Moose meta-modeling infrastructure

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Moose

- platform for software and data analysis
- language independent meta-modeling toolkit

A platform for the development of
exploratory environments
for any language

FAMIX

- the basic meta-model for Moose
- language independent
- needs to cover several programming paradigms
- uniforms representation of procedural and object-oriented languages

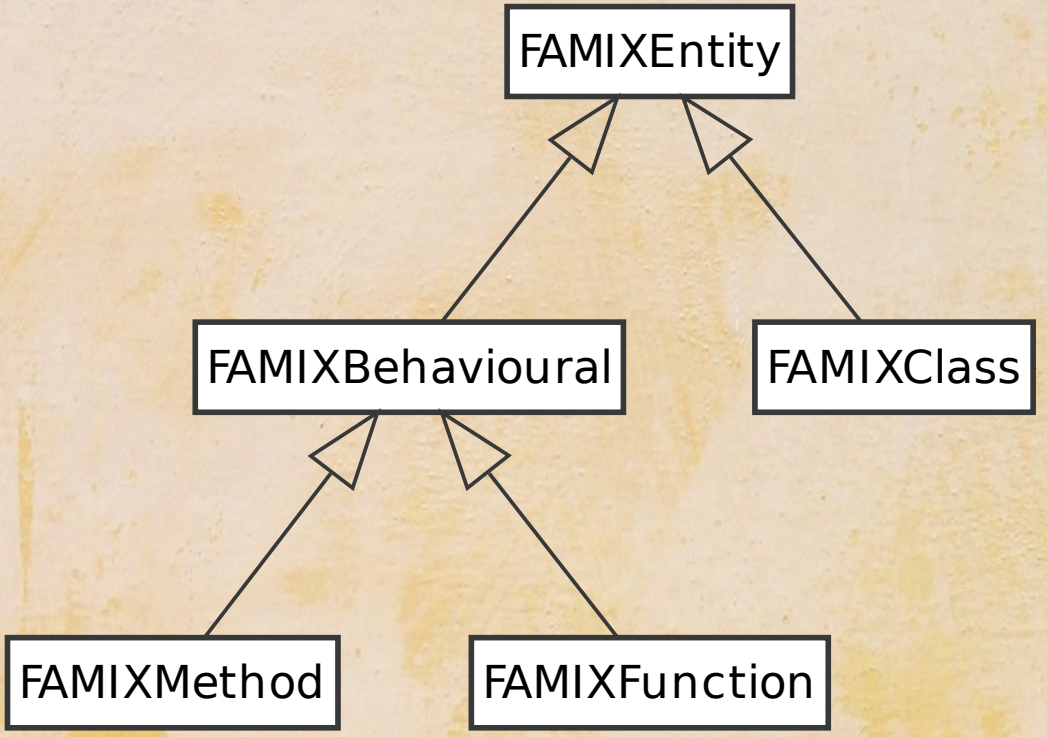
FAMIX issues

- impossible to uniform all languages
- one language implementation can have different meta-models
- SQL? DSLs? Structured data?
- AST-level meta-models?
- need of custom extensions
- multiple inheritance

