Querying, visualizing models

ANNE ETIEN

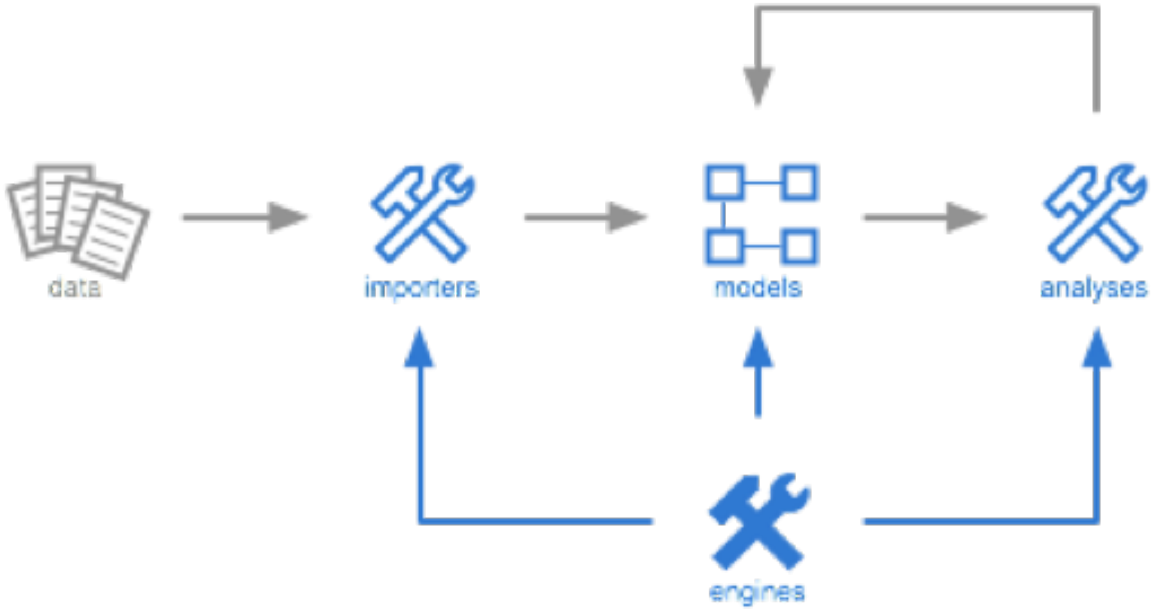
Overview

- FAMIX metamodel
- Access models
- Query
- Select
- Navigate

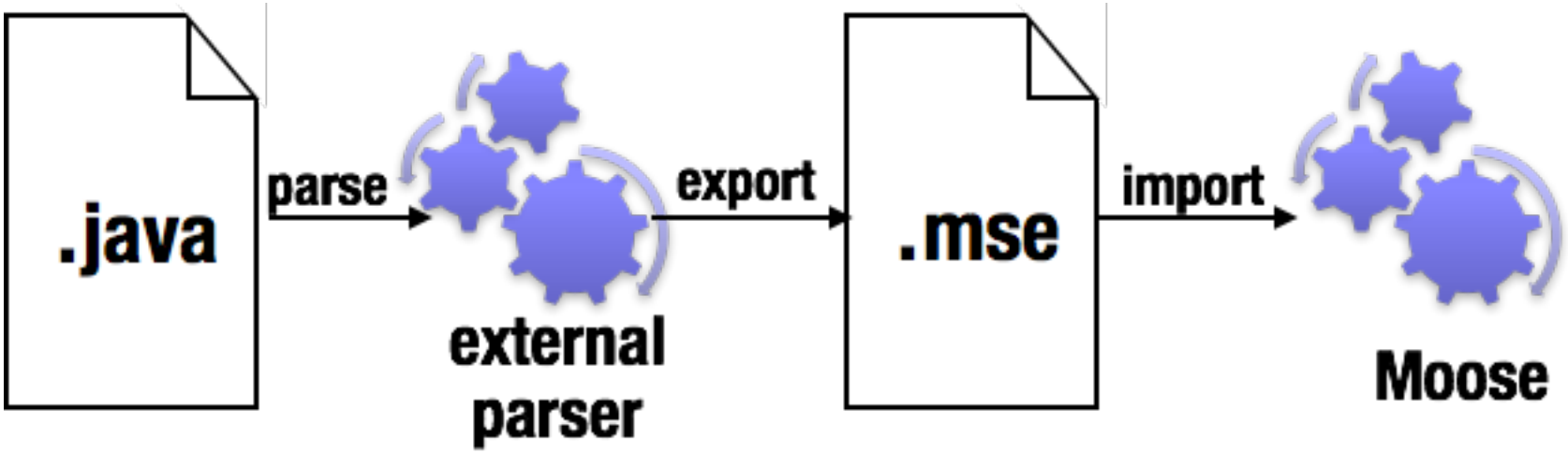
Moose

an extensible toolbox for software and data analysis

- Importers
- Model
- Visualizations
- Rules engines
- Etc…

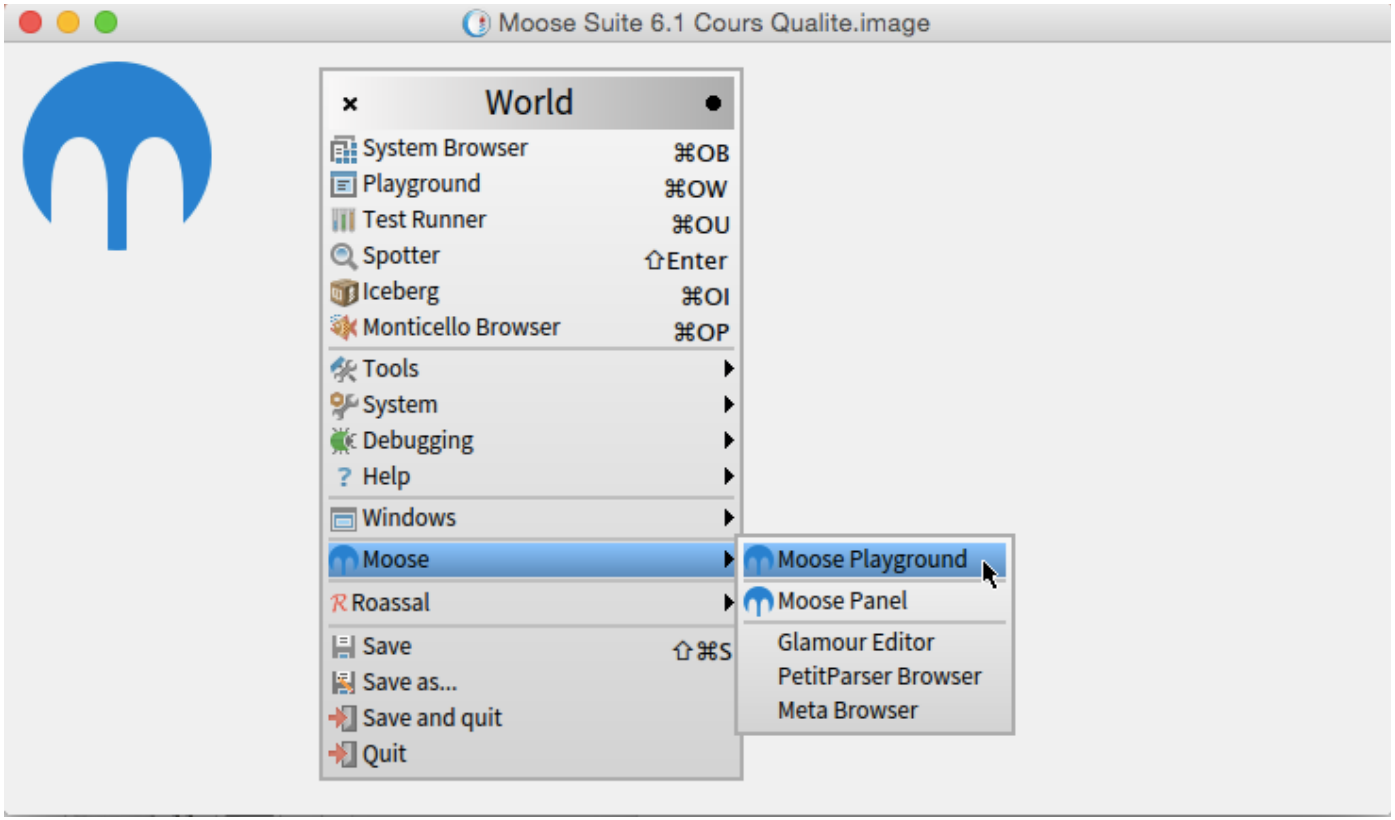


From Java code to Moose Model



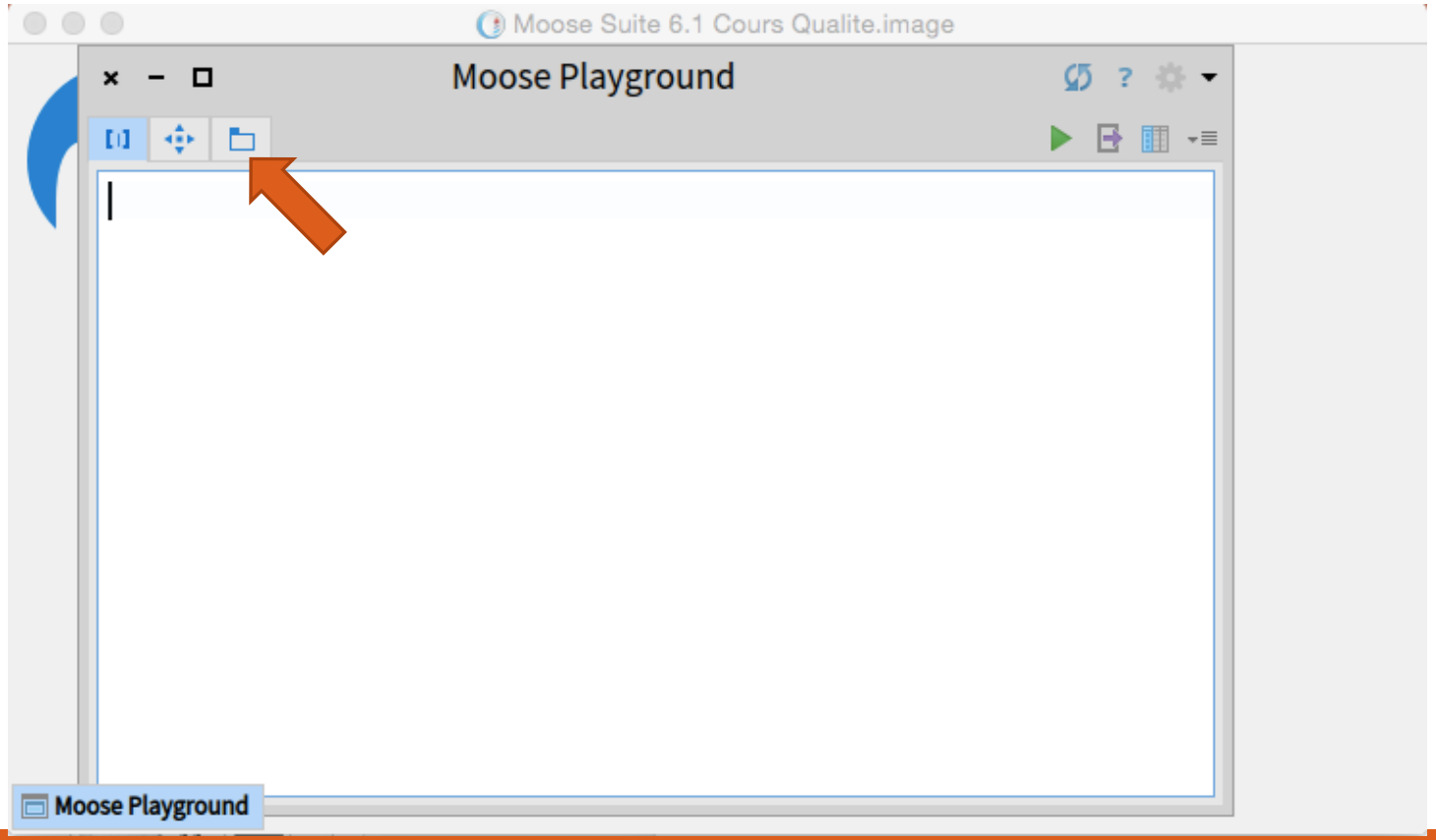
Import du Projet (Source)

