Eclipse Modelling Framework : Foundations and Testing

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Venue: Modelling and Simulation Design Lab, McGill University

Eclipse Modelling Framework

- A set of software tools that come with Eclipse, the very popular code editor, manager, highlighter etc.
- Specifying a Meta-model: *Ecore*
- Code Generation : Java Classes
- Specification of Model Transformation in Java

Core of EMF = ECore

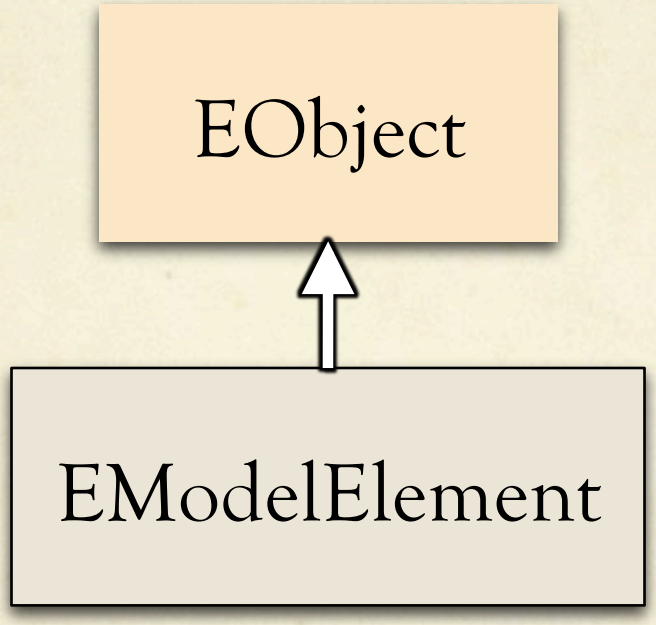
- An IBM Eclipse standard for defining concepts and relationships in a meta-model
- Embodiment: XML file with extension "*.ecore*"
- Visual Syntax: Like UML Class Diagrams
- But, minimal compared to UML
- Adopted by industry and academia extensively in Europe, and some parts of North America

ECore

In Ecore everything is an object.

Actually, an EObject is an object.

ECore

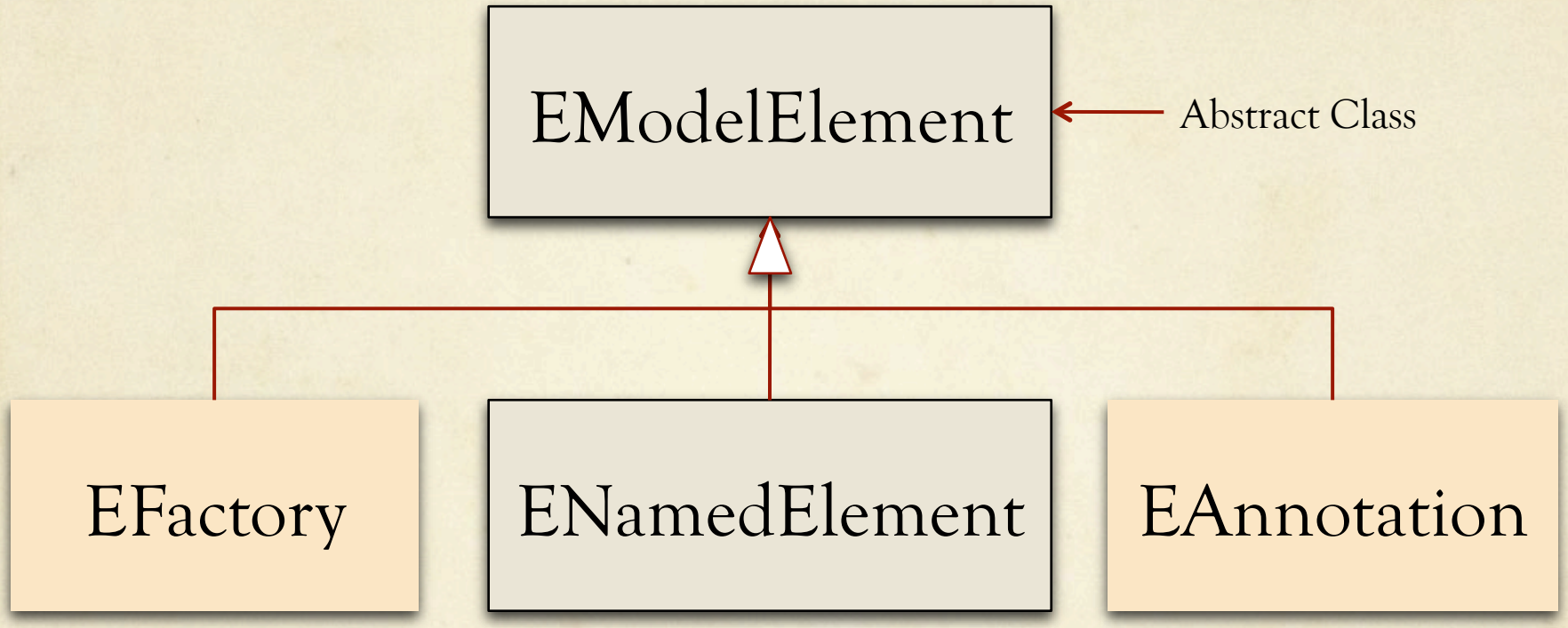


EModelElement extends EObject to create Modeling Elements

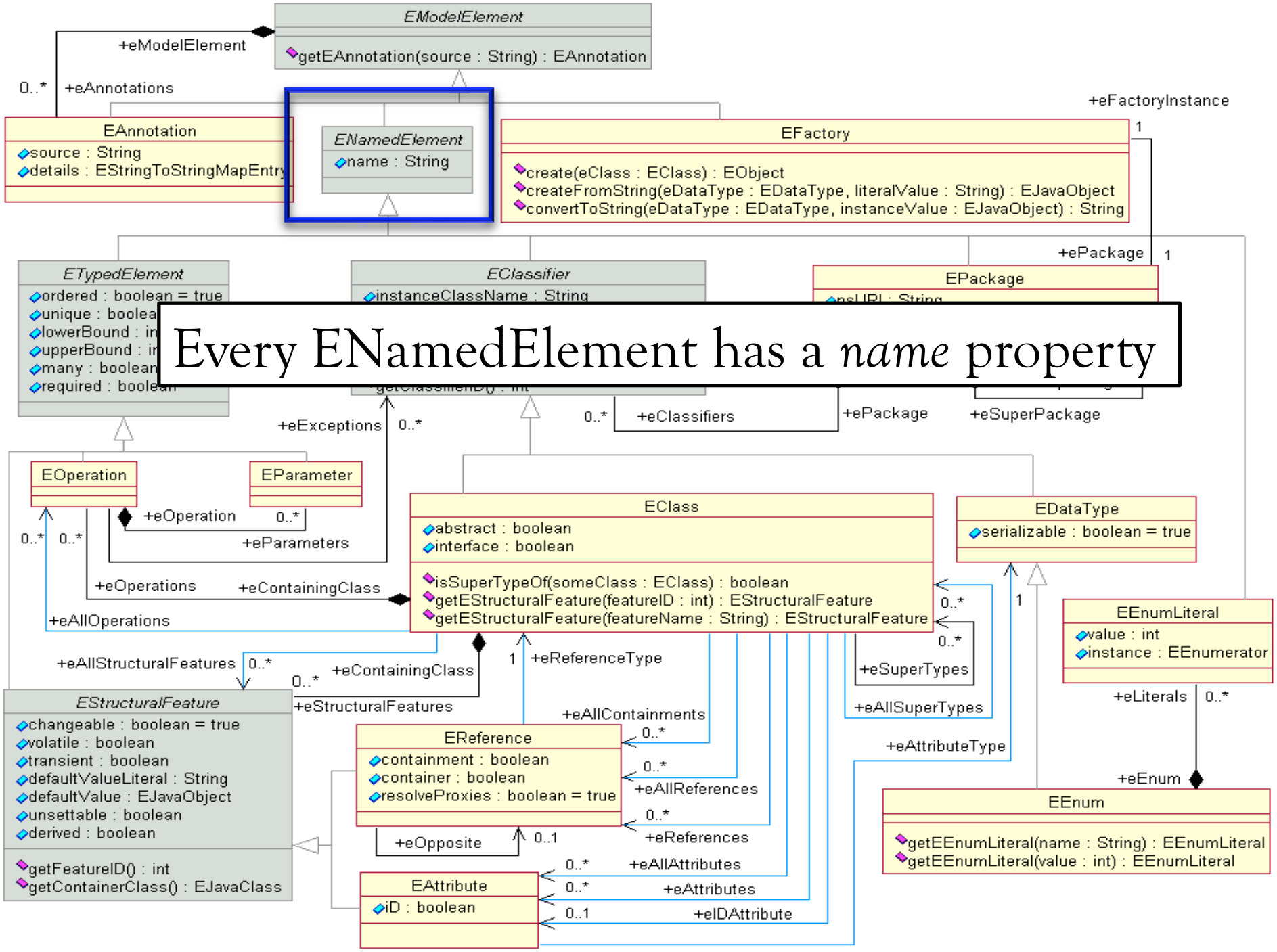
But objects are a notion from the programming world!