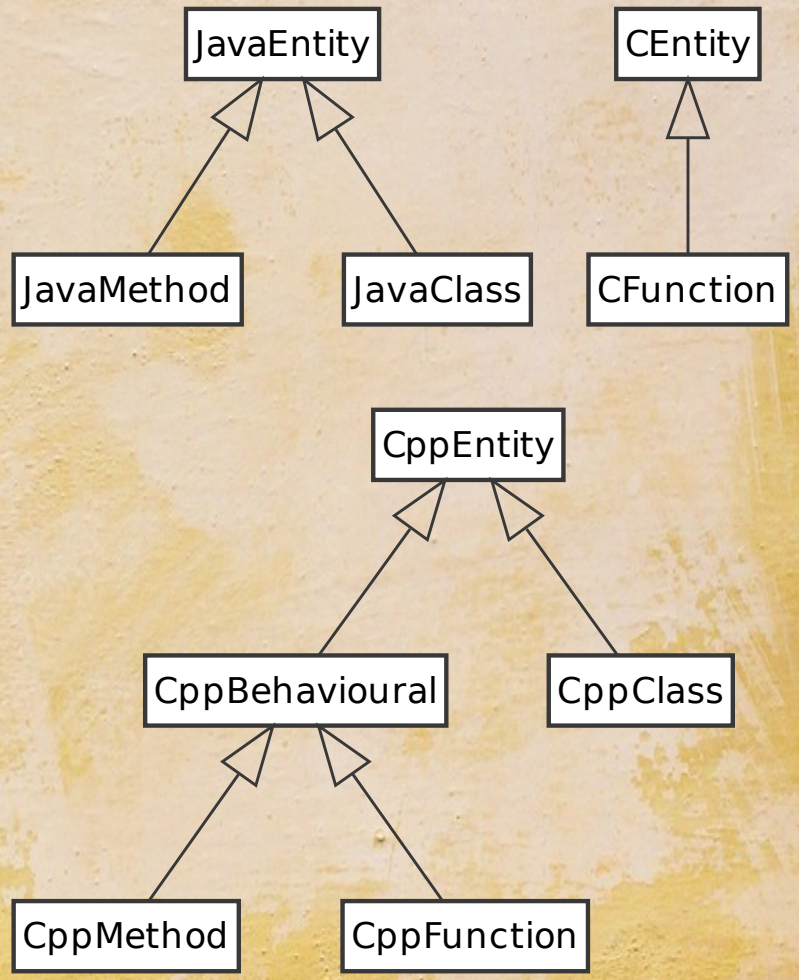
new Famix

Standalone meta-models

Old Famix:



New Famix:



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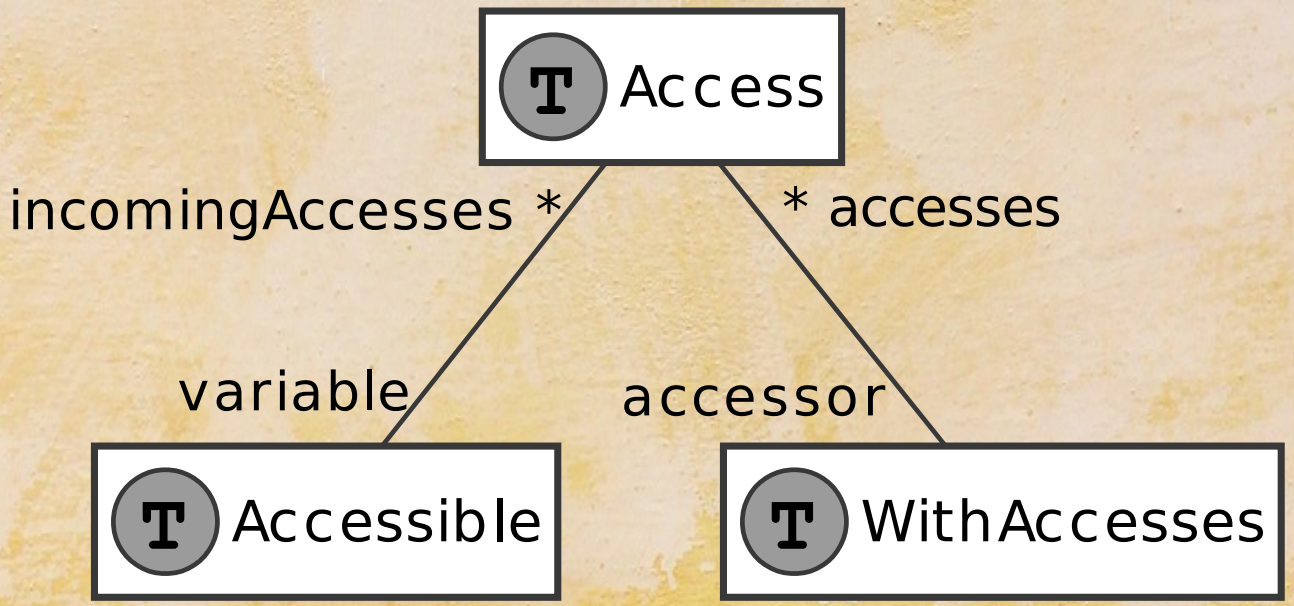
Meta-model composition

- Famix = collection of trait groups
- relations
- useful messages, metrics, tools support...