- Click on Moose desktop



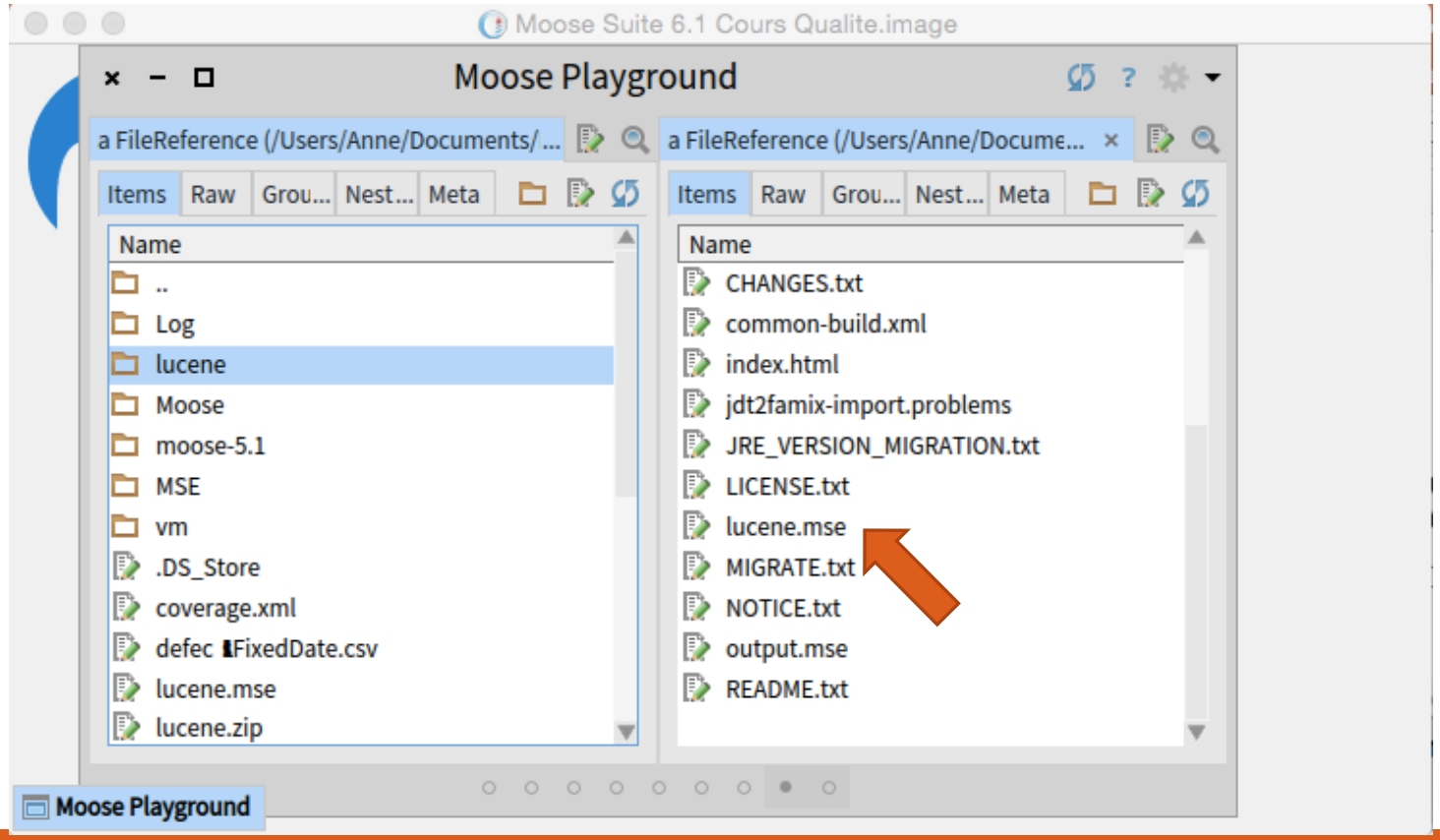
Import du Projet (Source)

- Import the model



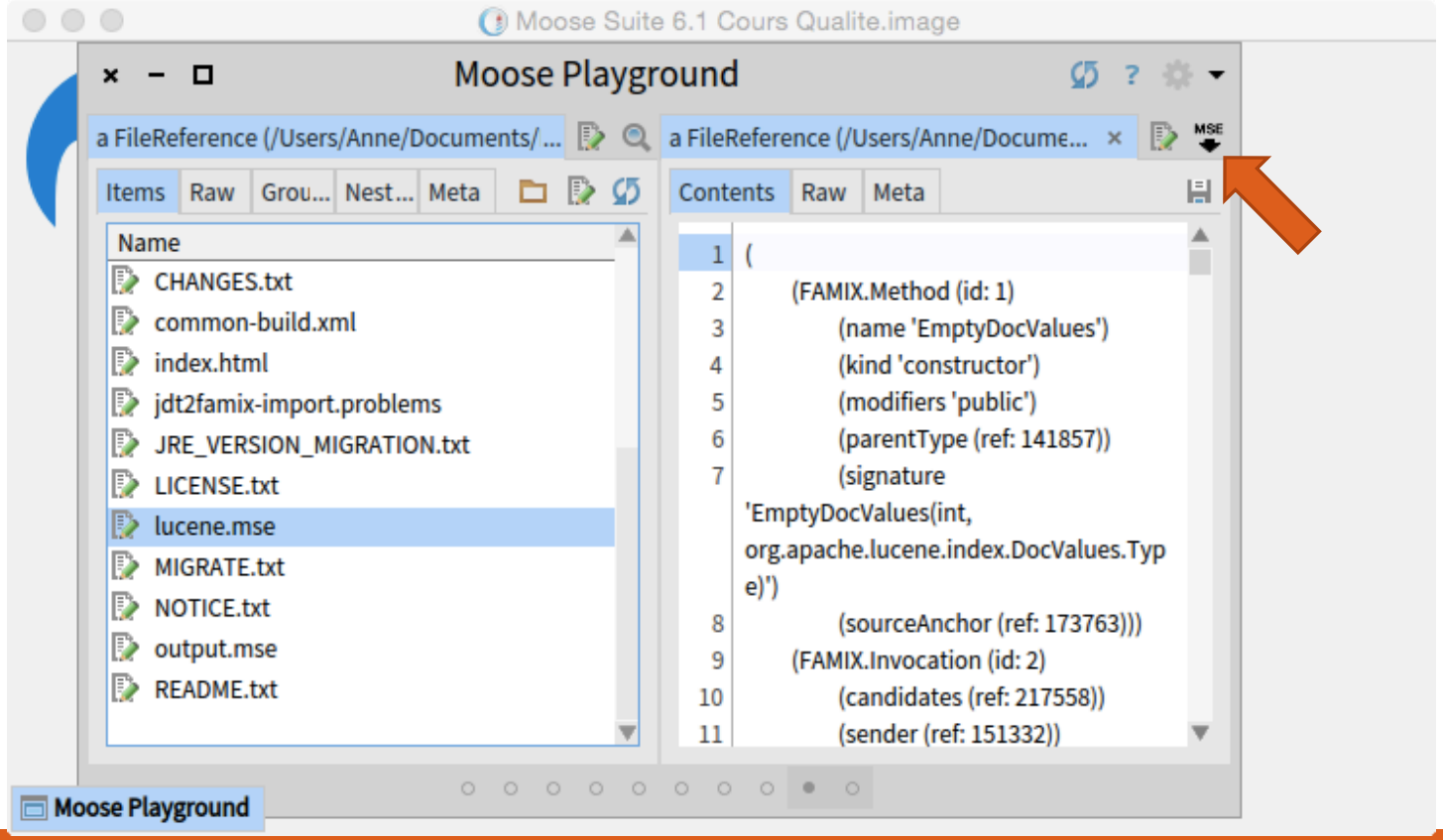
Import du Projet (Source)

- Import the model by selecting the mse file



Import du Projet (Source)