(Keeps in touch with the programming world! < Key Ecore Idea!)

ECore



And, so are all the rest of the ModelElements


EModelElement
getEAnnotation(source : String) : EAnnotation
+eModelElement
0..*
+eAnnotations
EAnnotation
source : String
details : EStringToStringMapEntry
ENamedElement
name : String
EFactory
create(eClass : EClass) : EObject
createFromString(eDataType : EDataType, literalValue : String) : EJavaObject
convertToString(eDataType : EDataType, instanceValue : EJavaObject) : String
+eFactoryInstance
1
ETypedElement
ordered : boolean = true
unique : boolea
lowerBound : in
upperBound : in
many : boolean
required : boolean
EClassifier
instanceClassName : String
EPackage
+ePackage
1
Every ENamedElement has a name property
+eExceptions
0..*
0..*
+eClassifiers
+ePackage
+eSuperPackage
EOperation
EParameter
+eOperation
0..*
+eParameters
0..*
0..*
+eOperations
+eContainingClass
+eAllOperations
EClass
abstract : boolean
interface : boolean
isSuperTypeOf(someClass : EClass) : boolean
getEStructuralFeature(featureID : int) : EStructuralFeature
getEStructuralFeature(featureName : String) : EStructuralFeature
EDataType
serializable : boolean = true
0..*
+eSuperTypes
0..*
+eAllSuperTypes
1
EEnumLiteral
value : int
instance : EEnumerator
+eLiterals
0..*
+eEnum
EEnum
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getEEnumLiteral(value : int) : EEnumLiteral
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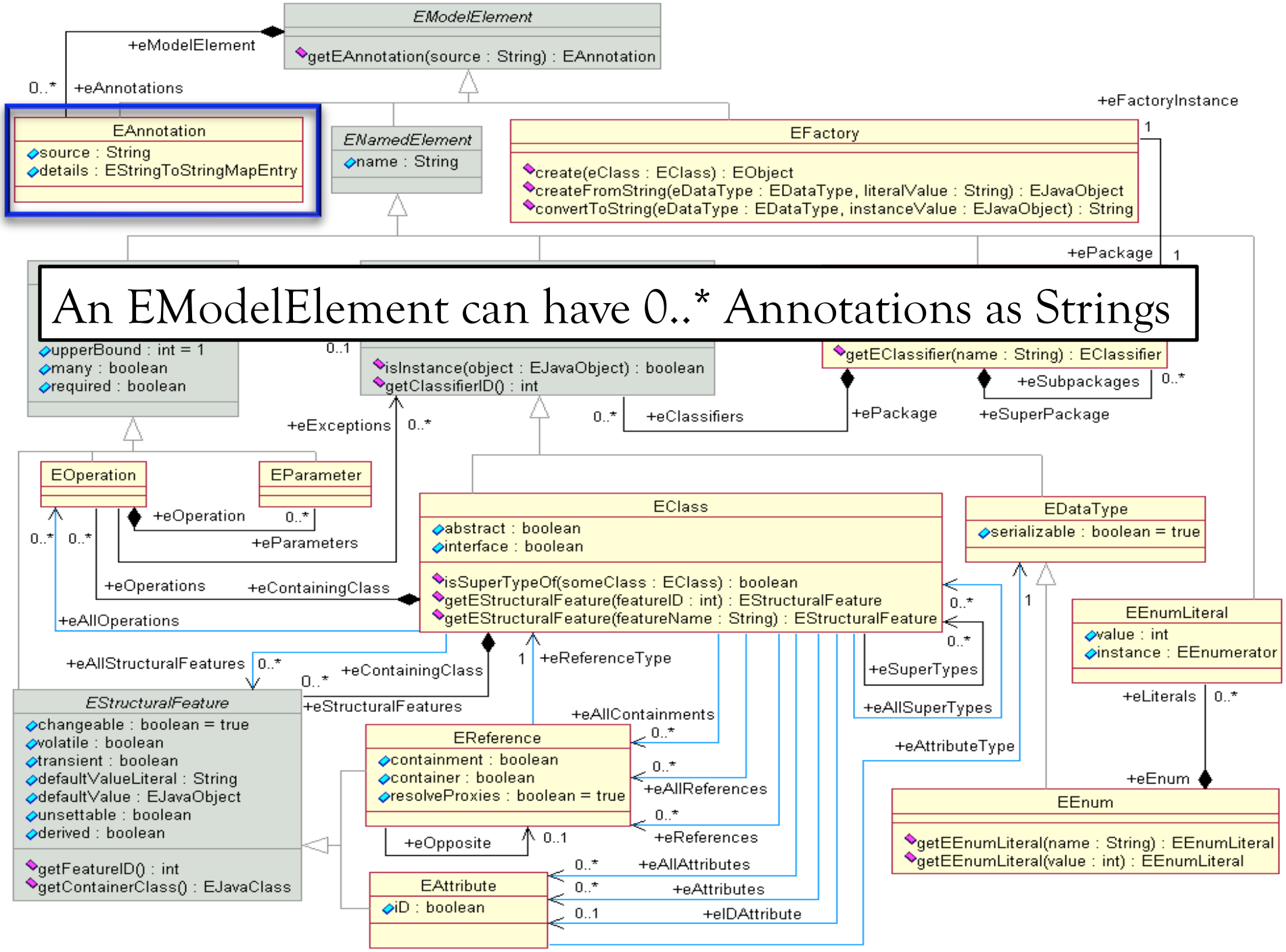
+eAllStructuralFeatures
0..*
0..*
+eContainingClass
+eStructuralFeatures
1
+eReferenceType
EStructuralFeature
changeable : boolean = true
volatile : boolean
transient : boolean
defaultValueLiteral : String
defaultValue : EJavaObject
unsettable : boolean
derived : boolean
getFeatureID() : int
getContainerClass() : EJavaClass
+eAllContainments
EReference
containment : boolean
container : boolean
resolveProxies : boolean = true
0..*
+eAllReferences
0..*
+eReferences
+eOpposite
0..1
EAttribute
iD : boolean
0..*
+eAllAttributes
0..*
+eAttributes
0..1
+eIDAttribute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convertToString(eDataType : EDataType, instanceValue : EJavaObject) : String
+eFactoryInstance
1
+ePackage
1
