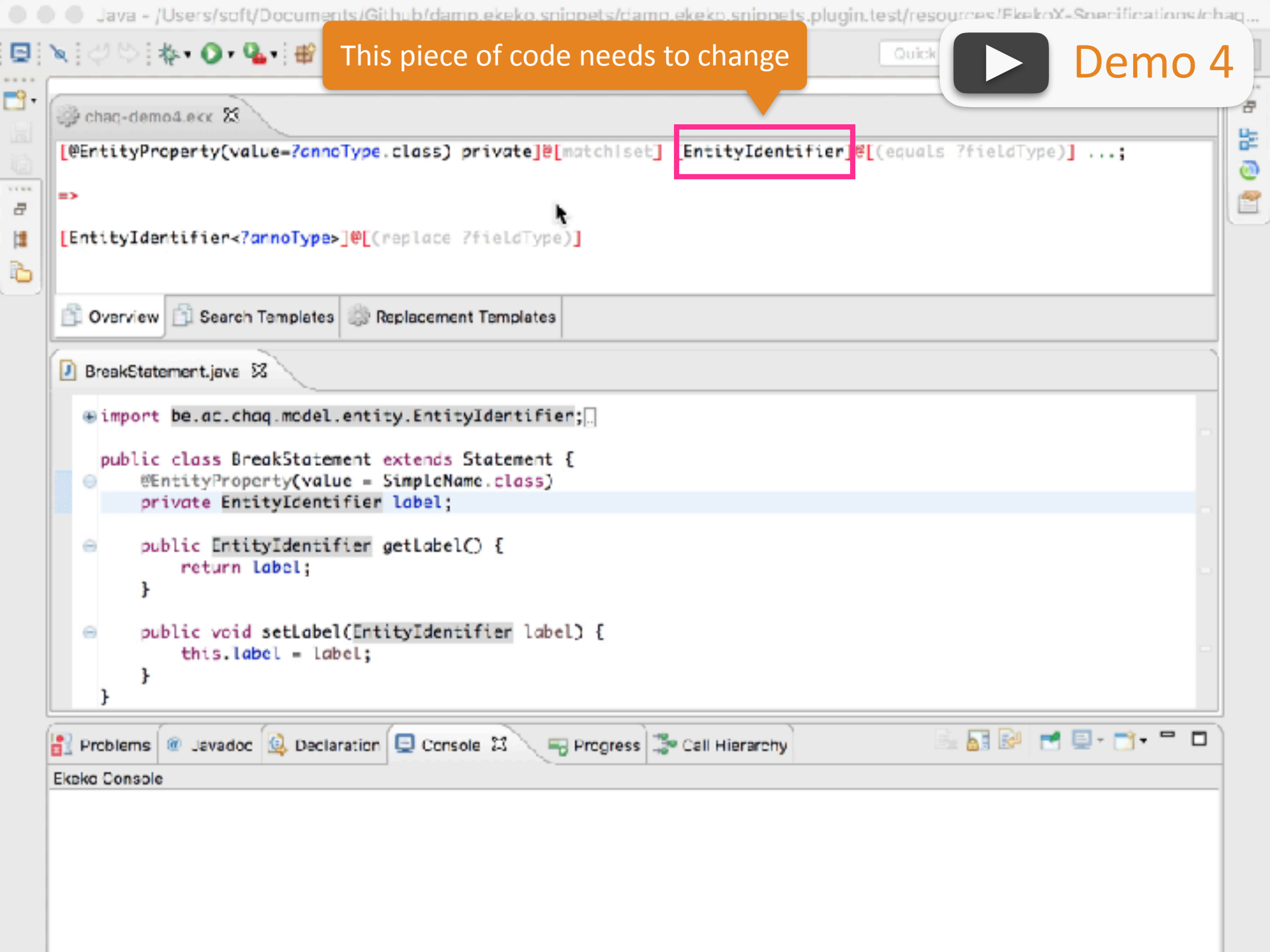