- Import the model by clicking on the MSE button



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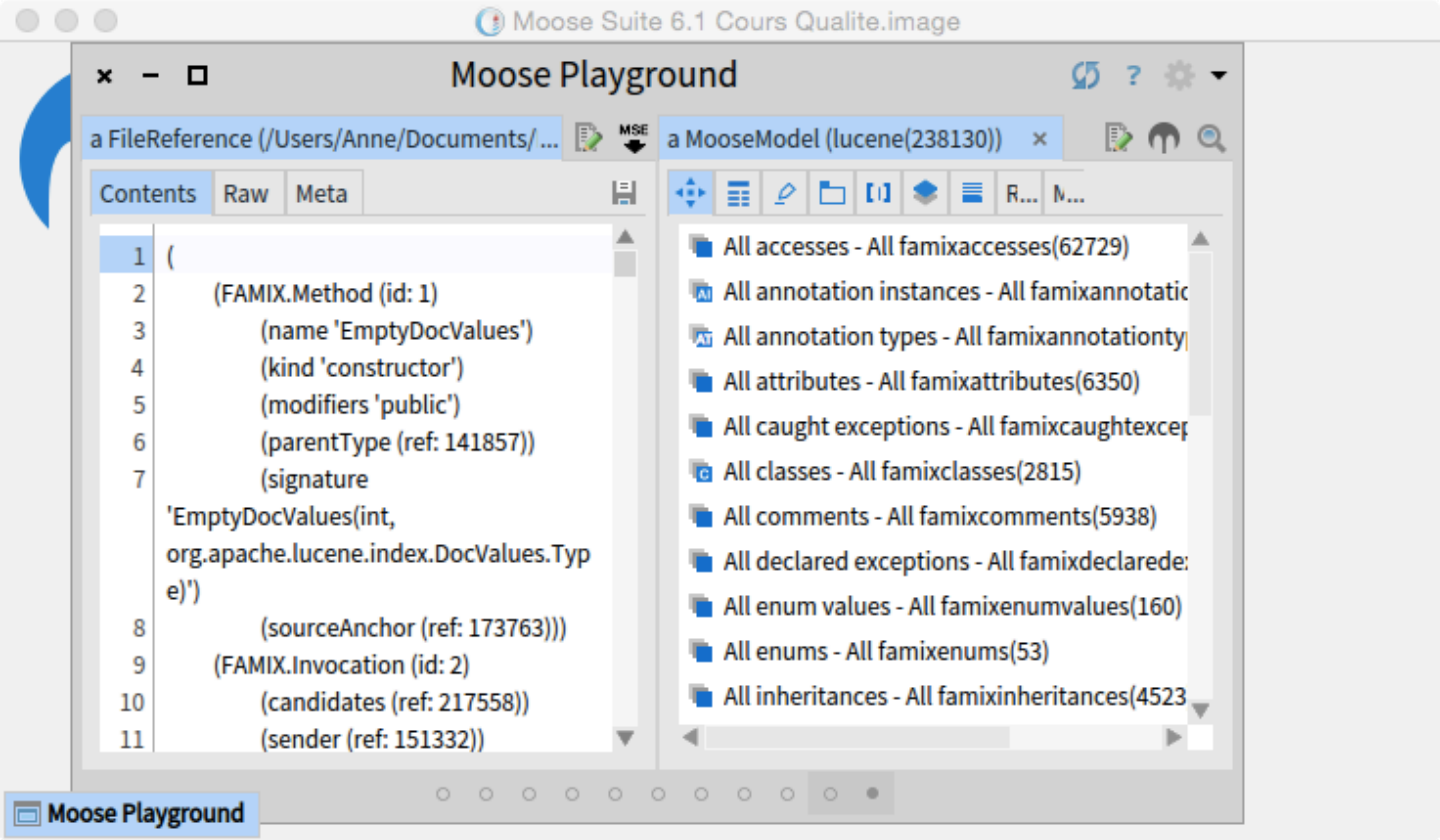


Pharo

Less is More

- No constructors
- No types declaration
- No interfaces
- No packages/private/protected
- No parametrized types
- No boxing/unboxing
- And really powerful

A Pure OO World

Only objects!

- mouse, booleans, arrays, numbers, strings, windows, scrollbars, canvas, files, trees, compilers, sound, url, socket, fonts, text, collections, stack, shortcut, stream…

3 kinds of messages

- Unary messages
  - Message without argument

```
5 factorial
Transcript cr
```

- Binary messages
  - Message with only one argument and is named by one or more symbol characters

```
3 + 4
```

- Keywords messages
  - Message with one or more arguments that are inserted in the message name

```
2 between: 0 and: 5
Transcript show: 'hello world'
```

Precedence

- Parentheses > unary > binary > keyword and finally from left to right.
- `(10 between: 1 and: 2 + 4 * 3) not`
- Here, the messages `+` and `*` are sent first then `between:and:` is sent, and finally `not`.
- The rule suffers no exception: operators are just binary messages with no notion of mathematical precedence, so
  - `2 + 4 * 3` reads left-to-right and gives 18,not 14!

From Java to Pharo

- `postman.send(mail,recipient);`
- `postman.send(mail,recipient);`
- `postman send mail recipient`
- `postman send mail to recipient`
- `postman send: mail to: recipient`

Highlighting Java syntax

Removing Java syntax

Adding small word to distinguish parameters

Pharo message with two parameters

Pharo Syntax

- Six reserved words only
  - `nil` the undefined object
  - `true, false` boolean objects
  - `self` the receiver of the current message (equivalent to `this` in Java)
  - `super` the receiver, in the superclass context
  - `thisContext` the current invocation on the call stack

Pharo Syntax

- Reserved punctuation characters
  - `"comment"`
  - `'string'`
  - `#symbol` unique string
  - `$a` the character a
  - `12 2r1100 16rC` twelve (decimal, binary, hexadecimal)
  - `3.14 1.2e3` floating-point numbers
  - `.` expression separator (period)
  - `;` message cascade (semicolon)
  - `:=` assignment
  - `^` return a result from a method (caret)
  - `[ :p | expr ]` code block with a parameter
  - `| foo bar |` declaration of two temporary variables
  - `#(abc 123)` literal array with the symbol #abc and the number 123
  - `{foo. 3 + 2}` dynamic array built from 2 expressions

Conditionals: ifTrue:ifFalse:

- Booleans are objects
- Conditional are messages sent to booleans or block

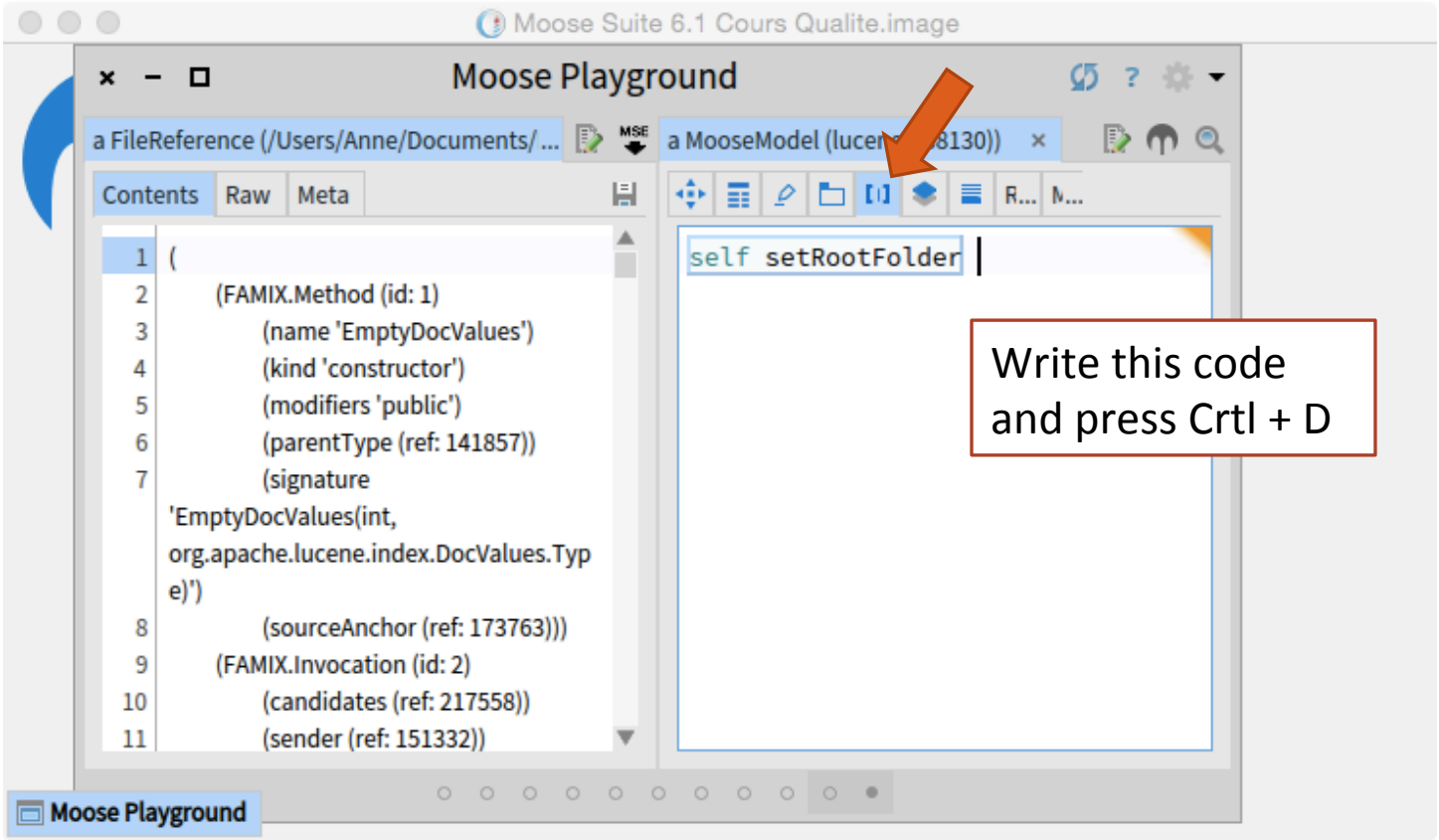
```
initialAnswer := fullName isEmptyOrNil

      ifTrue: ['FirstnameLastname' translated]
      ifFalse: [fullName].
```

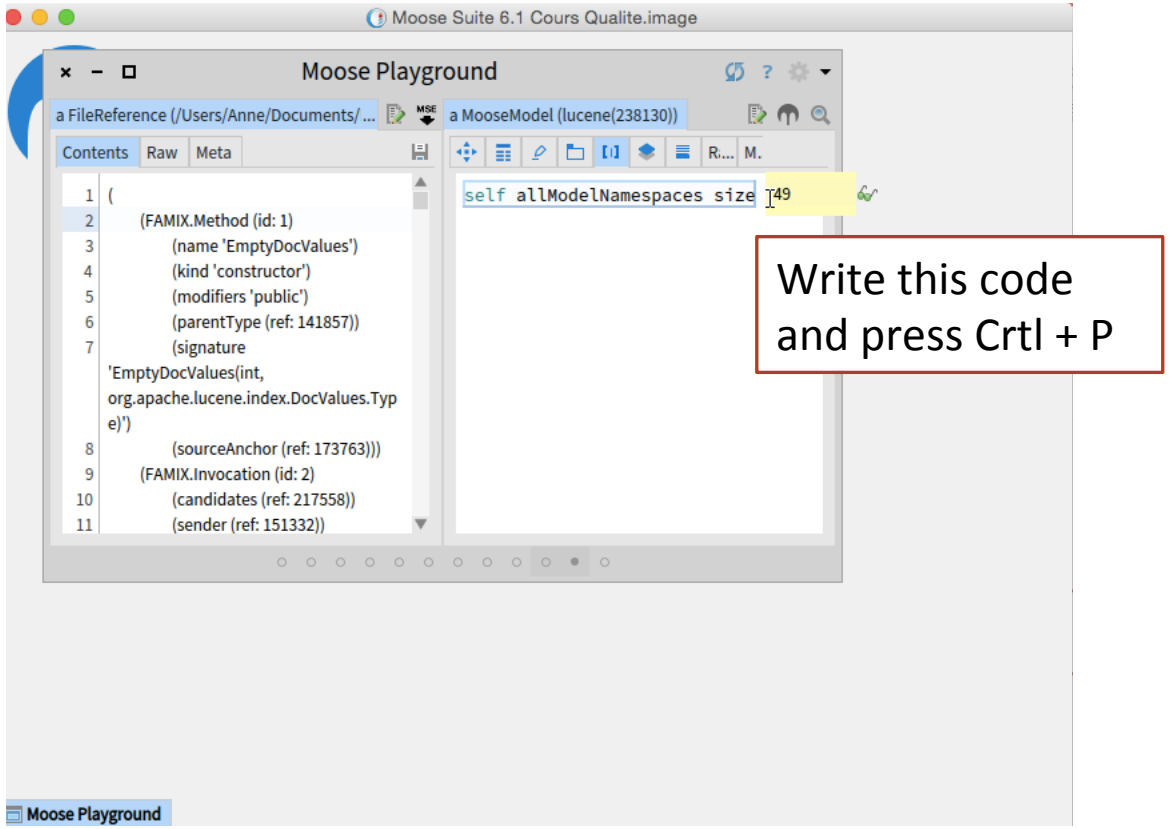
Getting a bit further

PERSONALIZED INFORMATION

Import du Projet (Source)