An EModelElement can have 0..* Annotations as Strings
upperBound : int = 1
many : boolean
required : boolean
0..1
isInstance(object : EJavaObject) : boolean
getClassifierID() : int
getEClassifier(name : String) : EClassifier
+eSubpackages
0..*
+eSuperPackage
0..*
+eClassifiers
+ePackage
+eExceptions
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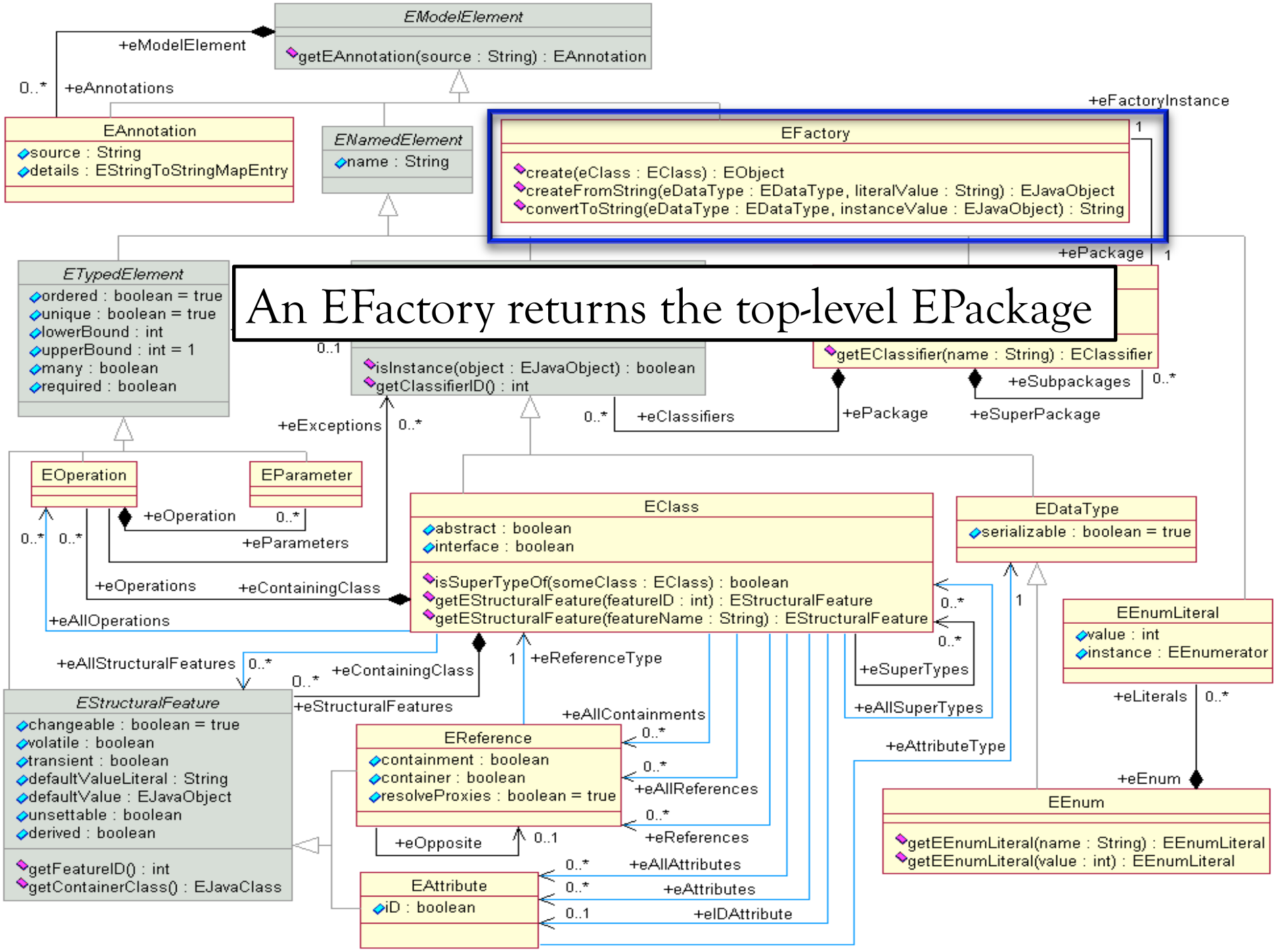
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convertToString(eDataType : EDataType, instanceValue : EJavaObject) : String
+ePackage
1
ETypedElement
ordered : boolean = true
unique : boolean = true
lowerBound : int
upperBound : int = 1
many : boolean
required : boolean
An EFactory returns the top-level EPackage
0..1
isInstance(object : EJavaObject) : boolean
getClassifierID() : int
getEClassifier(name : String) : EClassifier
+eSubpackages
0..*
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+eClassifiers
+ePackage
+eExceptions
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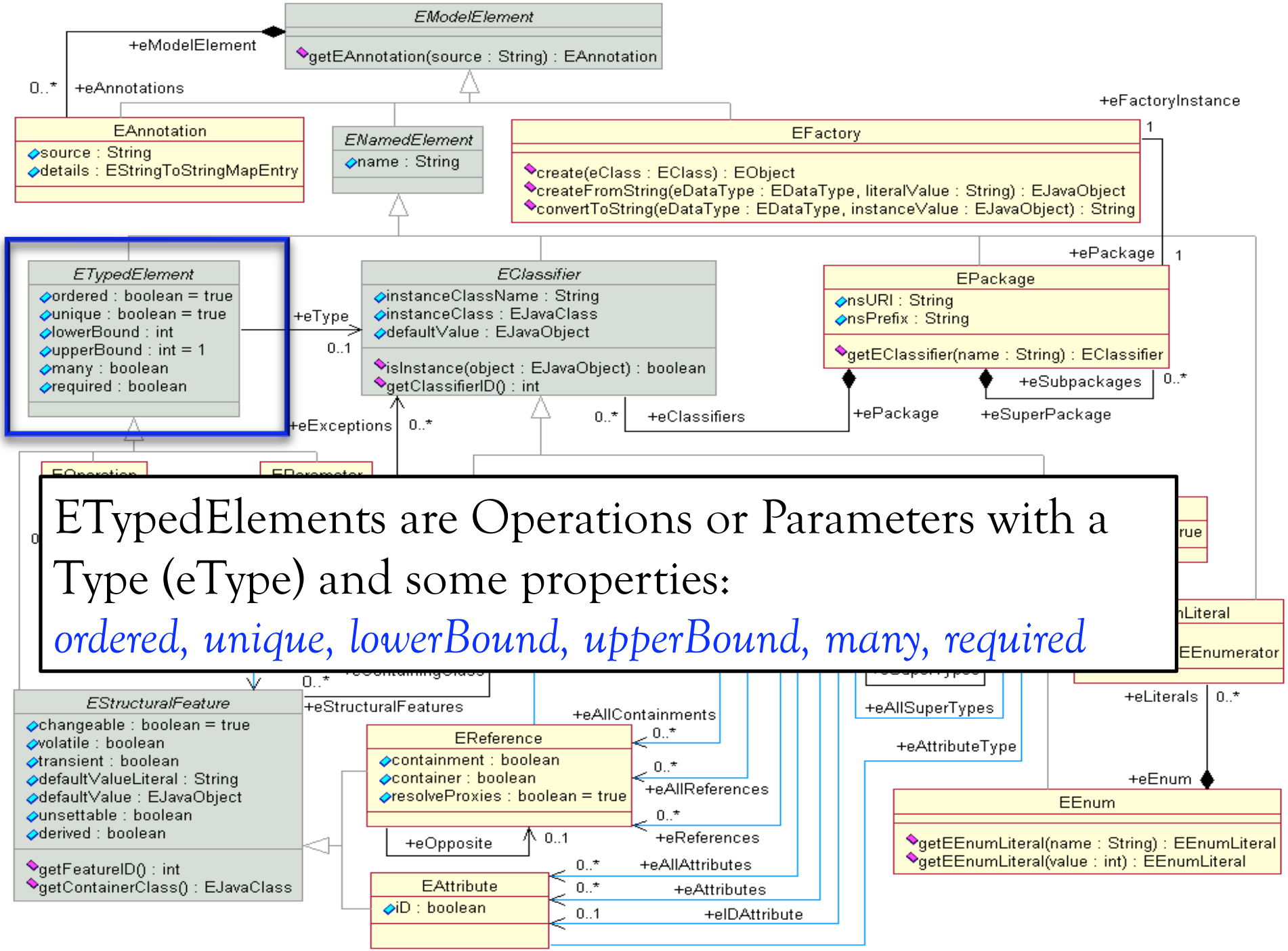
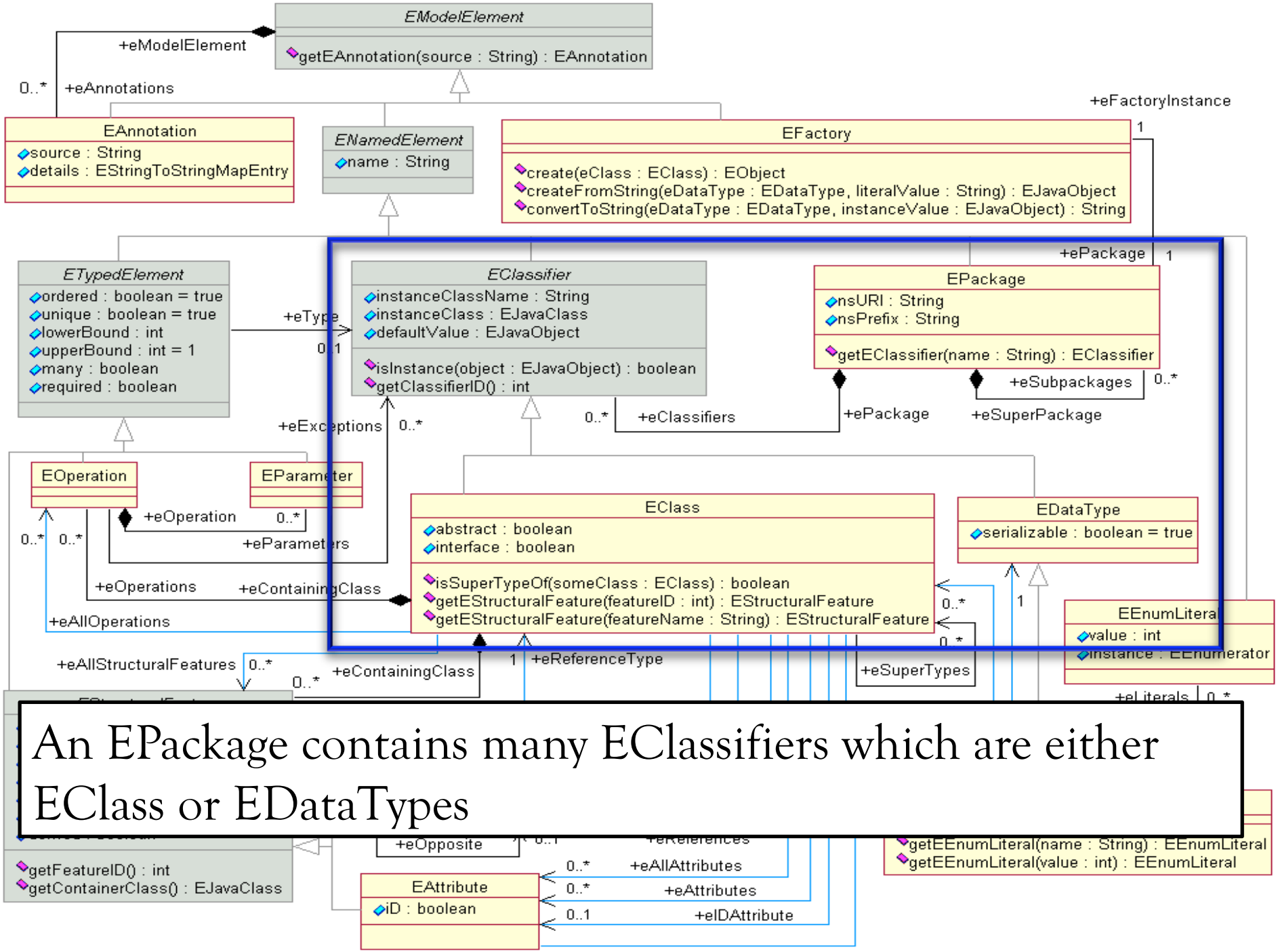
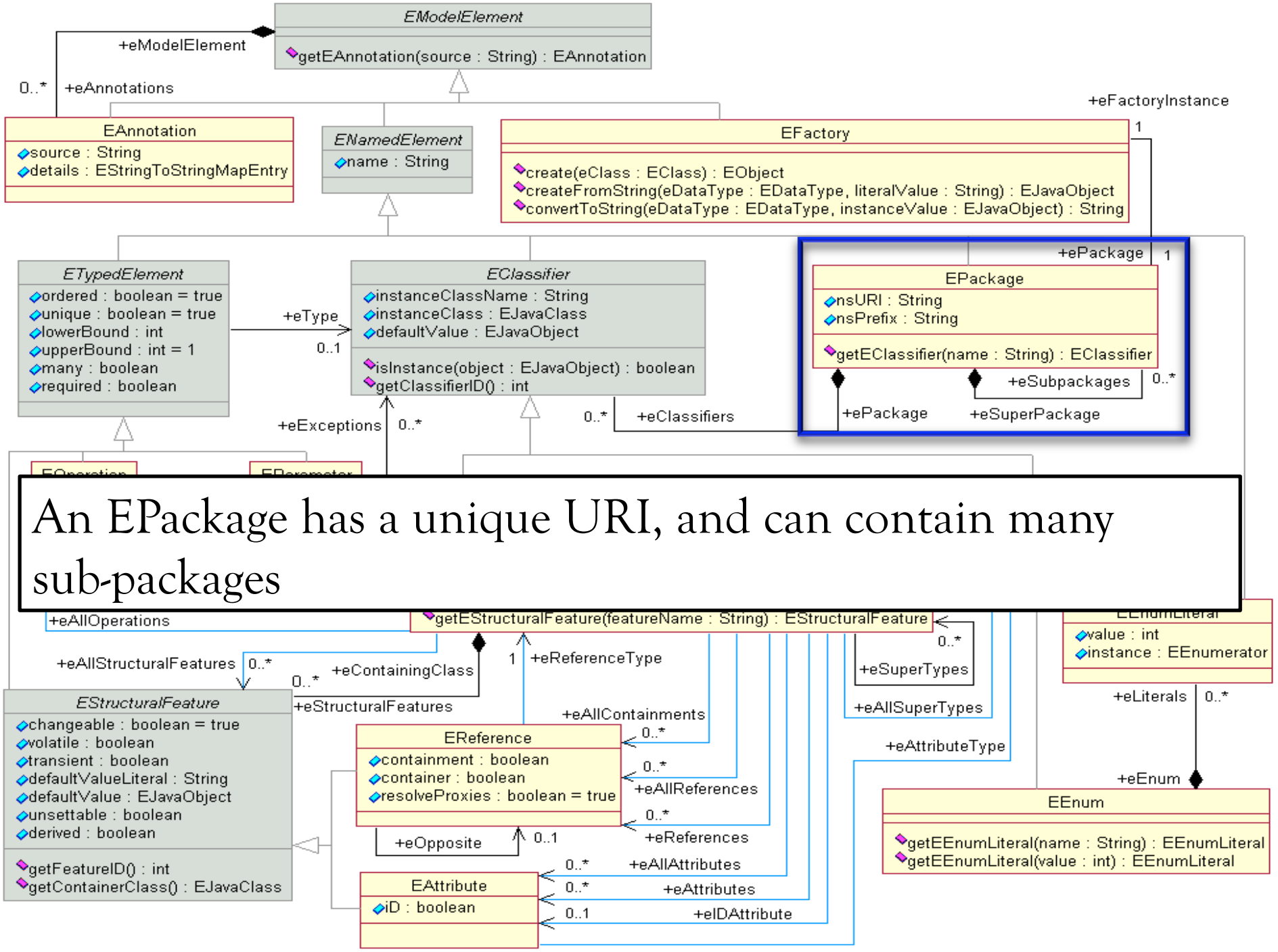