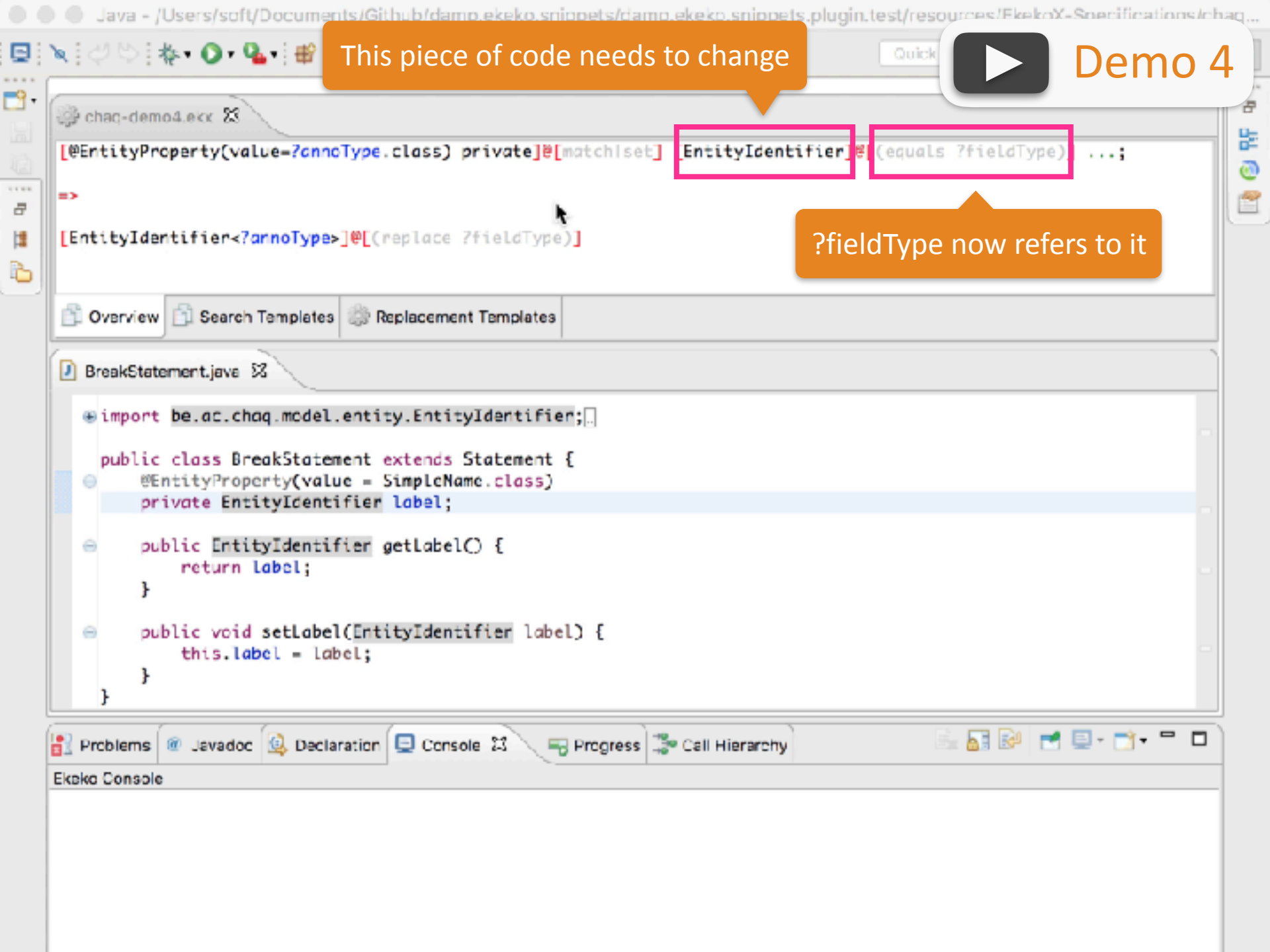
Call Hierarchy
Ekeko Console