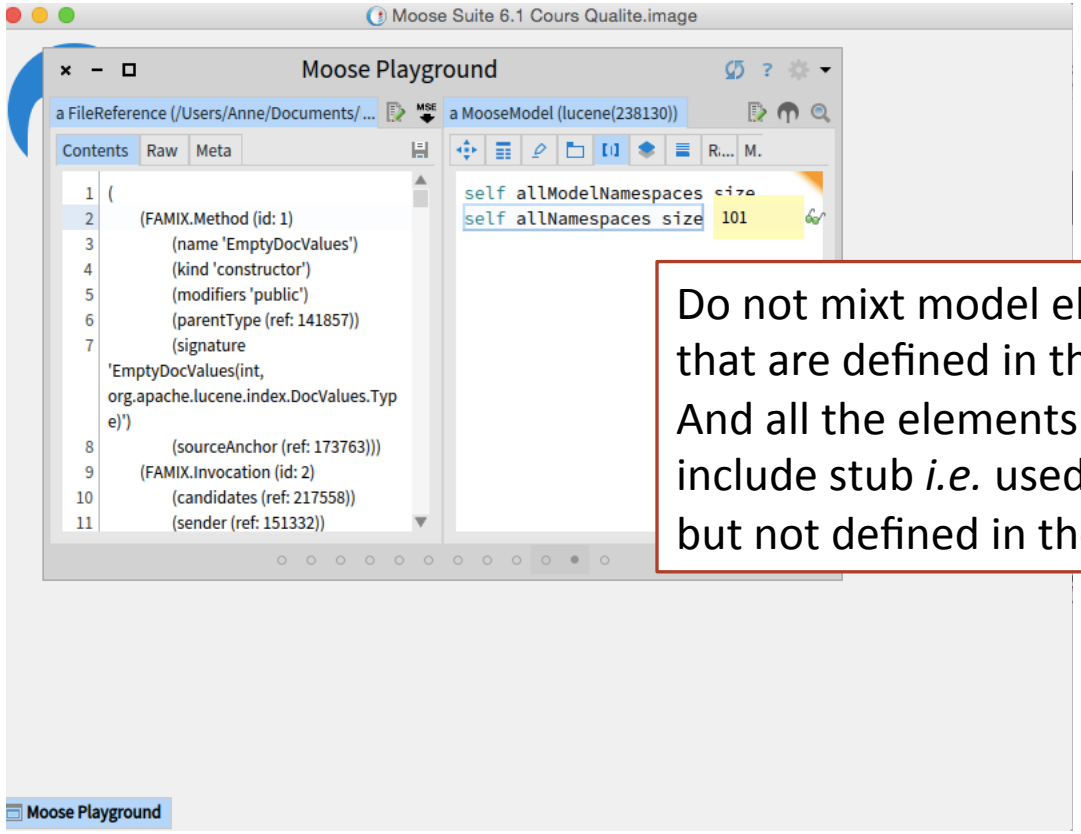


How many packages do we have in the model?



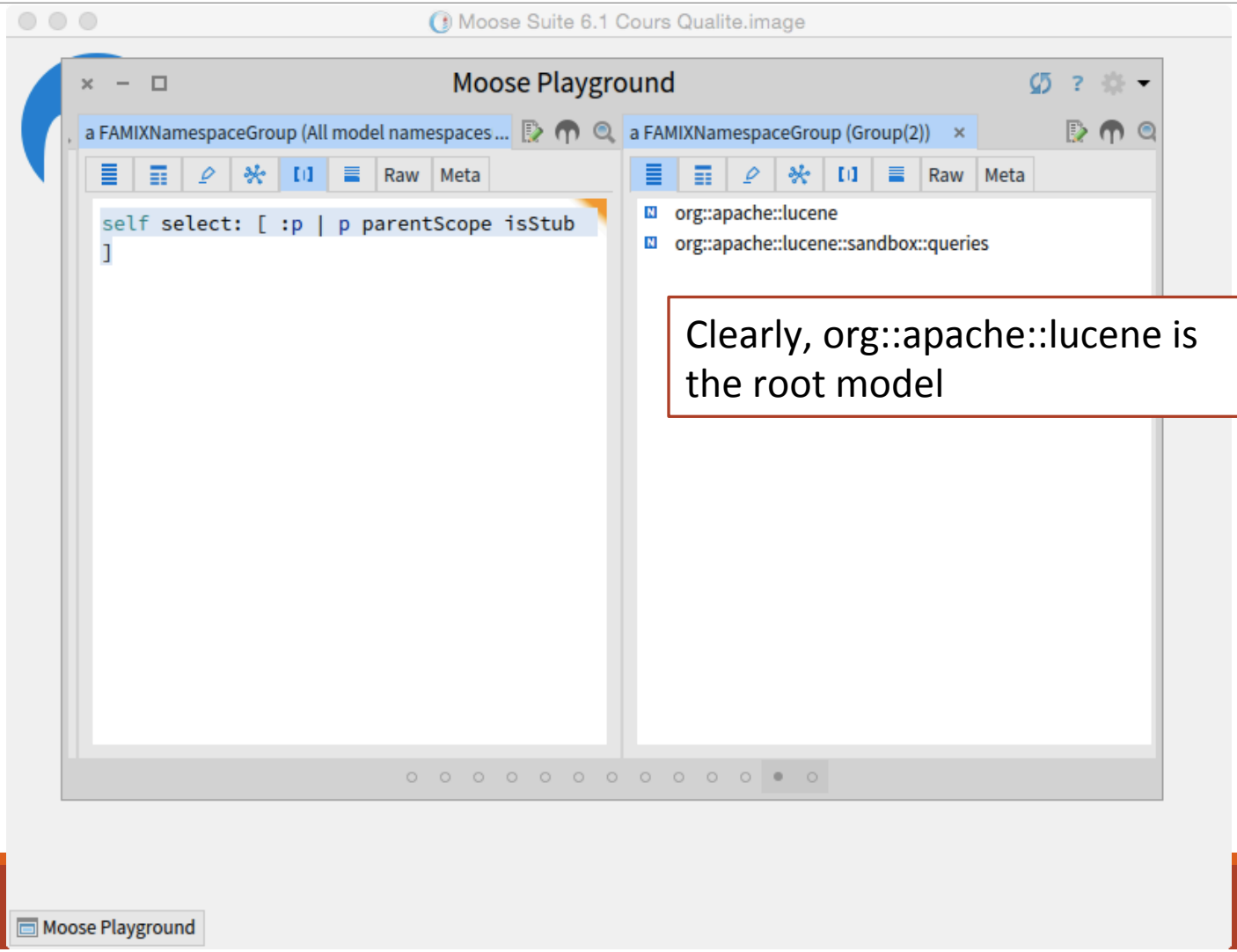
Write this code and press Crtl + P

How many packages do we have in the model?



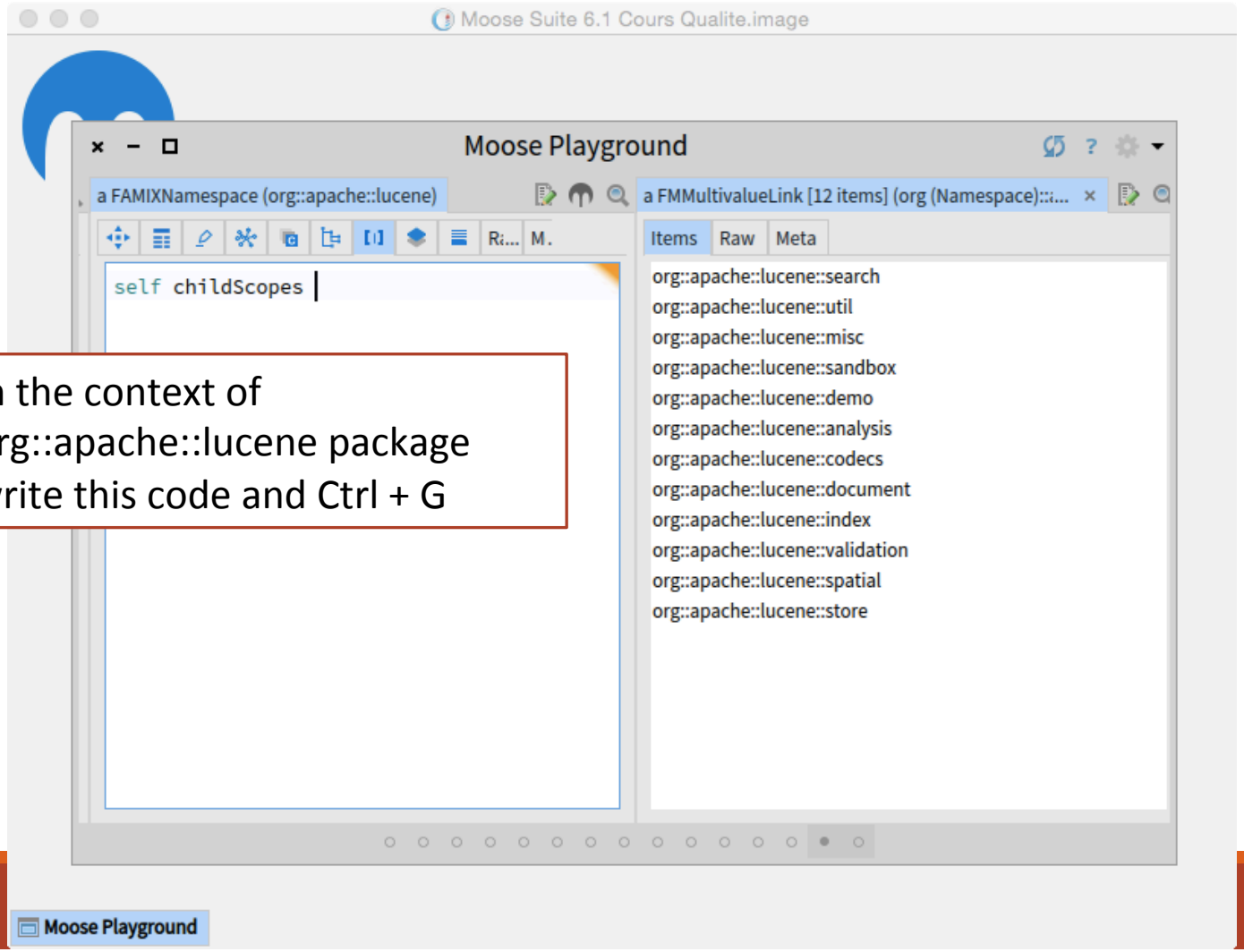
Do not mixt model elements that are defined in the model
And all the elements that also include stub *i.e.* used elements but not defined in the model

How many root packages do we have in the model?