ETypedElements are Operations or Parameters with a Type (eType) and some properties:

ordered, unique, lowerBound, upperBound, many, required



An EPackage contains many EClassifiers which are either EClass or EDataTypes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convertToString(eDataType : EDataType, instanceValue : EJavaObject) : String
+eFactoryInstance
1
ETypedElement
ordered : boolean = true
unique : boolean = true
lowerBound : int
upperBound : int = 1
many : boolean
required : boolean
+eType
0..1
EClassifier
instanceClassName : String
instanceClass : EJavaClass
defaultValue : EJavaObject
isInstance(object : EJavaObject) : boolean
getClassifierID() : int
+ePackage
1
EPackage
nsURI : String
nsPrefix : String
getEClassifier(name : String) : EClassifier
+eSubpackages
0..*
+ePackage
+eSuperPackage
+eExceptions
0..*
0..*
+eClassifiers
An EPackage has a unique URI, and can contain many sub-packages
+eAllOperations
getEStructuralFeature(featureName : String) : EStructuralFeature
+eAllStructuralFeatures
0..*
0..*
+eContainingClass
+eStructuralFeatures
1
+eReferenceType
0..*
+eSuperTypes
+eAllSuperTypes
value : int
instance : EEnumerator
+eLiterals
0..*
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container : boolean
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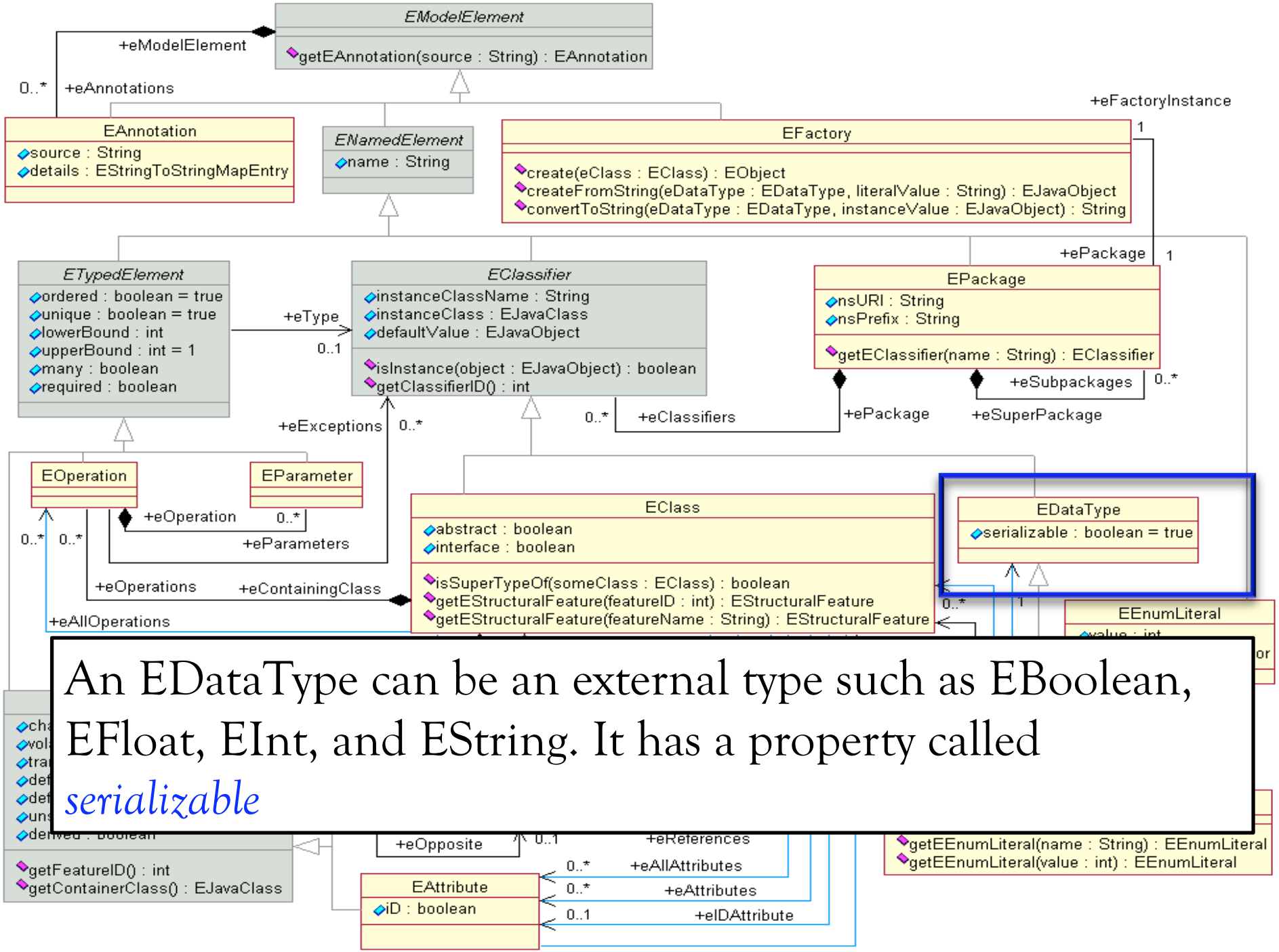
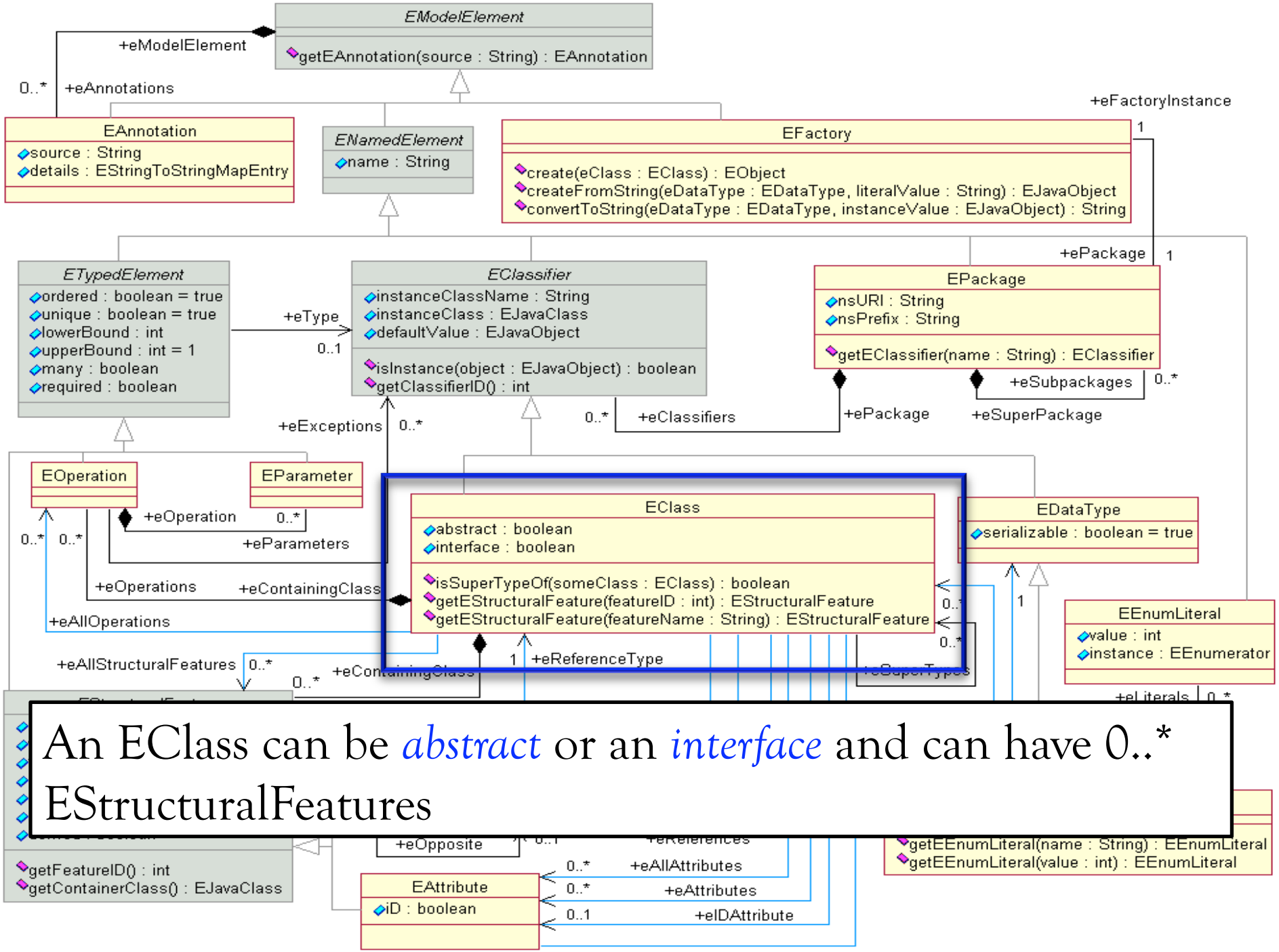
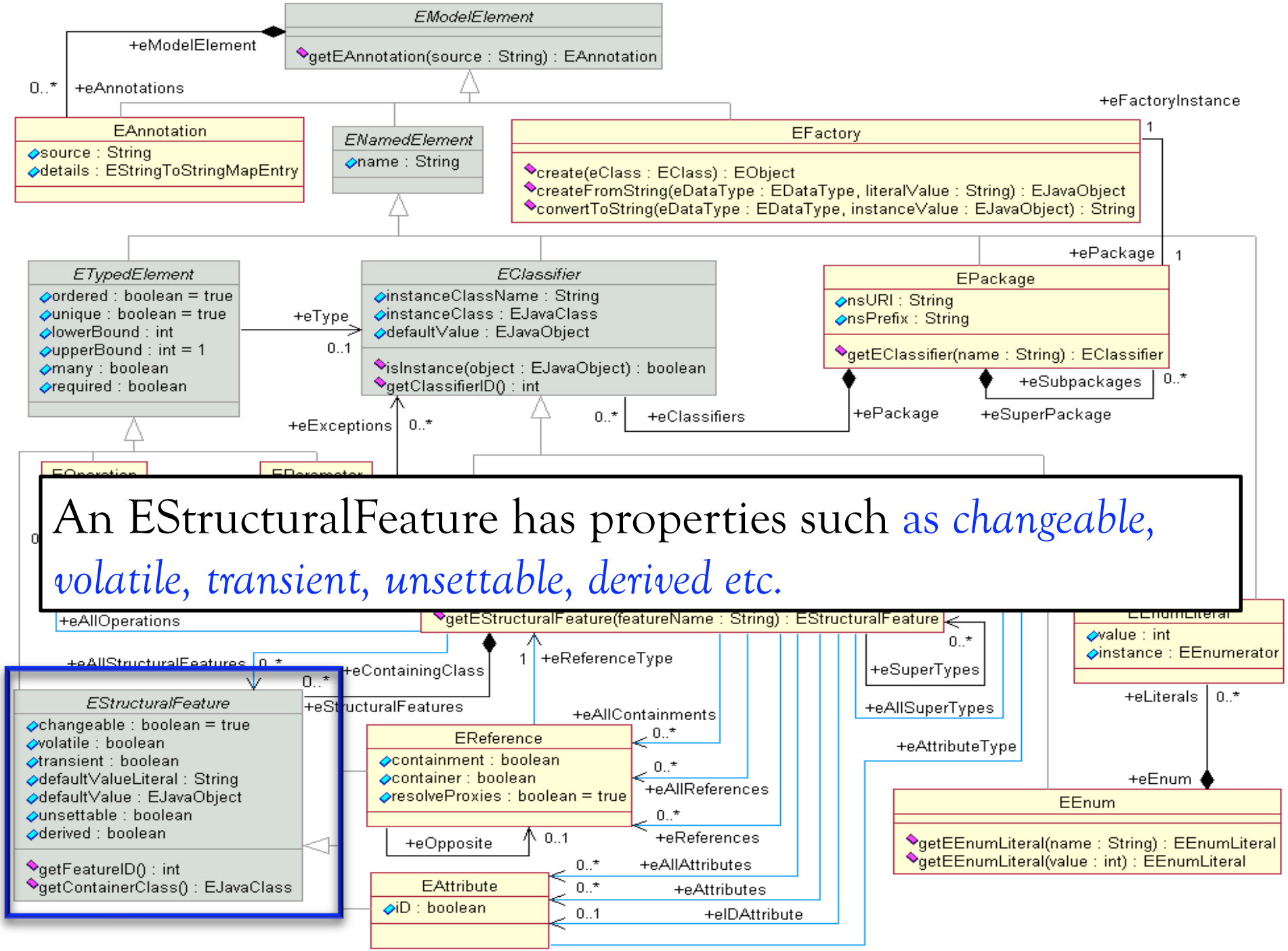
0..*
0..*
+eAllReferences
0..*
+eReferences
+eOpposite
0..1
+eAttributeType
+eEnum
EEnum
getEEnumLiteral(name : String) : EEnumLiteral
getEEnumLiteral(value : int) : EEnumLiteral
EAttribute
iD : boolean
0..*
+eAllAttributes
0..*
+eAttributes
0..1
+eIDAttribute