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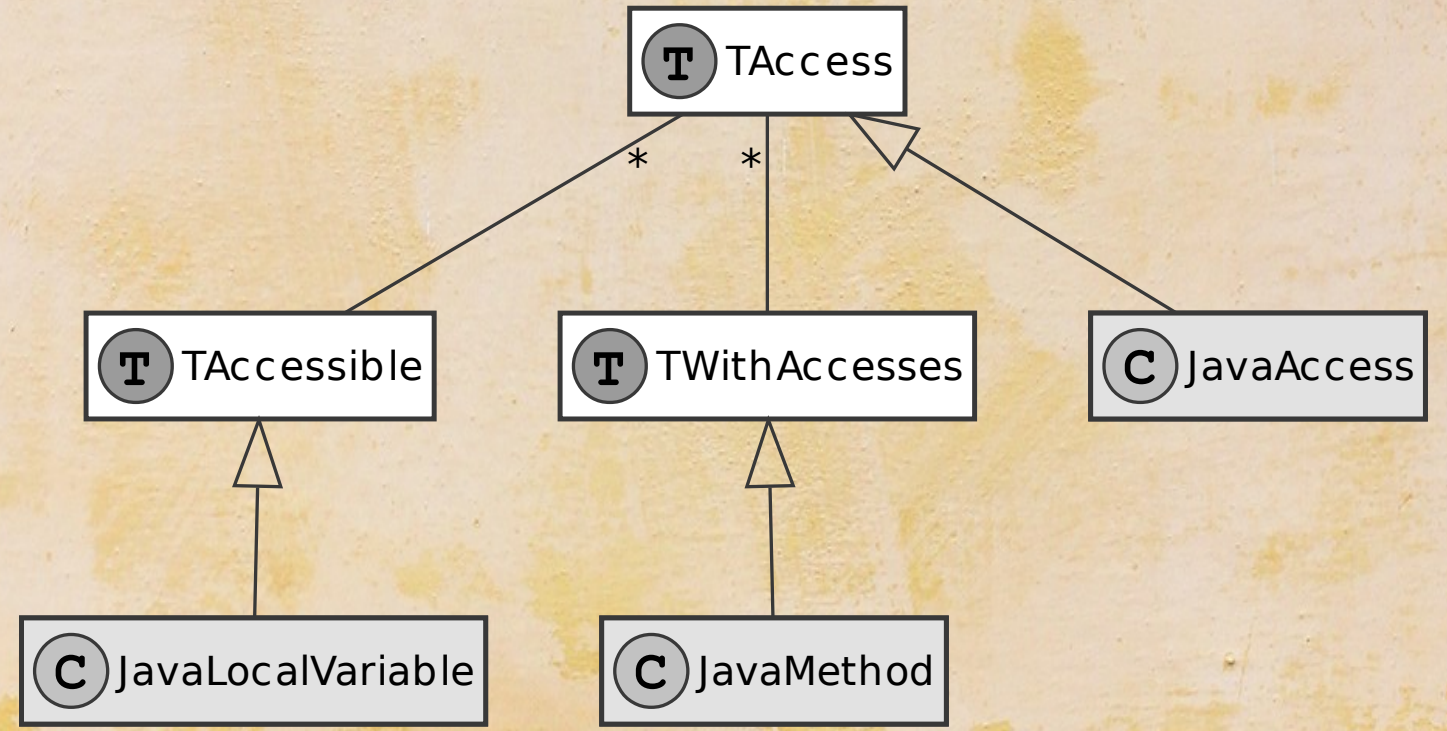
Meta-model composition

- meta-model entities use common traits



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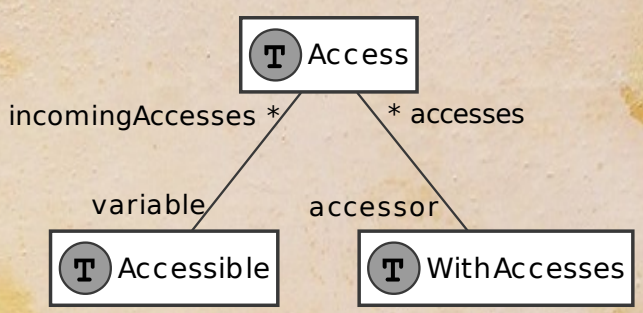
Relations