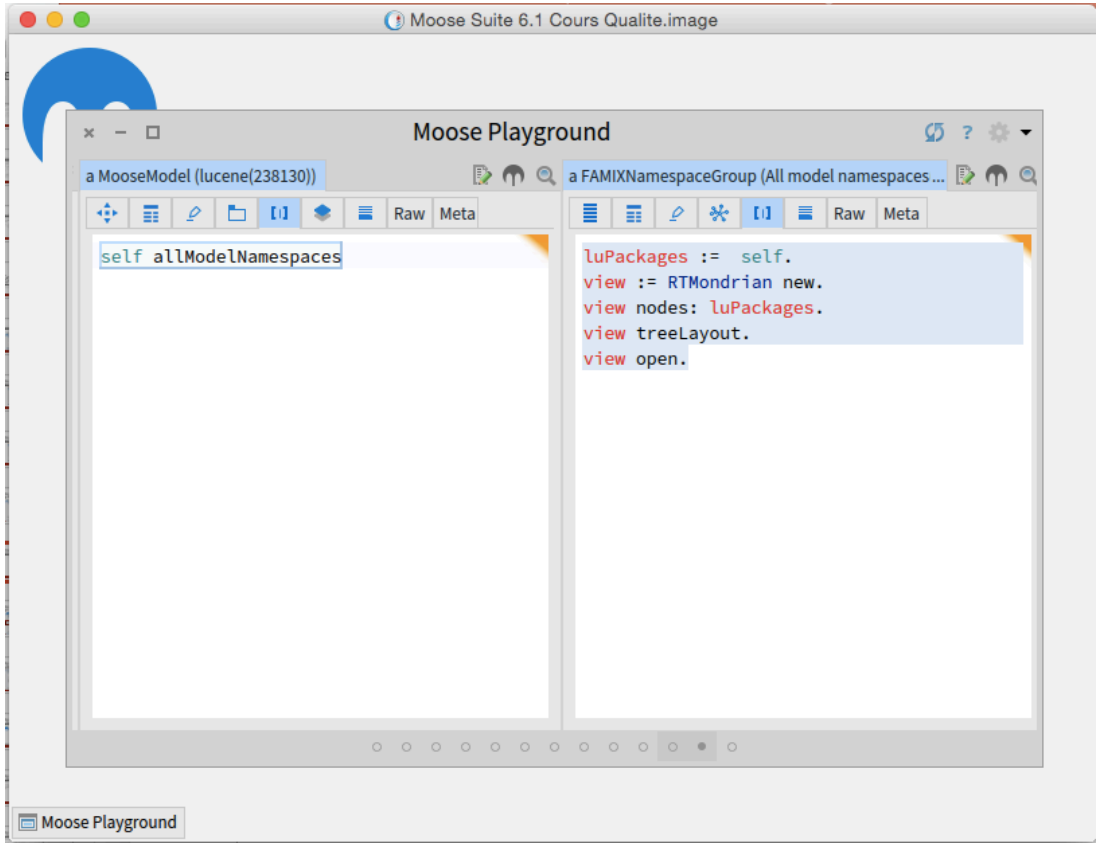
Clearly, org::apache::lucene is the root model

Which packages does the root package contain?



In the context of org::apache::lucene package write this code and Ctrl + G

What is the package hierarchy?



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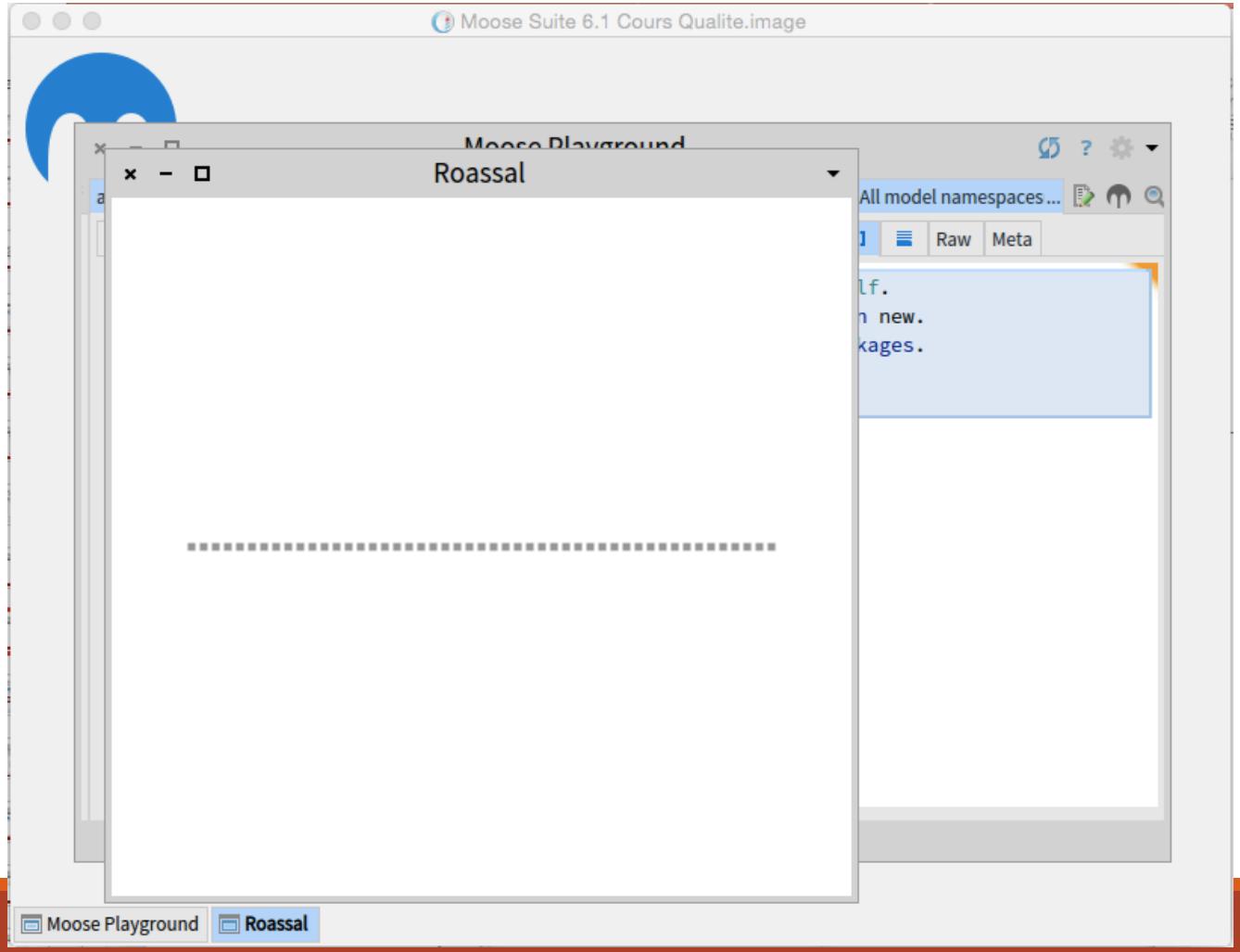

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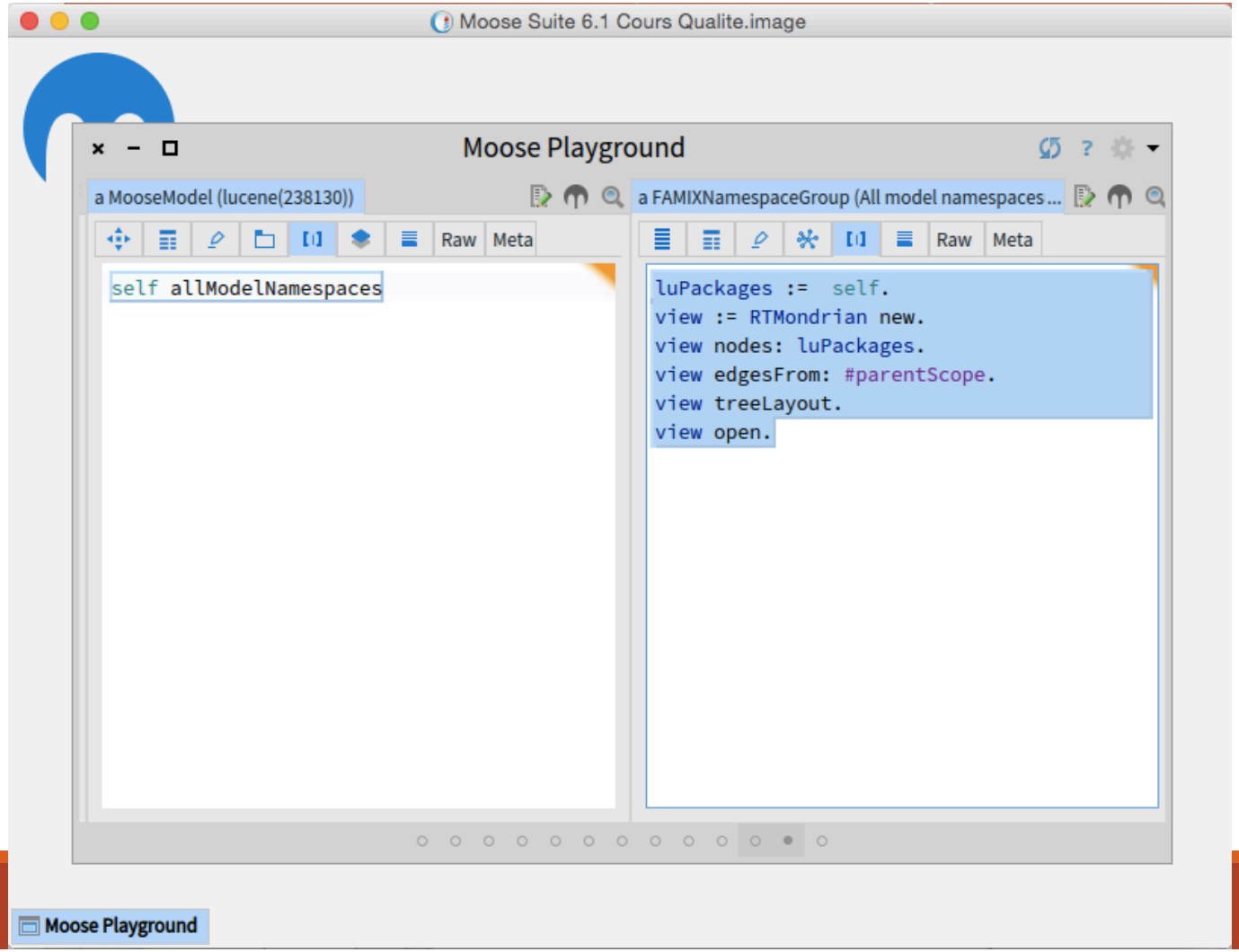