An EDataType can be an external type such as EBoolean, EFloat, EInt, and EString. It has a property called *serializable*



An EClass can be *abstract* or an *interface* and can have 0..* EStructuralFeatures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ETypedElement
ordered : boolean = true
unique : boolean = true
lowerBound : int
upperBound : int = 1
many : boolean
required : boolean
+eType
0..1
EClassifier
instanceClassName : String
instanceClass : EJavaClass
defaultValue : EJavaObject
isInstance(object : EJavaObject) : boolean
getClassifierID() : int
+ePackage
1
EPackage
nsURI : String
nsPrefix : String
getEClassifier(name : String) : EClassifier
+eSubpackages
0..*
+eSuperPackage
+eExceptions
0..*
0..*
+eClassifiers
+ePackage
An EStructuralFeature has properties such as changeable, volatile, transient, unsettable, derived etc.
+eAllOperations
getEStructuralFeature(featureName : String) : EStructuralFeature
0..*
+eSuperTypes
+eAllSuperTypes
value : int
instance : EEnumerator
+eLiterals
0..*
+eAllStructuralFeatures
0..*
+eContainingClass
1
+eReferenceType
0..*
+eStructuralFeatures
EStructuralFeature
changeable : boolean = true
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unsettable : boolean
derived : boolean
getFeatureID() : int
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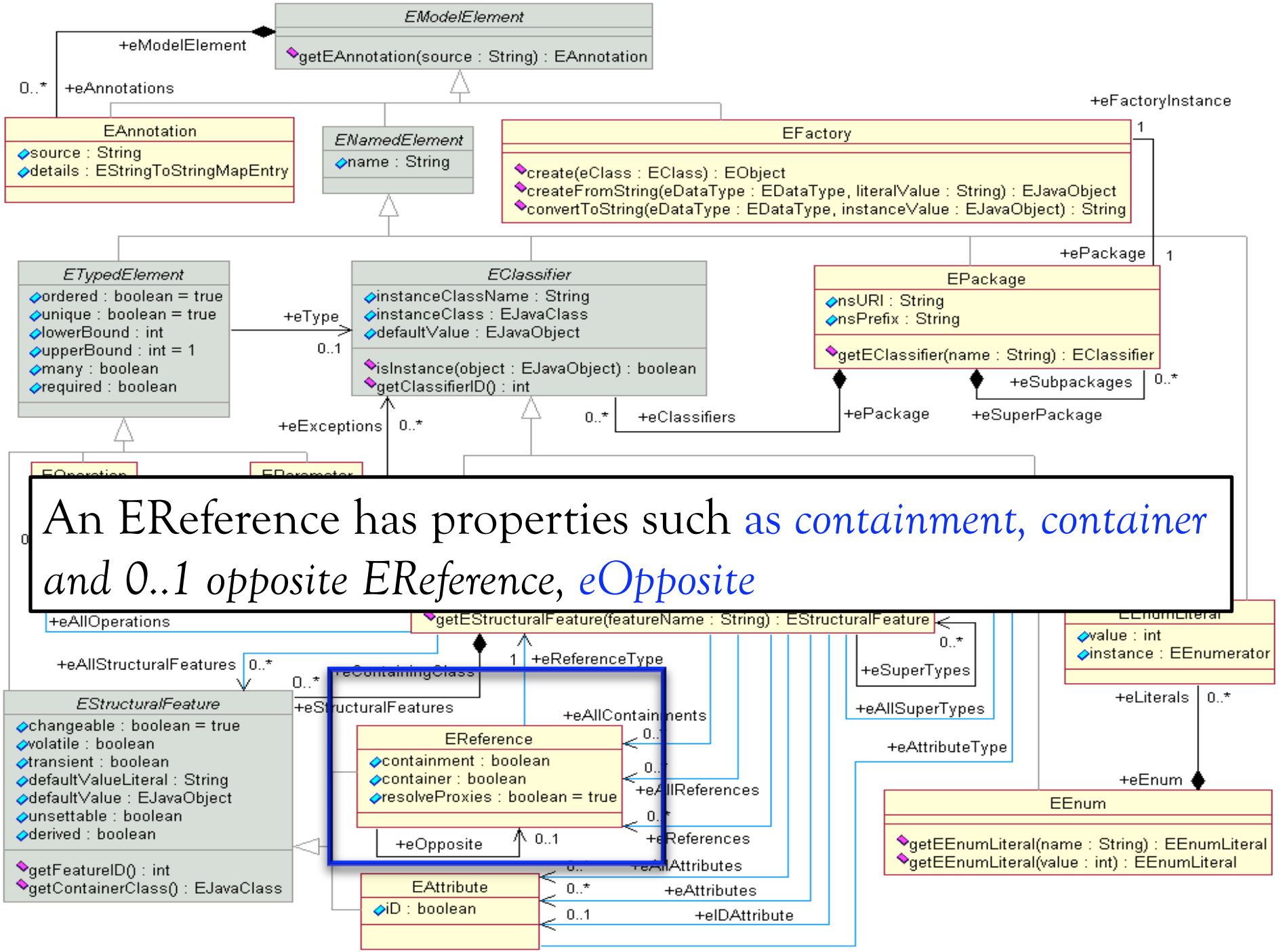
+eAllContainments
EReference
containment : boolean
container : boolean
resolveProxies : boolean = true
0..*
+eAllReferences
0..*
+eReferences
+eOpposite
0..1
+eAttributeType
+eEnum
EEnum
getEEnumLiteral(name : String) : EEnumLiteral
getEEnumLiteral(value : int) : EEnumLiteral
EAttribute
iD : boolean
0..*