- realized using slots
- automatic relation management




```
Trait named: #TAccess
        slots: {
            #accessor => FMOne type: #TWithAccesses opposite: #accesses.
            #variable => FMOne type: #TAccessible opposite: #incomingAccesses }

Trait named: #TAccessible
        slots: {
            #incomingAccesses => FMMany type: #TAccess opposite: #variable }

Trait named: #TWithAccesses
        slots: {
            #accesses => FMMany type: #TAccess opposite: #accessor }
```

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Stateful traits

- New feature of Pharo 7
- by Pablo Tesone
- separate ESUG 2018 talk – do not miss it!
- traits can provide instance variables
- image-side enhancement, no extra VM support
- loadable library (kernel without traits support)
- realized using custom Metaclasses

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How to create meta-models?

By hand?

FAMIXSourcedEntity subclass: #FAMIXNamedEntity
uses: FamixTInvocationsReceiver + FamixTNamed + FamixTPackageable + FamixTPossibleStub + FamixTWithAnnotationInstances + FamixTWithModifiers + TDependencyQueries + TEntityMetaLevelDependency...

- complex class definitions
- need to write some manual methods
  - annotations for FAME
  - accessors
  - additional containment definitions for Moose-Query
  - testing methods...

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Meta-model builder

- Smalltalk-based DSL for meta-models description

```
behaviouralEntity := builder newClassNamed: #BehaviouralEntity.
function := builder newClassNamed: #Function.

behaviouralEntity <|-- function.
function --|> #TFunction

(namedEntity property: #name type: #String)
    comment: 'This is a comment'.
```

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Meta-model builder - relations

```
class -* method.

((tAccess property: #accessor)
    comment: 'Behavioural entity making the access to the variable';
    source)
        *-
((tWithAccesses property: #accesses)
    comment: 'Accesses to variables made by this behaviour').
```

- new Famix meta-model is described using DSL

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Meta-model generators

- Most meta-models share the same basic infrastructure
  - entity, namedEntity, sourceLanguage, association, sourced entity, comment...
- own meta-model generator as subclass of a predefined one
- FamixBasicInfrastructureGenerator
- FamixFileBasedLanguageGenerator
  - + file, fileAnchor, folder...

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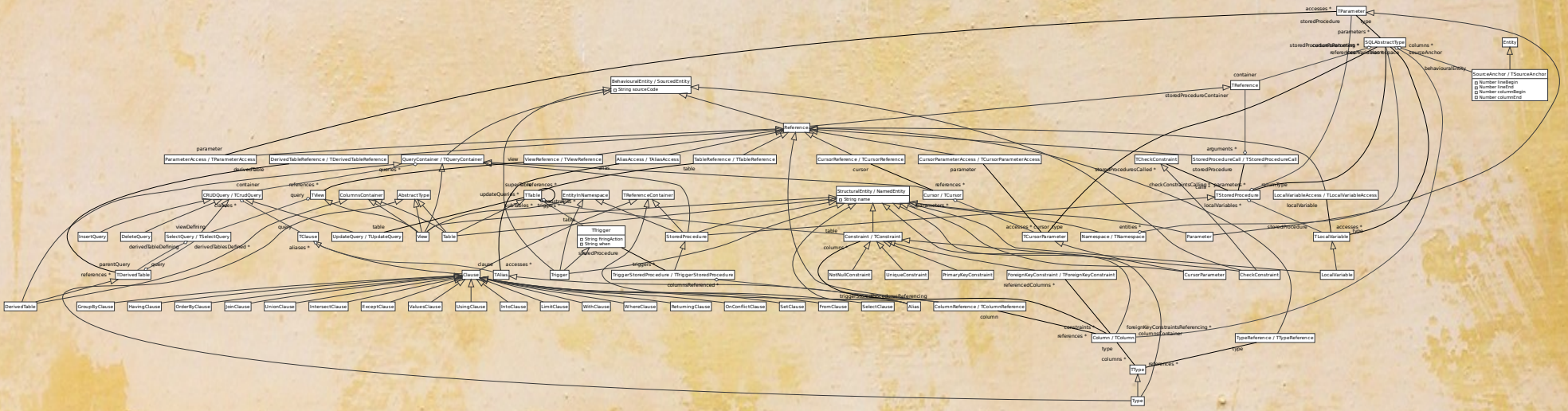
PL/pgSQL meta-model