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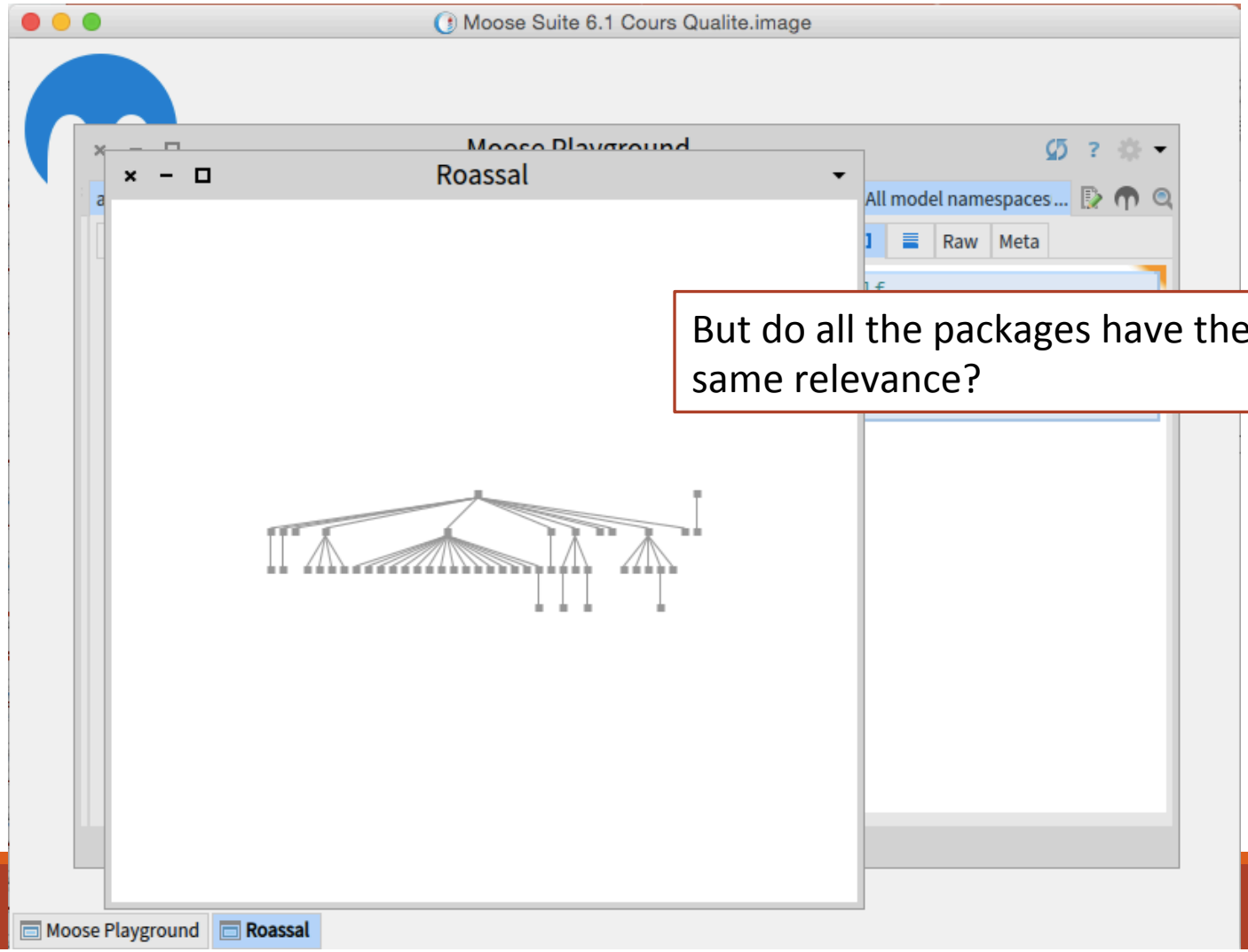
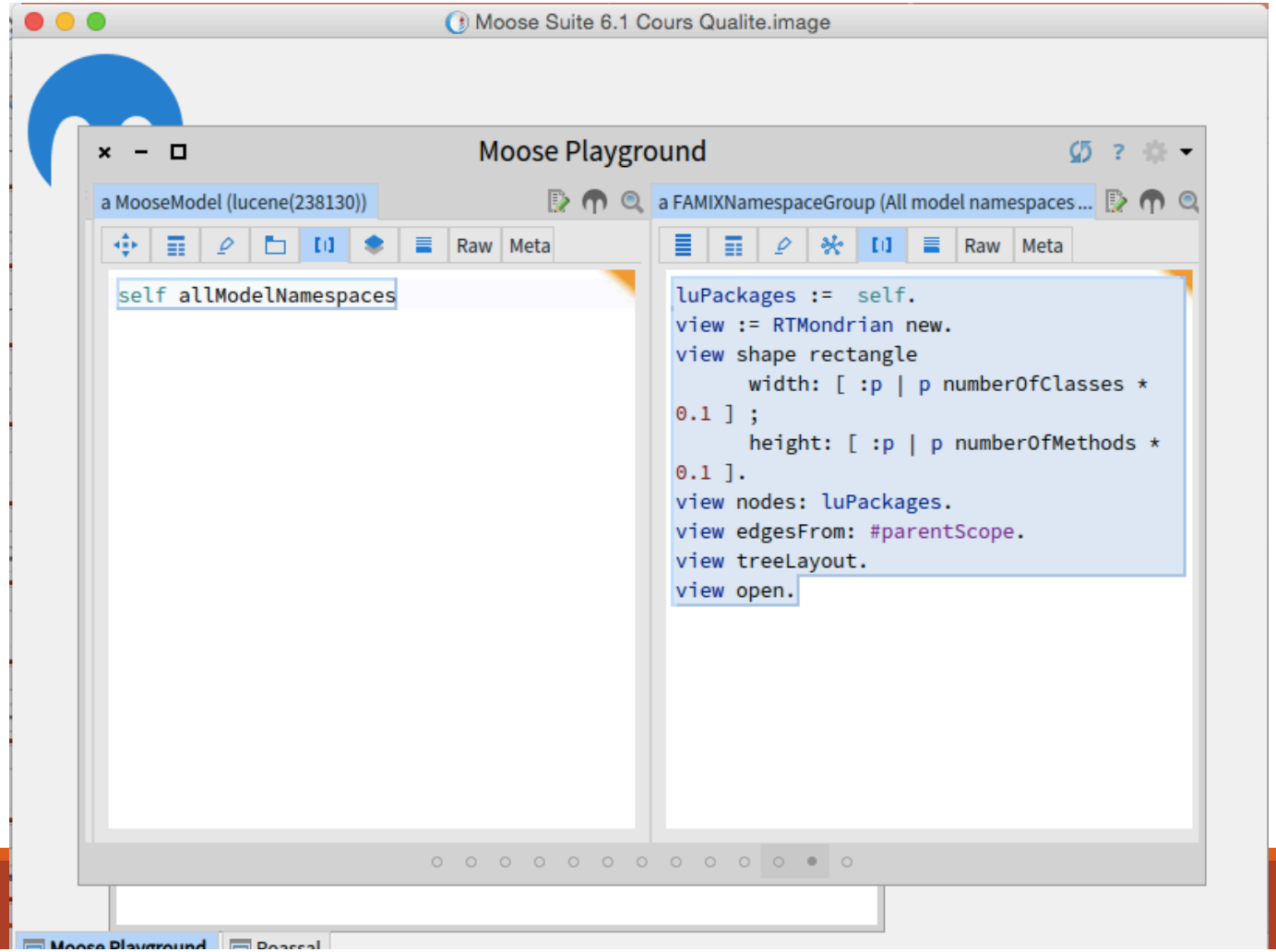


But do all the packages have the same relevance?

What is the package hierarchy?



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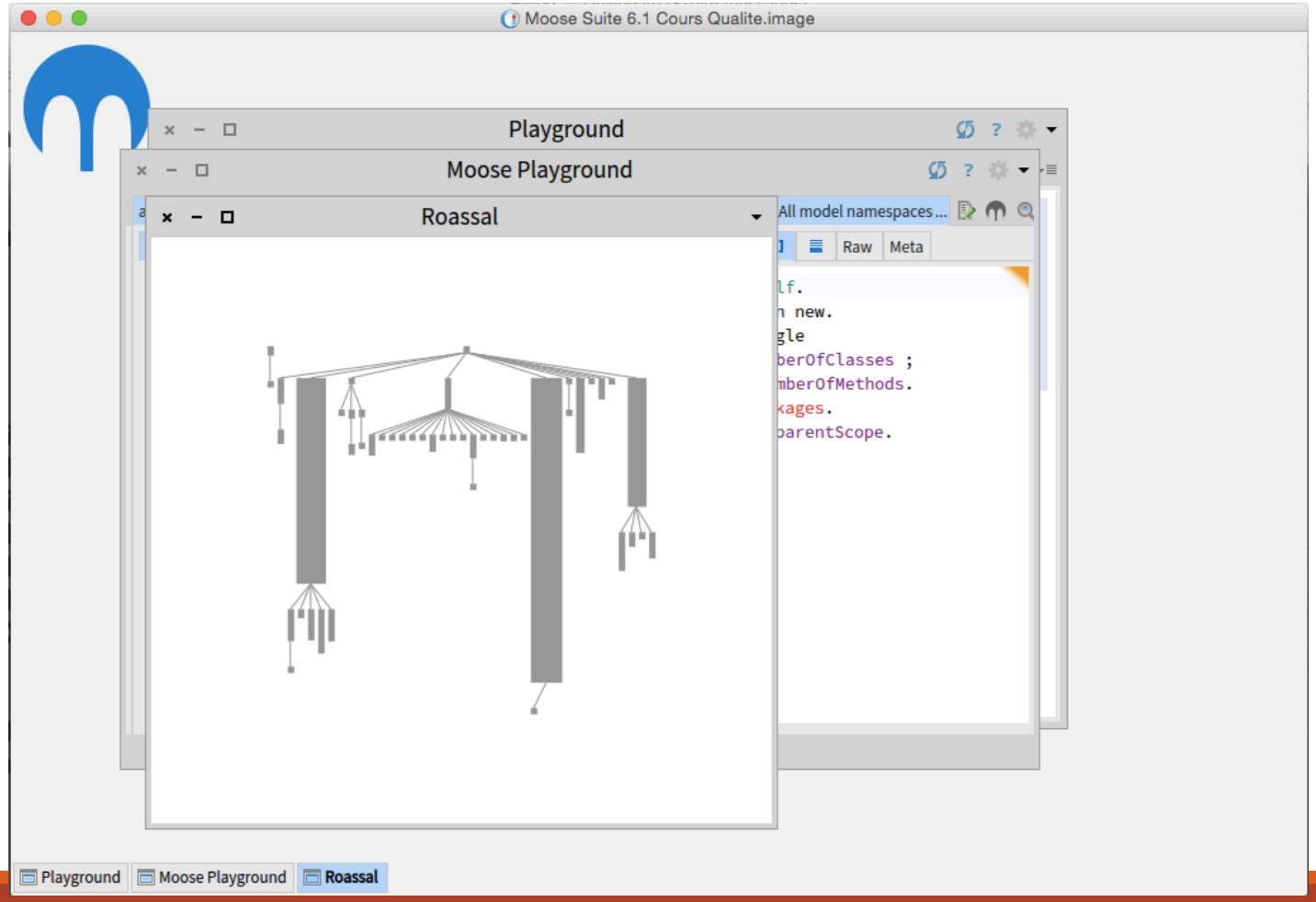