This piece of code needs to change
Demo 4
chaq-demo4.ekx
[@EntityProperty(value=?annoType.class) private]@[matchIset] _EntityIdentifier_]@[(equals ?fieldType)] ...;
=>
[EntityIdentifier<?annoType>]@[(replace ?fieldType)]
Overview
Search Templates
Replacement Templates
BreakStatement.java
import be.ac.chaq.model.entity.EntityIdentifier;
public class BreakStatement extends Statement {
@EntityProperty(value = SimpleName.class)
private EntityIdentifier label;
public EntityIdentifier getLabel() {
return label;
}
public void setLabel(EntityIdentifier label) {
this.label = label;
}
}
Problems
Javadoc
Declaration
Console
Progress
Call Hierarchy
Ekeko Console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[@EntityProperty(value=?annoType.class) private]@[matchIset] [EntityIdentifier]@[(equals ?fieldType)] ...;
=>
[EntityIdentifier<?annoType>]@[(replace ?fieldType)]
?fieldType now refers to it
Overview
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Replacement Templates
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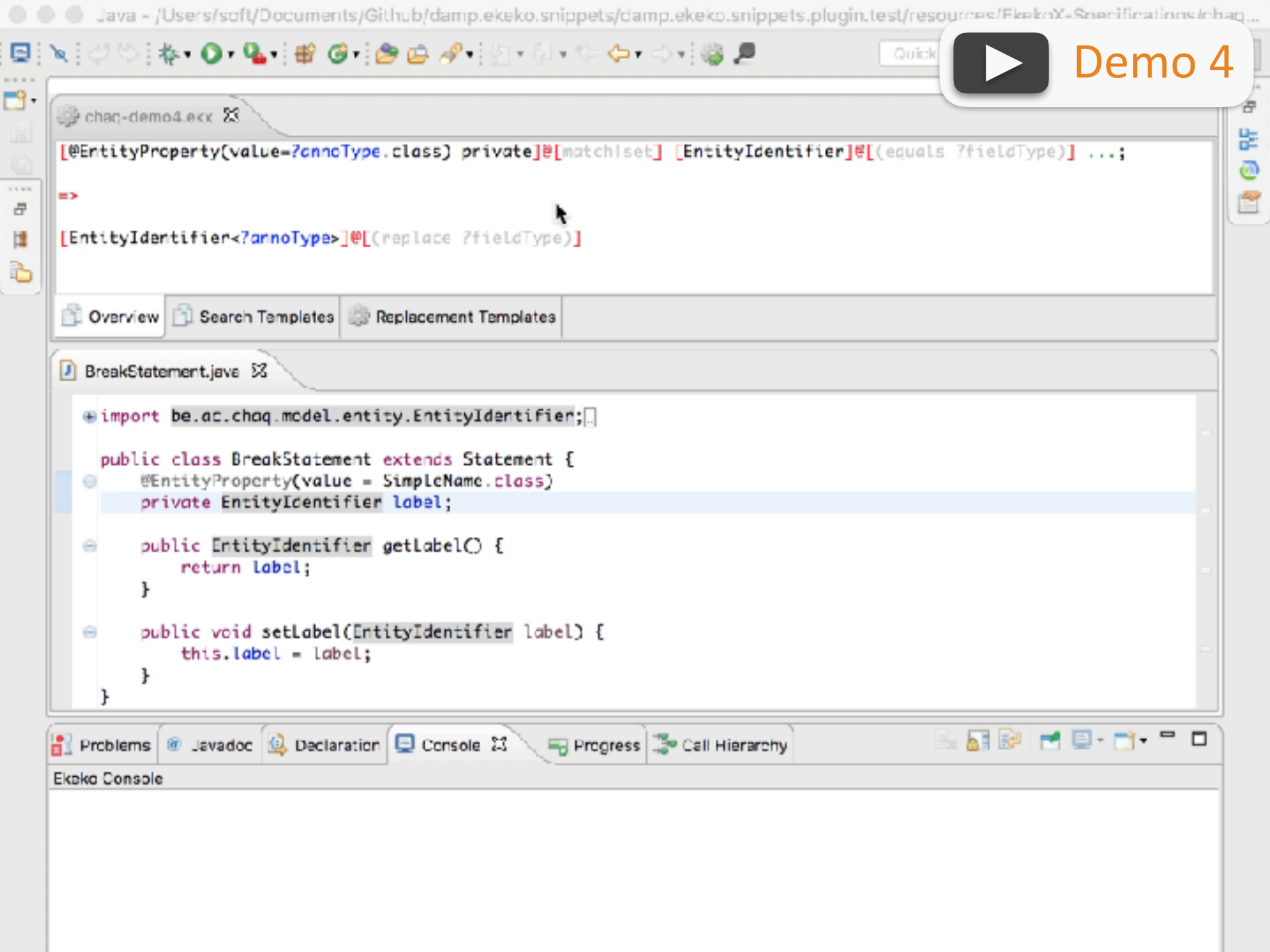
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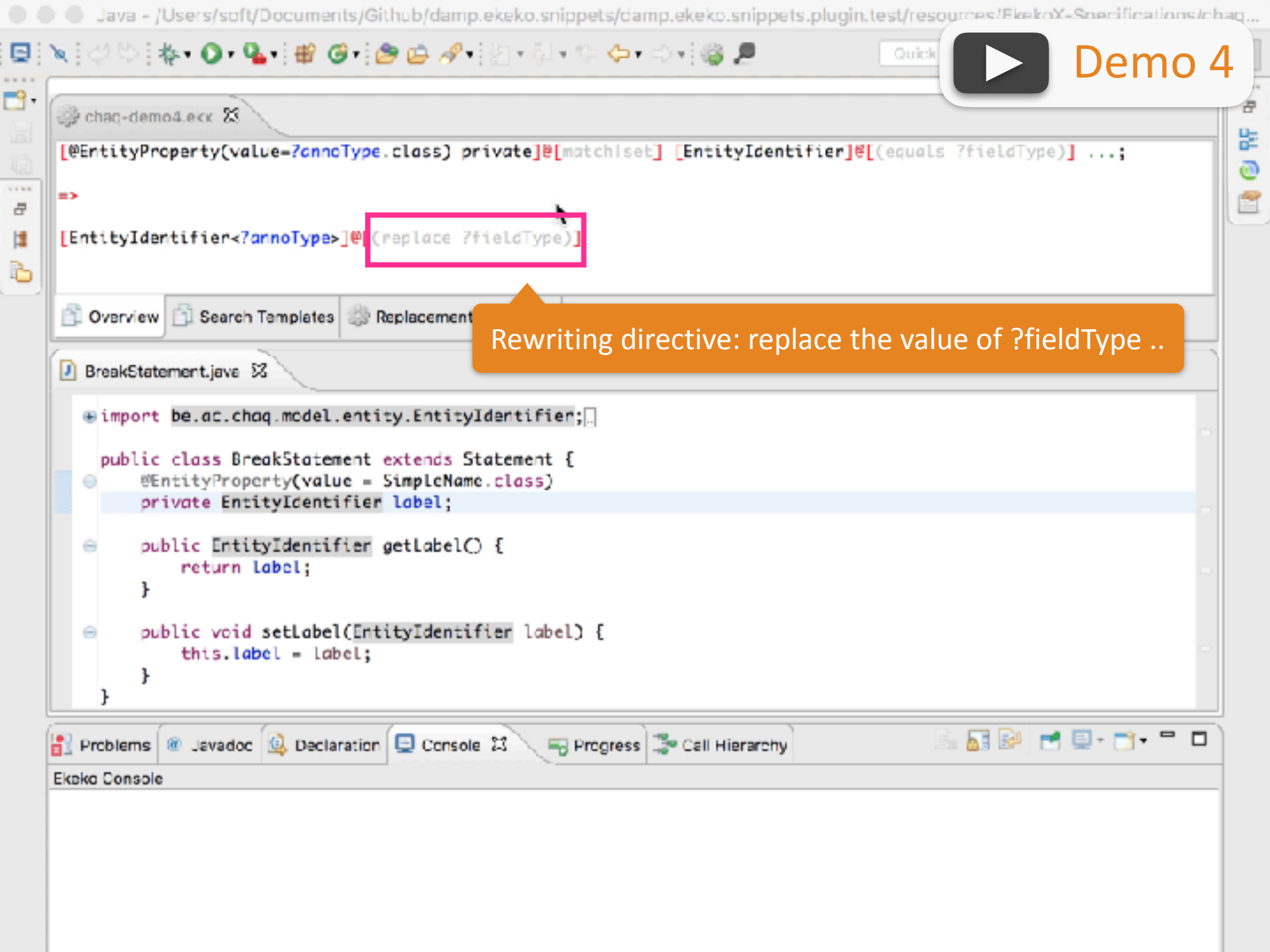
Demo 4
chaq-demo4.ekx
[@EntityProperty(value=?annoType.class) private]@[matchInSet] [EntityIdentifier]@[(equals ?fieldType)] ...;
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Overview
Search Templates
Replacement
Rewriting directive: replace the value of ?fieldType ..