- Julien Delplanque
- multiple inheritances

  e.g. Table: ColumnsContainer, AbstractType, StructuralEntity



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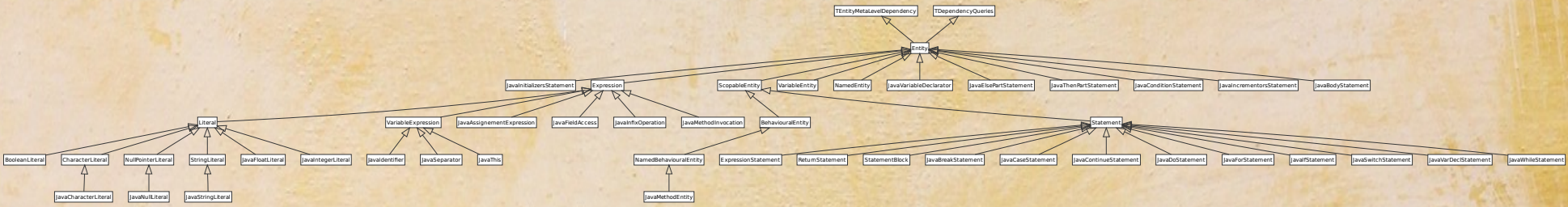
FAST

- Benoît Verhaeghe
- AST-level metamodel
- Java



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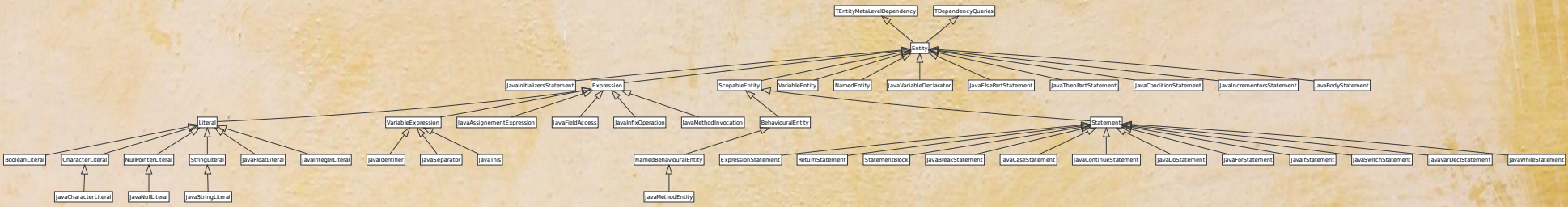

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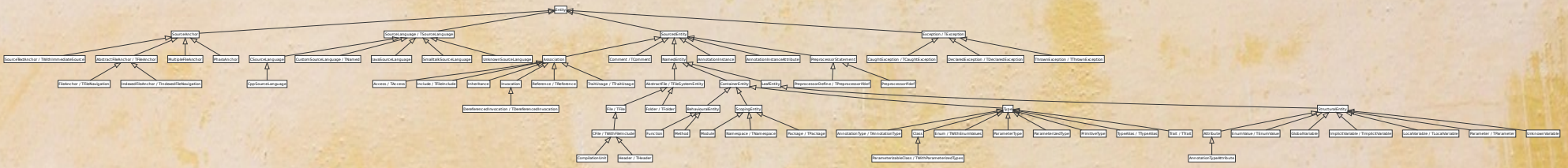
Old FAMIX compatibility metamodel



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DEMO

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Generator problem

When you generate code, how to enable manual code modifications or extensions and still be able to modify definition of the generator and support re-generation of it?