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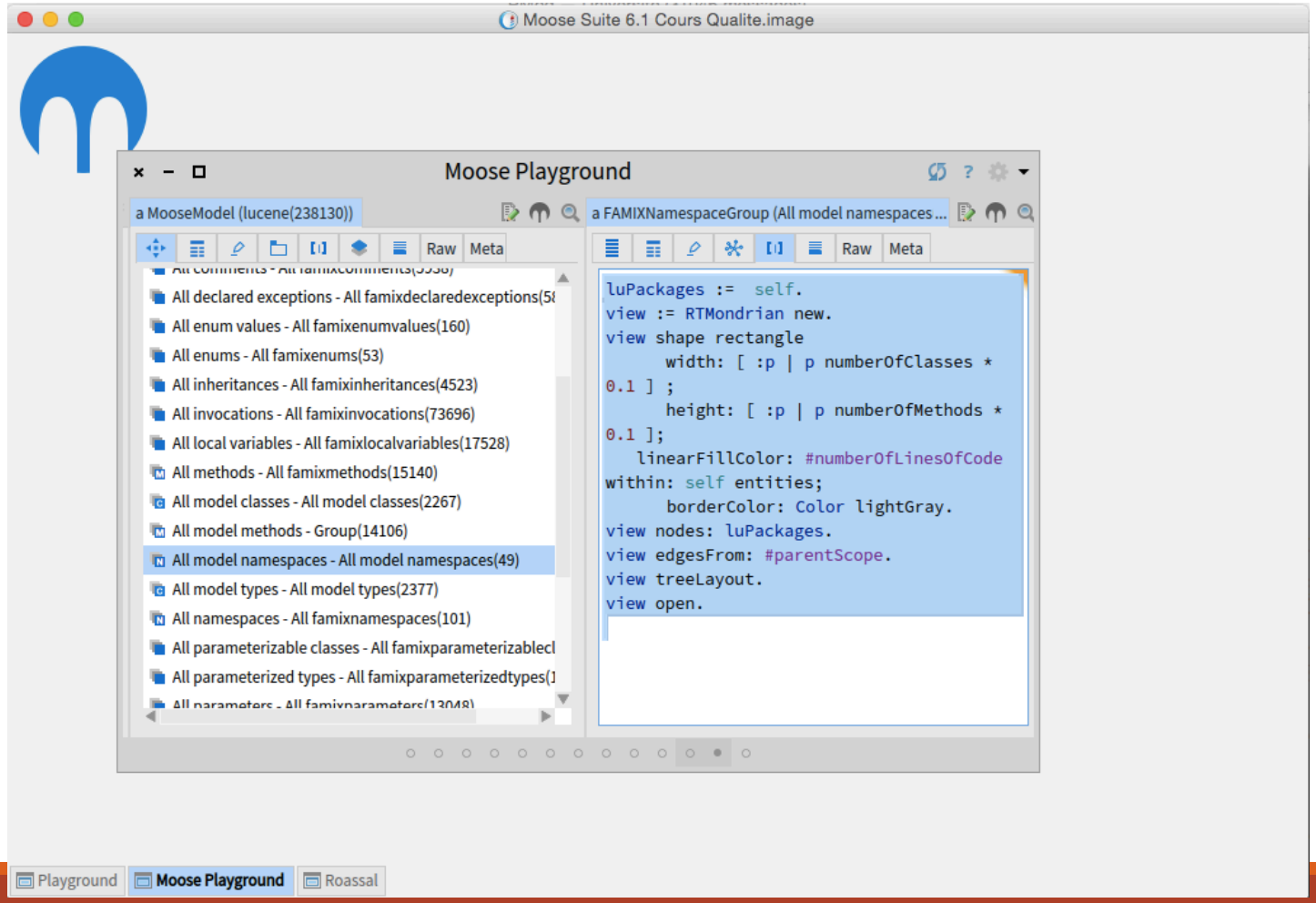

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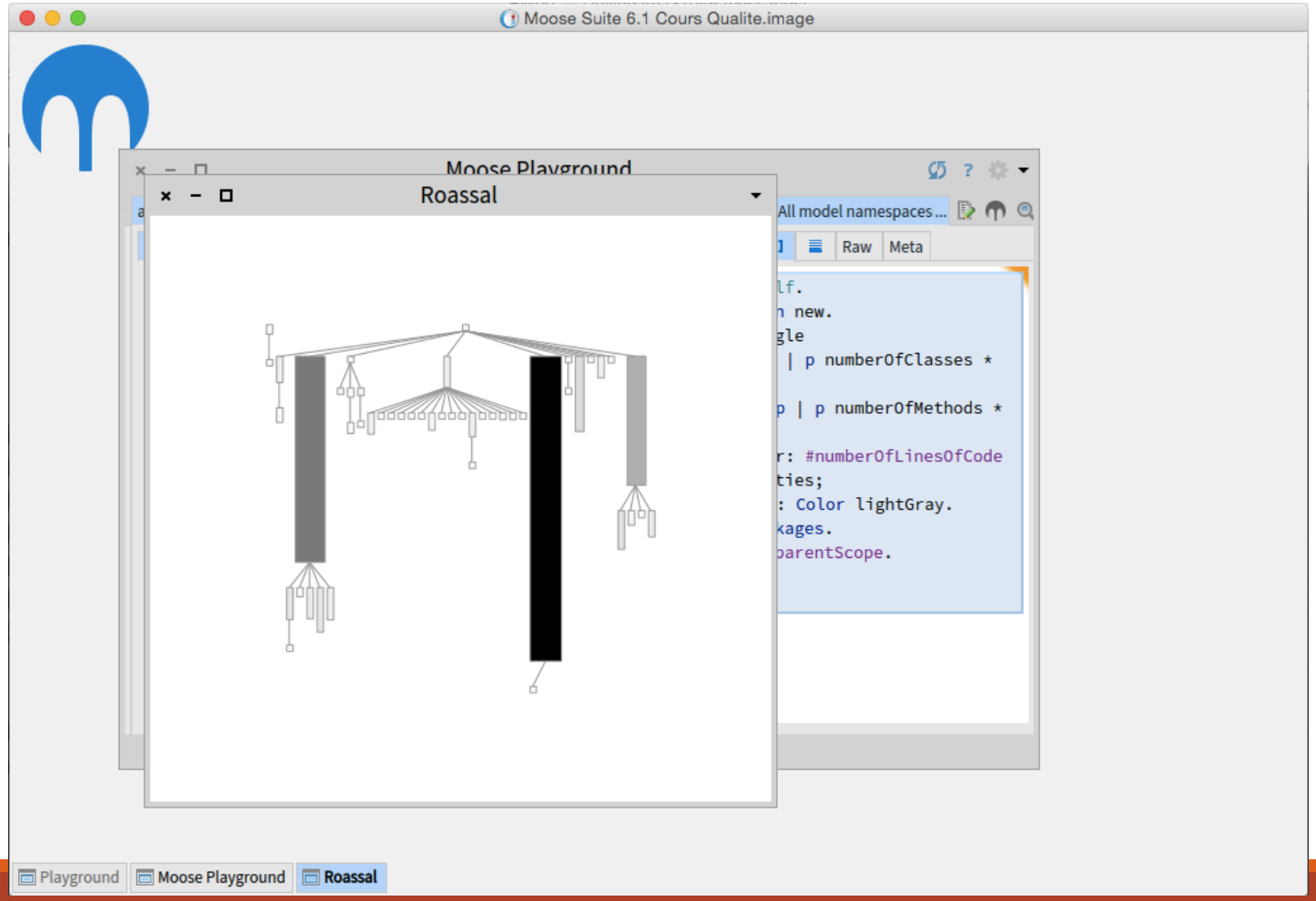


Focus on external library

- What are the used external library?

```
externalLib := self allNamespaces select:
[:n | n isStub and: [ n classes
notEmpty ] ].
```

- What is the adherence with the systems?

```
self allNamespaces select: [:n | n isStub
and: [ n classes notEmpty ] ] thenCollect:
[ :n | n queryIncomingDependencies ]
```

Focus on classes

- Within the model context:
  - `self allClasses size` **2815**
  - `self allModelClasses size` **2267**
    - classes defined in the model vs stub
- Ordered descending classes by number of methods

```
self allModelClasses asOrderedCollection sorted:
[ :a :b | a numberOfMethods > b numberOfMethods ]
```

- and to see the values:

```
(self allModelClasses asOrderedCollection sorted:
[ :a :b | a numberOfMethods > b
numberOfMethods ]) collect: #numberOfMethods.
```

Focus on classes

- Mean number of methods per class:
  - `(self allModelClasses collect: [ :c | c numberOfMethods ]) asOrderedCollection average asFloat.` **6**
- Median number of methods per class:
  - `((self allModelClasses collect: [ :t | t numberOfMethods ]) asOrderedCollection sort: [ :a :b | a <b ]) median.` **4**

Compute the fraction

Focus on classes

- Mean number of lines of code per class:
  - `(self allModelClasses collect: [ :c | c numberOfLinesOfCode ]) asOrderedCollection average asFloat.` **77.2**
- Median number of lines of code per class
  - `((self allModelClasses collect: [ :t | t numberOfLinesOfCode ]) asOrderedCollection sort: [ :a :b | a <b ]) median.` **31**

Focus on classes – more detail

- Not anonymous classes without method:
  - `(self allModelClasses select: [ :c | c isAnonymousClass not and: [ c numberOfMethods = 0 ] ] )`
    - 5 classes to analyse
- Not anonymous classes without line of code:
  - `(self allModelClasses select: [ :c | c isAnonymousClass not and: [ c numberOfLinesOfCode = 0 ] ] )`
    - 5 classes to analyse
  - The same classes? **Yes**
    - Relevance of these classes