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Call Hierarchy
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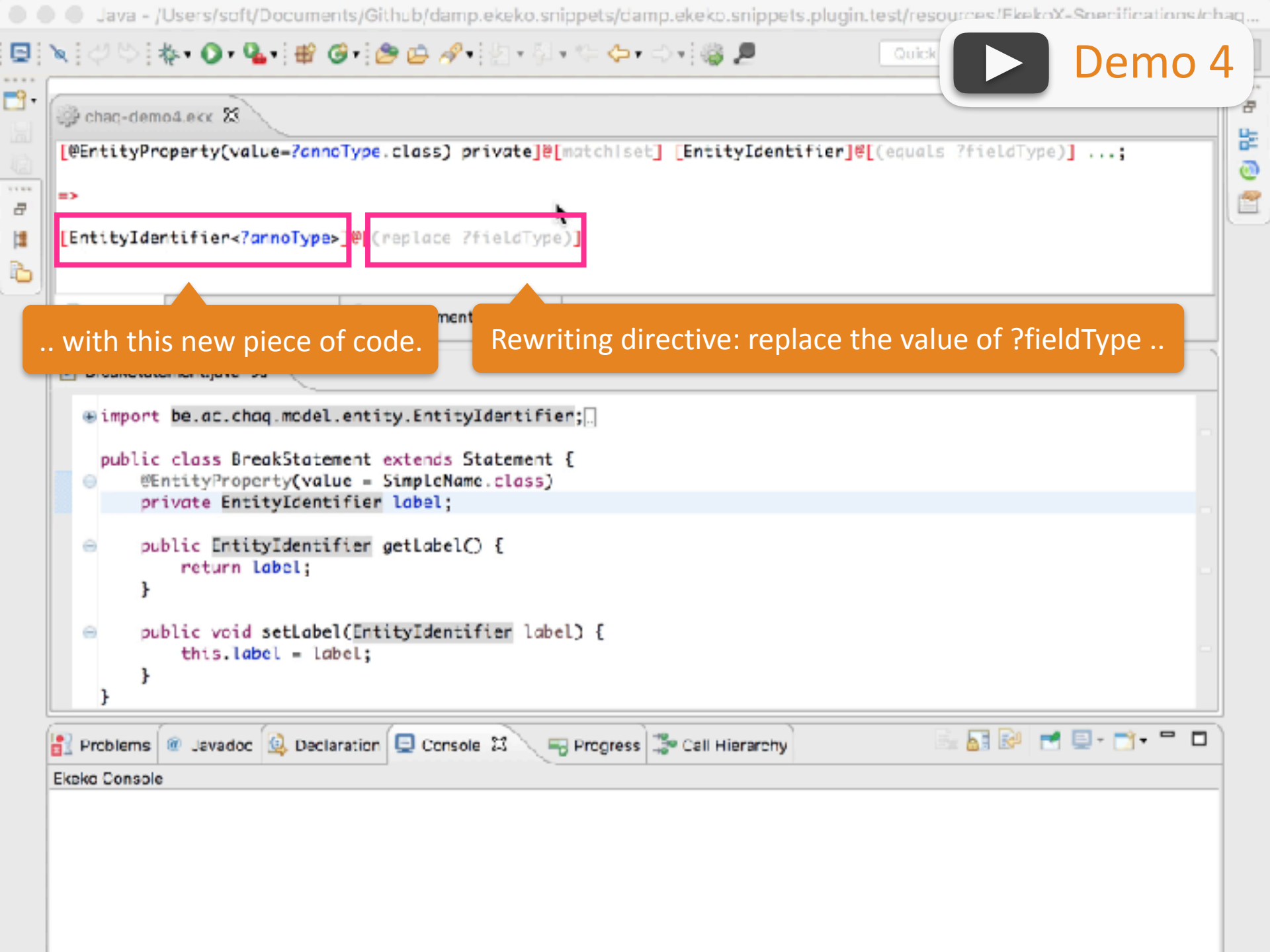
Demo 4
chaq-demo4.ekx
[@EntityProperty(value=?annoType.class) private]@[matchIset] [EntityIdentifier]@[(equals ?fieldType)] ...;
=>
[EntityIdentifier<?annoType>]@[(replace ?fieldType)]
.. with this new piece of code.
Rewriting directive: replace the value of ?fieldType ..