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Ring 2

- Generators to not generate code directly but create a Ring model
- this model is then applied on the image with respect to its current content
- BONUS:
  - fast and easy-to-write tests
  - browse the model with Calypso

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Generated methods

tAccess withTesting.

- automatic testing methods (e.g. #isAccess) in the root entities of the meta-model
- annotations...
- containment navigation utility methods

  belongsTo / belongsTo:

  - primary container
  - used by (Moose-Query)

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Importing contex

- cherry picking on models during import
- dependencies aware
- automatic

```
builder generateImportingContext: true.

user: context importMethod
importer: context shouldImportMethod

customization: #requires:
```

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Extensions

Problem: We want provide some utility methods or metrics that depend the meta-model structure

example:

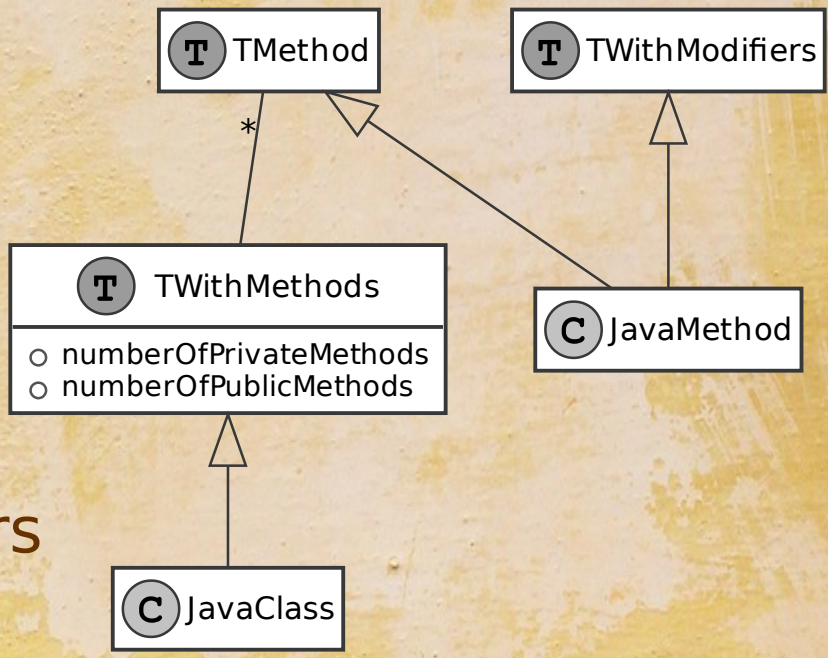
numberOfPrivateMethods

- on entity that owns methods

  TWithMethods