Focus on classes - « god » classes

- Instead of putting an arbitrary value, you can play with the previous collection and see how many methods has the 10th, 50th or 100th biggest classes.

```
((self allModelClasses asOrderedCollection
   sorted: [ :a :b |
     a numberOfMethods > b numberOfMethods
  ]) collect: #numberOfMethods) at: 10
```

Focus on classes - « god » classes

- (contain more than 50 methods)

```
(self allModelClasses select: [ :each | each
numberOfMethods > 50 ]) size
```

6

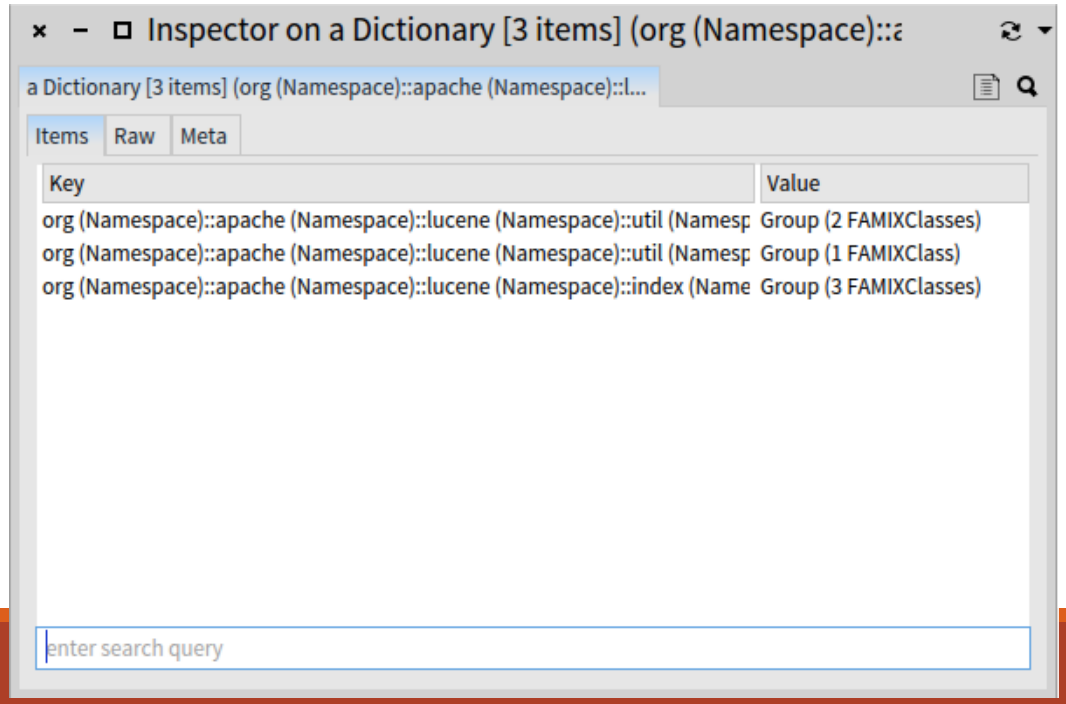
- Inspect the collection to see its elements (Ctrl + I or Ctrl + G)

```
(self allModelClasses select: [ :each | each
numberOfMethods > 50 ])
```

Focus on classes - « god » classes

- Where are the largest classes located?

```
(self allModelClasses select: [ :each | each
numberOfMethods > 50 ])
groupedBy: #belongsTo
```



Focus on classes - « god » classes

- Another definition (contain more than 500 lines of code)

```
(luClasses select: [ :each | each
numberOfLinesOfCode > 500 ]) size
```

19

Focus on classes – annotations

- What are the classes with an annotation?

```
self allModelClasses select:
[ :t | t annotationInstances notEmpty ]
```

What are these annotations?

```
((self allModelClasses select:
[ :t | t annotationInstances notEmpty ])
collect: #annotationTypes)
asOrderedCollection flattened asBag
```

Gives the number of occurrences for each different value

Focus on deprecated classes

- What are the deprecated classes?

```
deprecatedClasses := (self
allModelClasses select: [ :t | t
annotationInstances notEmpty

and: [ t annotationTypes

    anySatisfy: [ :a | a name =
            'Deprecated' ] ] ])
```

Focus on deprecated classes

- Are these deprecated classes referenced?

```
deprecatedClasses select: [ :c | c
incomingReferences notEmpty ]
```

None

- Are their methods invoked?

```
deprecatedClasses select: [:c | c
queryAllIncomingInvocations notEmpty]
```

Yes for all

Focus on methods

- Within the model context:
  - `self allMethods size` **8871**
  - `self allModelMethods size` **8263**
    - Methods defined in the model vs stub
- Ordered descending methods by number of lines of code

```
self allModelMethods asOrderedCollection
sorted: [ :a :b | a numberOfLinesOfCode > b
numberOfLinesOfCode ]
```

- and to see the values:

```
(self allModelMethods asOrderedCollection
sorted: [ :a :b | a numberOfLinesOfCode > b
numberOfLinesOfCode ]) collect:
#numberOfLinesOfCode.
```

Focus on methods – Compléxité cyclomatique

- Ordered descending methods by number of lines of code

```
self allModelMethods asOrderedCollection
sorted: [ :a :b | a cyclomaticComplexity >
b cyclomaticComplexity ].
```

- and to see the values:

```
(self allModelMethods asOrderedCollection
sorted: [ :a :b | a cyclomaticComplexity >
b cyclomaticComplexity ].) collect:
#numberOfLinesOfCode.
```

Max = 83!!!
170 methods have a cc ≥ 10

Focus on methods – annotations

- What are the methods with an annotation?

```
self allModelMethods select: [ :m | m
annotationInstances notEmpty ]
```

- What are these annotations?

```
((self allModelMethods select: [ :m | m
annotationInstances notEmpty ])collect:
#annotationTypes) asOrderedCollection
flattened asBag.
```

Focus on deprecated methods

- What are the deprecated methods?

```
deprecatedMethods := (self allModelMethods
select: [ :m | m annotationInstances
notEmpty
and: [ m annotationTypes
     anySatisfy: [ :a | a name =
              'Deprecated' ] ] ]).
```

- Are those methods invoked?

```
deprecatedMethods select: [:m | m
incomingInvocations notEmpty].
```

Yes for some

Focus on test methods

- What are the tests methods?

```
testMethods := (self allModelMethods
select: [ :m | m annotationInstances
notEmpty
and: [ m annotationTypes
     anySatisfy: [ :a | a name =
              'Test' ] ] ]).
```

86 methods to analyse

- Test methods not including assertion

```
testMethods reject: [ :m | m
invokedMethods anySatisfy: [ :n | n name
beginsWith: 'assert' ] ]
```

Focus on methods - comments

- Which methods do not get comments?

```
self allModelMethods select: [ :m | m
comments isEmpty ]
```

- Which methods without Test in its name or its class name without comment

6910 methods

```
self allModelMethods select: [ :m | (m
mooseName includesSubstring: 'Test')
not and: [m comments isEmpty ]].
```

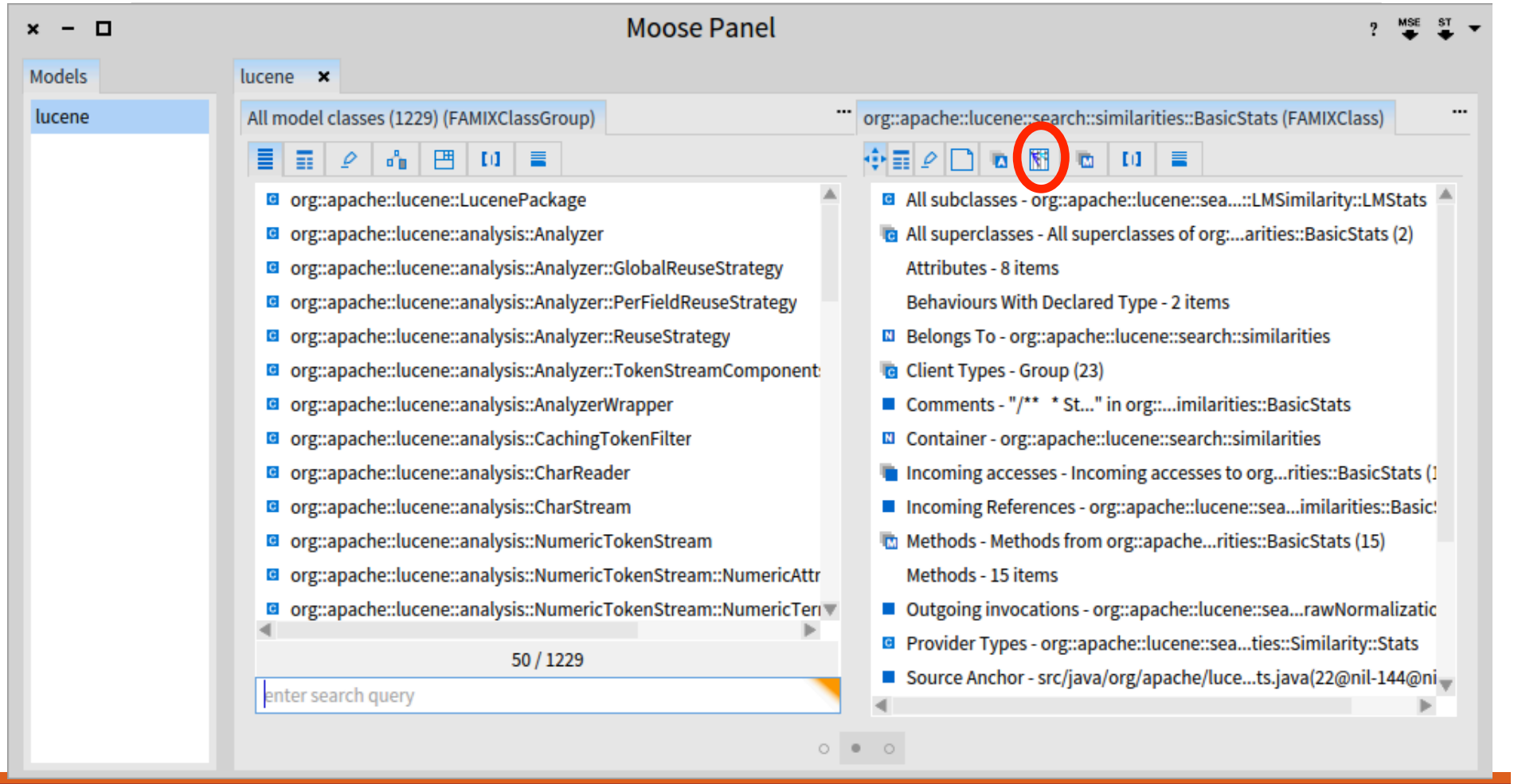
Focus on methods – main

- Identifying the `main`() method

```
self allModelMethods select: [ :m | (m
name = 'main')].
```

14 methods!!
What are the starting point?

Global view of a class



Global view of a class: Blueprint