+eAllAttributes
0..*
+eAttributes
0..1
+eIDAttribute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+ePackage
1
EPackage
nsURI : String
nsPrefix : String
getEClassifier(name : String) : EClassifier
+eSubpackages
0..*
+eSuperPackage
+eExceptions
0..*
0..*
+eClassifiers
+ePackage
An EReference has properties such as containment, container and 0..1 opposite EReference, eOpposite
+eAllOperations
getEStructuralFeature(featureName : String) : EStructuralFeature
+eAllStructuralFeatures
0..*
1
+eReferenceType
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containment : boolean
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+eOpposite
0..1
+eAllReferences
+eReferences
+eAttributeType
+eEnum
EEnum
getEEnumLiteral(name : String) : EEnumLiteral
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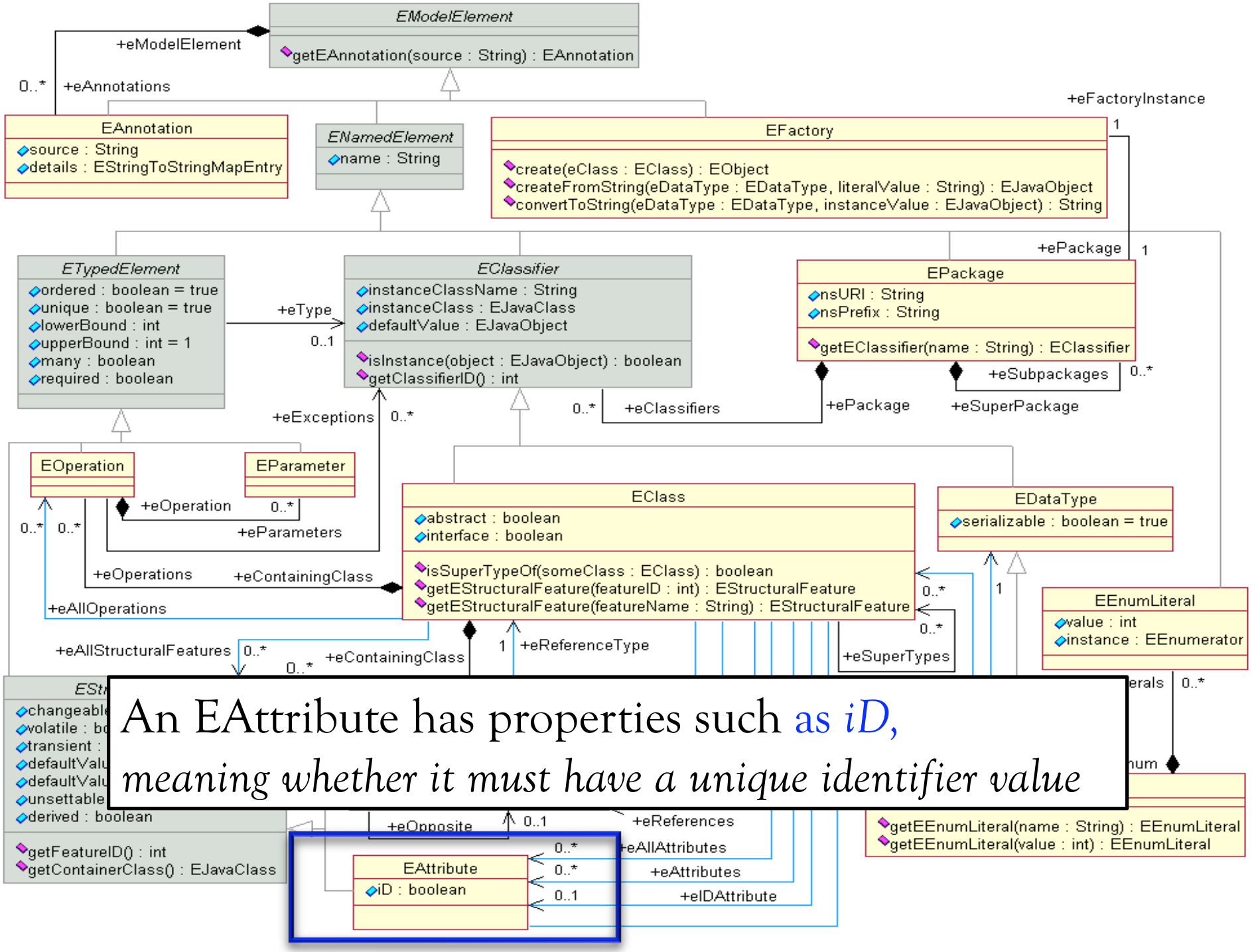
+eAllAttributes
EAttribute
iD : boolean
0..*
+eAttributes
0..1
+eIDAttribute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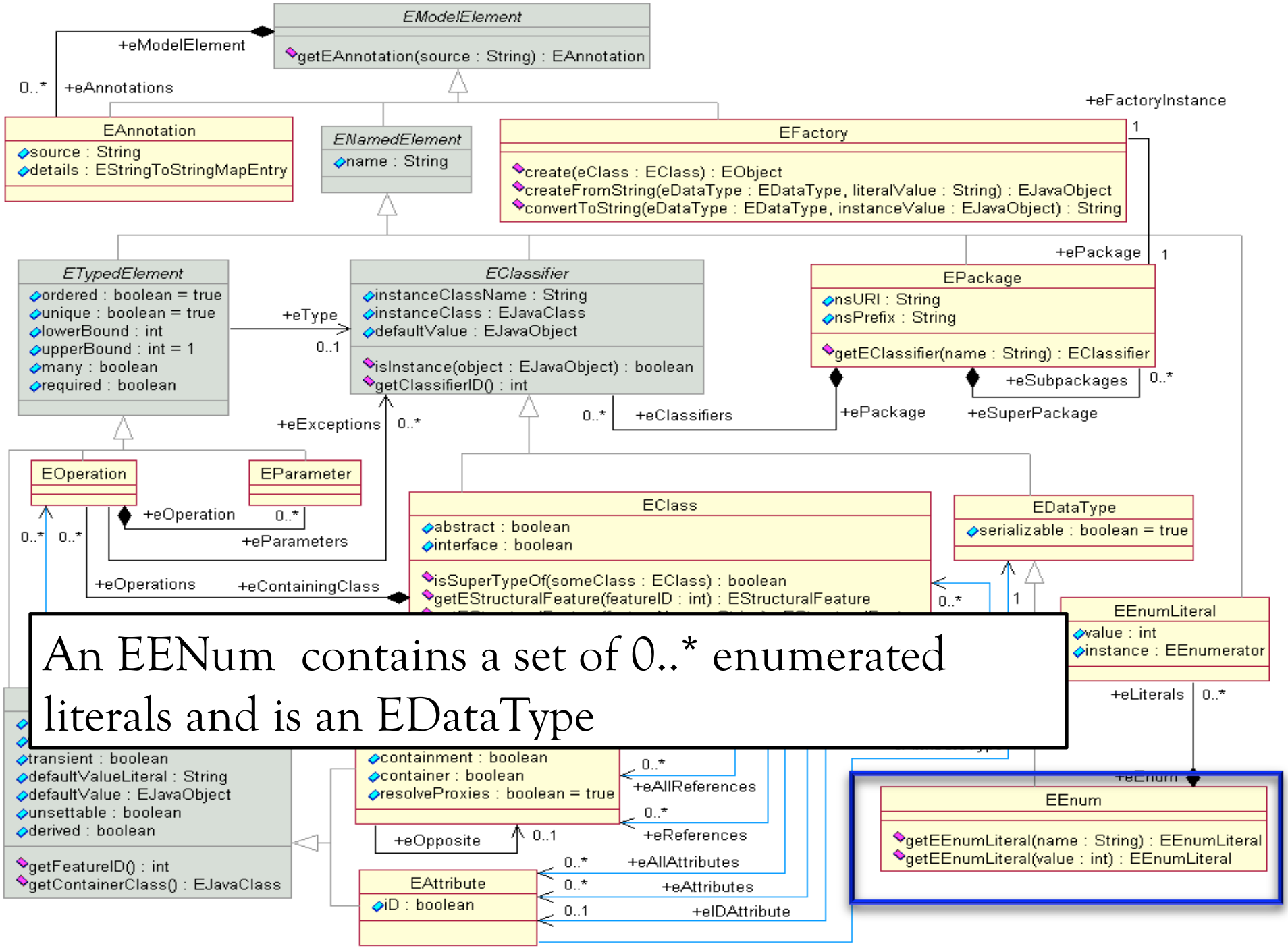
+eOpposite
0..1
+eReferences
+eAllAttributes
+eAttributes
+eIDAttribute
EAttribute
iD : boolean
0..*
0..*
0..1
getEEnumLiteral(name : String) : EEnumLiteral
getEEnumLiteral(value : int) : EEnumLiteral
An EAttribute has properties such as iD,
meaning whether it must have a unique identifier value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0..*
+eAllReferences
0..*
+eReferences
+eOpposite
0..1
EEnum
getEEnumLiteral(name : String) : EEnumLiteral
getEEnumLiteral(value : int) : EEnumLiteral
0..*
+eAllAttributes
0..*
+eAttributes
0..1
+eIDAttribute
EAttribute
iD : boolean
An EENum contains a set of 0..* enumerated literals and is an EDataType