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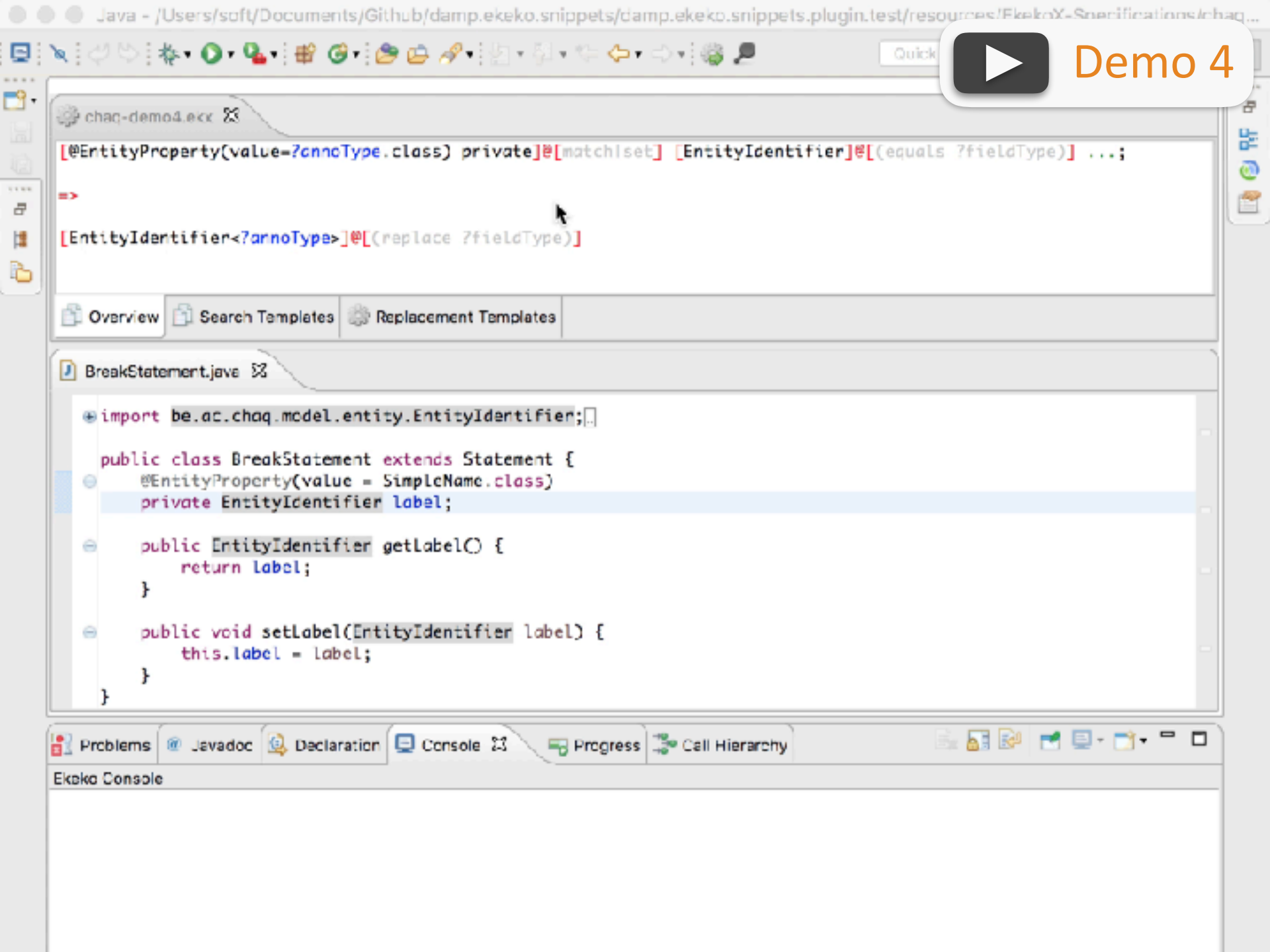
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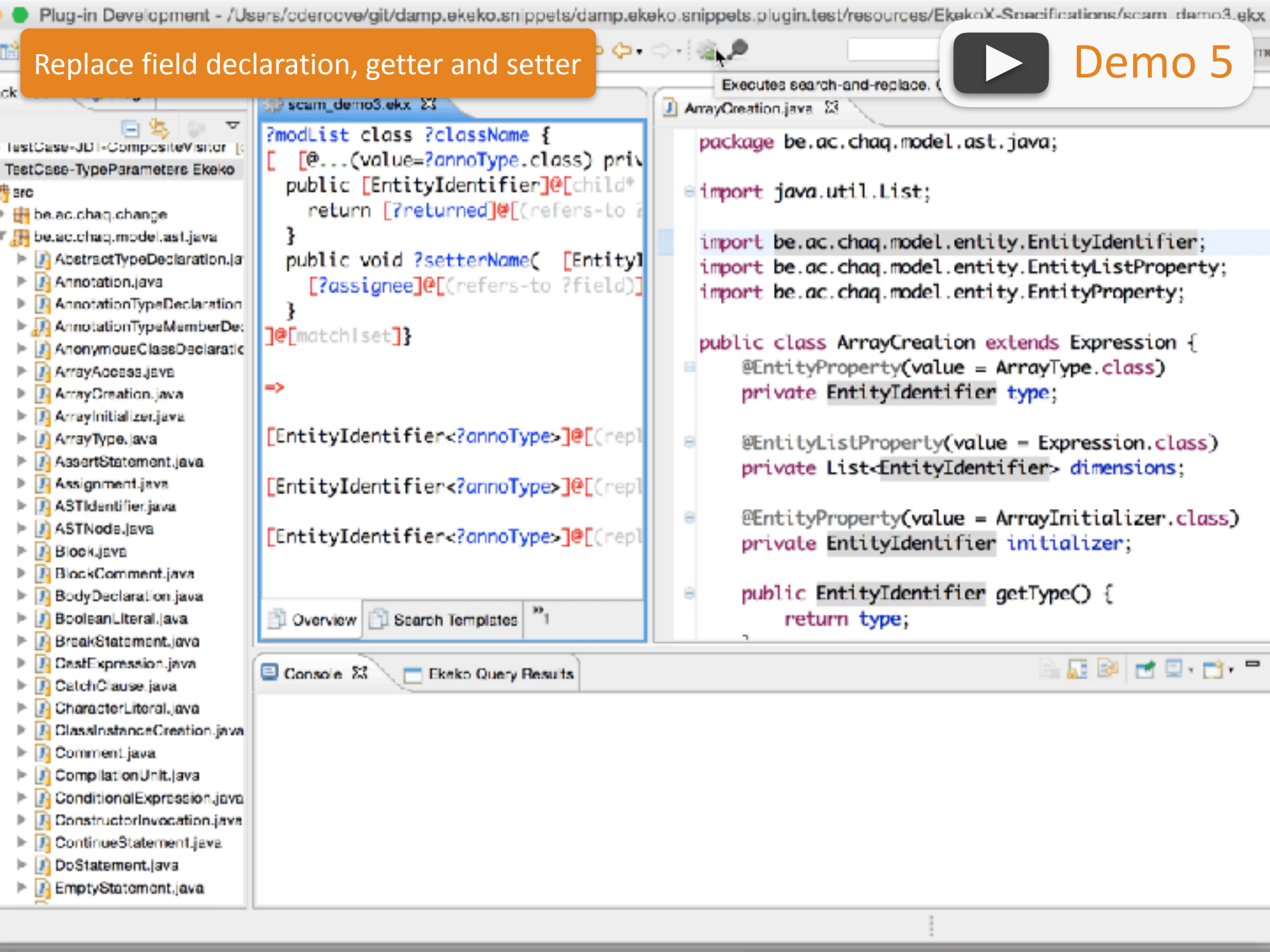
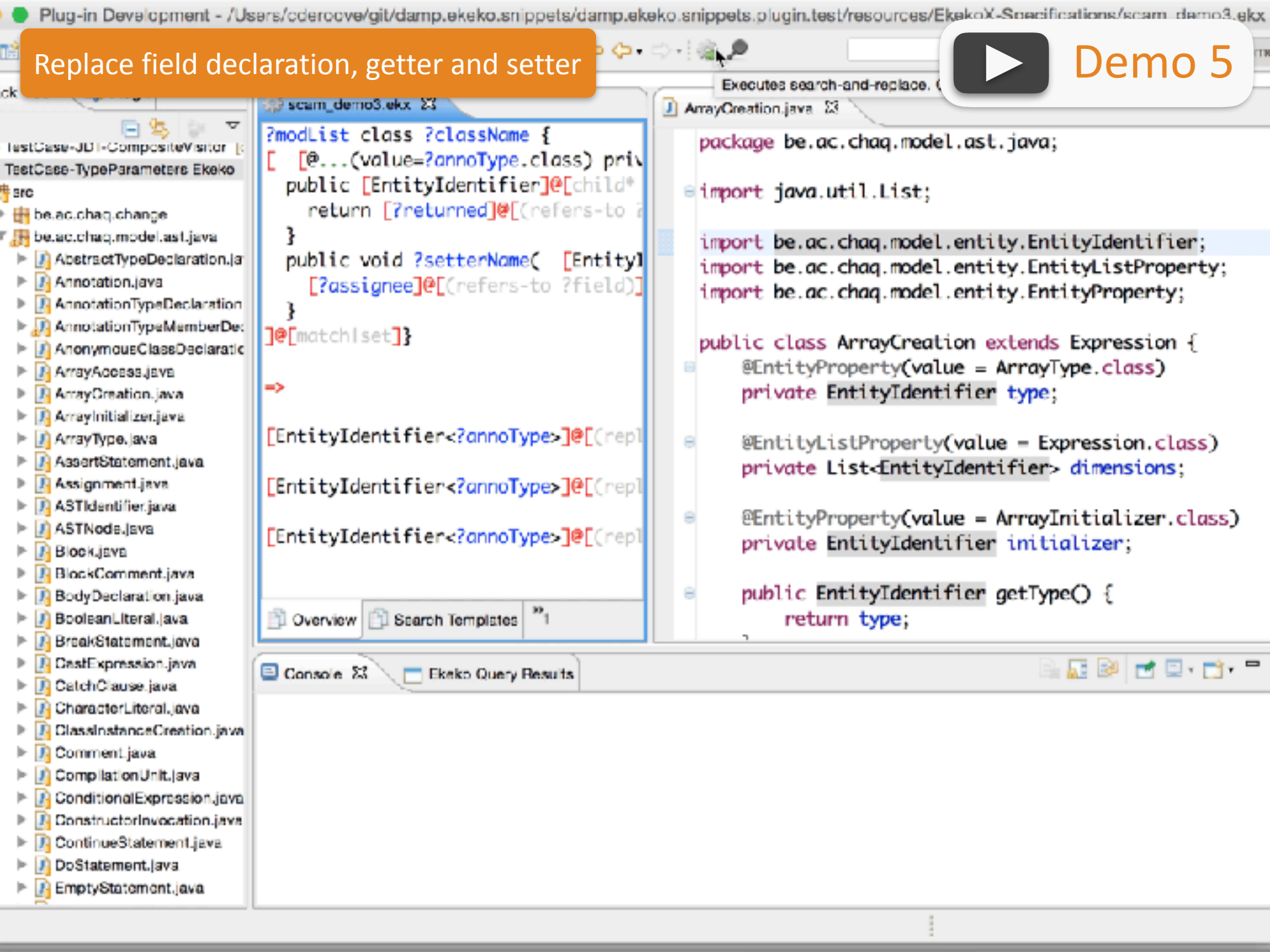
Replace field declaration, getter and setter

Demo 5



Replace field declaration, getter and setter

Demo 5



Cha-Q search-and-replace

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- FOD Financiën pilot study:
  - ~62% of systematic edits can be fully automated
  - Remainder can be partially automated

Cha-Q search-and-replace

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- What can Cha-Q search-and-replace do for *you*?

find and fix all occurrences of the same bug

co-maintain multiple system variants

upgrade existing clients to a newer API version

evolve existing code to newer versions of Java

create custom refactorings

automate repeating maintenance tasks

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