- methods must support modifiers

  TWithModifiers



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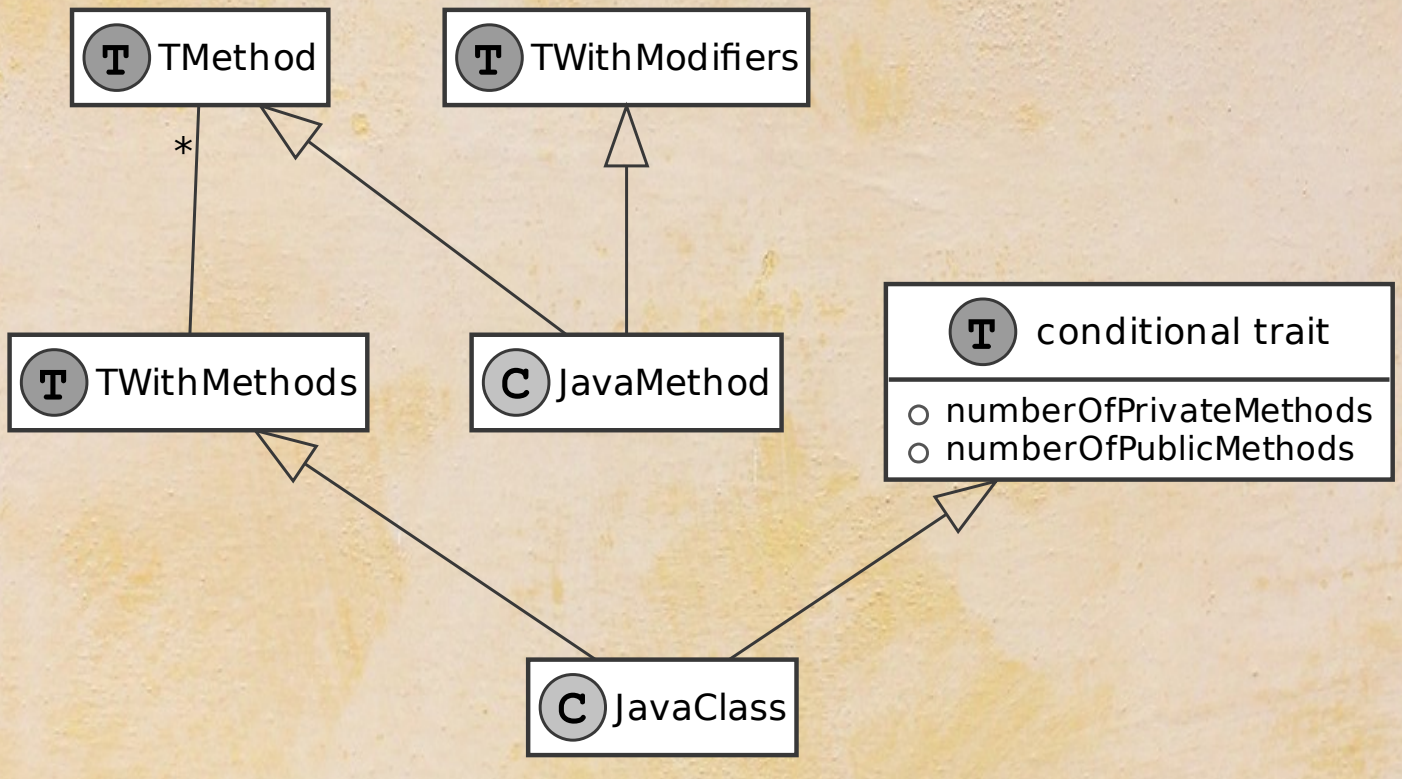
Conditional traits



- traits that are automatically used by entities that pass a condition

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Conditional traits

- **Advantage:** we can provide clean meta-models with rich functionality and tools support without making meta-model generation more complex for the user
- **Disadvantage:** more traits in the class definition, a lot of small traits

What if we want to know number of private methods for a package?

- more complex conditions (roots, common superclasses)
- Moose-Query

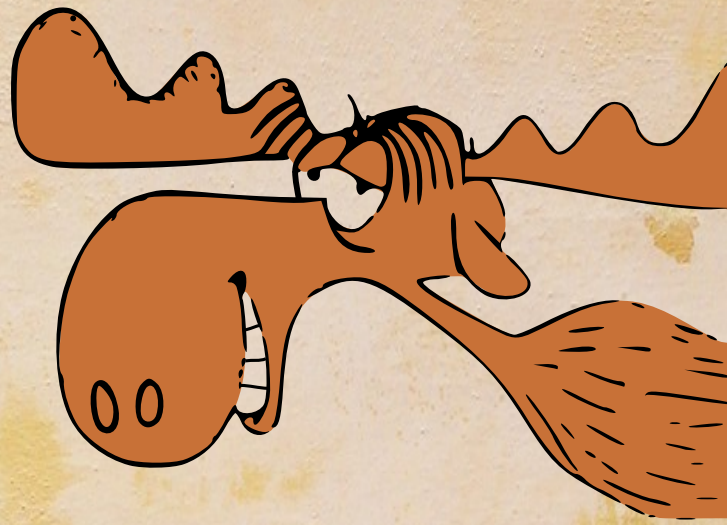
Git

- All Moose platform packages managed by Git
- Iceberg, Tonel
- Reproducible builds, CI

https://github.com/moosetechnology/Moose

https://github.com/pavel-krivanek/Moose

Summary



- Custom meta-models composition
- Groups of stateful traits
- Relations using slots
- DSL for meta-model description
- Basic language infrastructure generators
- Ring meta-model for code generation
- old FAMIX compatibility
- Importing contexts
- Conditional traits
- Git migration