ECore Transformations

- How is an .ecore file containing the meta-model serialized or stored ?

  Lets dissect an example ECore File for

  Simple UML Class Diagrams!

ECore Model

- **The Top-level EPackage**

```
<?xml version="1.0" encoding="UTF-8"?>
<ecore:EPackage xmi:version="2.0"
    xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance"
    xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
name="simpleUML_MM"
    nsURI="http://simpleUML_MM.ecore"
nsPrefix="simpleUML_MM">
```

An ECore model always starts with an EPackage

ECore Model

- **EClassifiers enclosed in EPackages**

<eClassifiers xsi:type="ecore:EClass" name="Classifier"
abstract="true">

</eClassifiers>

An ECore model contains eClassifier tags with the specification Of ecore:EClass or ecore:EDataType as Types and associated Properties such as abstract, interface etc.

ECore Serialization Summary

What is in them, basically?

- EPackages with properties
- EClassifiers with properties
- EStructuralFeatures with properties
- We also have EAnnotations but we ignore them for the ECore2Alloy Transformation

ECore Transformation : Testing

- Deals with EPackages, EClassifiers, EStructuralFeatures in an *.ecore* file
- We need to find partitions of the input domain to test a transformation for ECore Models.
- Lets summarize these partitions
- We consider a subset of ECore for the *ECore2Alloy* Transformation

EPackage Partitions

1 , > 1 EPackage objects ePackage with
ePackage.name="", ePackage.name!=""
ePackage.eSubPackeges=0,1,>1
ePackage.eSuperPackages=0,1,>1
ePackage.eClassifiers=0,1,>1

For example, we don't consider the properties nsPrefix and nsURI as we don't use it for the Ecore 2 Alloy Transformation

Total Models = 22

EDataType Partitions

1,>1 EDataType objects eDataType with

eDataType.name="", eDataType.name!="", eDataType.name!="EBool", eDataType.name!="EFloat", eDataType.name!="EInt", eDataType.name! ="EBoolean",

eDataType.instanceClassName="", eDataType.instanceClassName!="" eDataType.instanceClassName= boolean, eDataType.instanceClassName= int, eDataType.instanceClassName= float, eDataType.instanceClassName= java.lang.String,

#eDataType.ePackage =0, #eDataType.ePackage=1,#eDataType.ePackage>1,

We consider special strings for the Ecore 2 Alloy Transformation

Total Models = 30

EClass Partitions

1,>1 EClass objects eClass with

eClass.name="", eClass.name!=""

eClass.abstract=True , eClass.abstract=False

#eClass.ePackage =0, #eClass.ePackage=1,#eClass.ePackage>1,
#eClass.eSuperTypes =0, #eClass.eSuperTypes=1,#eClass.eSuperTypes>1,
#eClass.eStructuralFeatures =0, #eClass.eStructuralFeatures =1,
#eClass.eStructuralFeatures >1,

We ignore eOperations and interface for the Ecore 2 Alloy Transformation

Total Models = 26

EAttribute Partitions

1,>1 EAttribute objects eReference with
eAttribute .name="", eAttribute .name!=""
eAttribute .iD=True, eAttribute .iD=False
eAttribute.changeable=True, eAttribute.changeable=False
eAttribute.defaultValue=boolean, eAttribute.defaultValue=int,
eAttribute.defaultValue=float, eAttribute.defaultValue=java.lang.String
eAttribute.defaultValueLiteral="", eAttribute.defaultValueLiteral!=""
#eAttribute.defaultValue.eContainingClass =0,
#eAttribute.defaultValue.eContainingClass =1,
#eAttribute.defaultValue.eContainingClass >1
eAttribute.ordered=True, eAttribute.ordered=False,
eAttribute.many=True, eAttribute.many=False,
eAttribute.lowerBound=0,1,>1,
eAttribute.upperBound=0,1,>1,eAttribute.required=True,
eAttribute.required=False

We ignore unsettable, derived for the Ecore 2 Alloy Transformation

Total Models = 52

EReference Partitions

1,>1 EReference objects eReference with
eReference .name="", eReference .name!=""
eReference.changeable=True, eReference.changeable=False
eReference.ordered=True, eReference.ordered=False,
eReference.many=True, eReference.many=False,
eReference.lowerBound=0,1,>1,
eReference.upperBound=0,1,>1,eReference.required=True,
eReference.required=False
eReference.containment=True, eReference.containment=False,
eReference.container=True, eReference.container=False
#eReference.containingClass=0,1,>1
#eReference.eOpposite=0,1
We ignore unsettable, derived, defaultValue, defaultValueLiteral, resolveProxies ,volatile, transient, unsettable, derived for the Ecore 2 Alloy Transformation
Total Models = 50

Conclusion

- Total number of test models to be synthesized for individual checks= 170 models
- The test models are mainly for ECore2Alloy
- Although they can be used to test other transformations

Thanks!