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Using ATL in a tool-chain to calculate coverage data for UML class diagrams

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Presentation Structure

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1. Introduction

1.1 Background Knowledge

1.2 Related Work

1.3 Problem & Motivation

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Coverage

- A way to measure test suite adequacy.
- Code Coverage (function, branch, condition, ...).
- Model-based Testing (test case generation).
  For example: UML for modeling software.

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What's the Problem?

Input: UML class diagrams and UML object diagrams

Output: The coverage of class diagrams calculated in a form of a report.

UML-Based Coverage Criteria

- Focuses on UML diagrams (structure & behaviour).
- UML Class Diagram Coverage Criteria.
- Three coverage criteria for UML Class Diagrams
  1. Generalisation
  2. Association-end Multiplicity
  3. Class Attribute
- Originally proposed by Andrews et al.

  Test adequacy criteria for UML design models. Soft. Test. Verif. & Reliability 13 (2) (April/June 2003) 95 - 127

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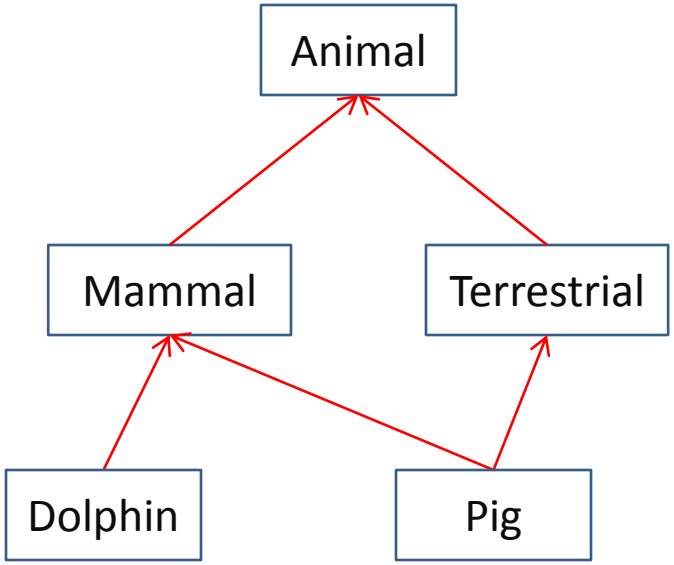
Generalisation Criteria



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Association-end Multiplicity Criteria

1. Partition the multiplicity into sets

{3}, {5} **X** {0,MAX-1,MAX}

2. Calculate Cartesian product

{3,0},{3,MAX-1}, {3,MAX}, {5,0}, {5,MAX-1}, {5, MAX}

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Class Attribute Criteria

Student.Name:String
Student.is1stYear:Bool

1. Find the representative values.
   - Student.Name = “HaoWu”
   - Student.Name =“”
   - Student.is1stYear = True
   - Student.is1stYear = False

2. Consider all the possibilities.

Name	is1stYear
Hao Wu	True
Hao Wu	False
“”	True
“”	False

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What's the Problem?

Input: UML class diagrams and UML object diagrams

Output: The coverage of class diagrams calculated in a form of a report.

Why are we so interested?

1. Check if a model is valid at metamodel level.
2. Generate test cases to cover those uncovered features in a model.

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2. Our Approach

2.1 The Implementation of Tool-Chain

2.2 A Coverage Metamodel

2.3 An Example

2.4 ATL Calculation Module

Our Tool-chain

- We choose USE [Gogolla, M., et al, Sci. Comp. Prog. 69 (1-3) (2007) 27-34] as our modelling platform.

- We define an ATL transformation from the UML class diagram to a "measurable entities" metamodel.

- We define the metrics [Mens, T. et al, Electronic Notes in Theoretical Computer Science 72 (2) (2002) 57-68] as ATL queries over this metamodel.

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Implementing Our Tool-chain

1. Modify USE in two ways:
   - Extract USE UML Metamodel and represent it in ECore format.
   - Implement a visitor that walks an object diagram
     This visitor generates the Java code that, compiled and run, instantiates our EMF metamodel.
2. Define a transformation in ATL [Jouault, F. Sci. Comp. Prog. 72 (1-2) (June 2008) 31-39].
3. Count “measurable entities”.
4. Calculate the coverage data.
5. Store the coverage data in a coverage metamodel.

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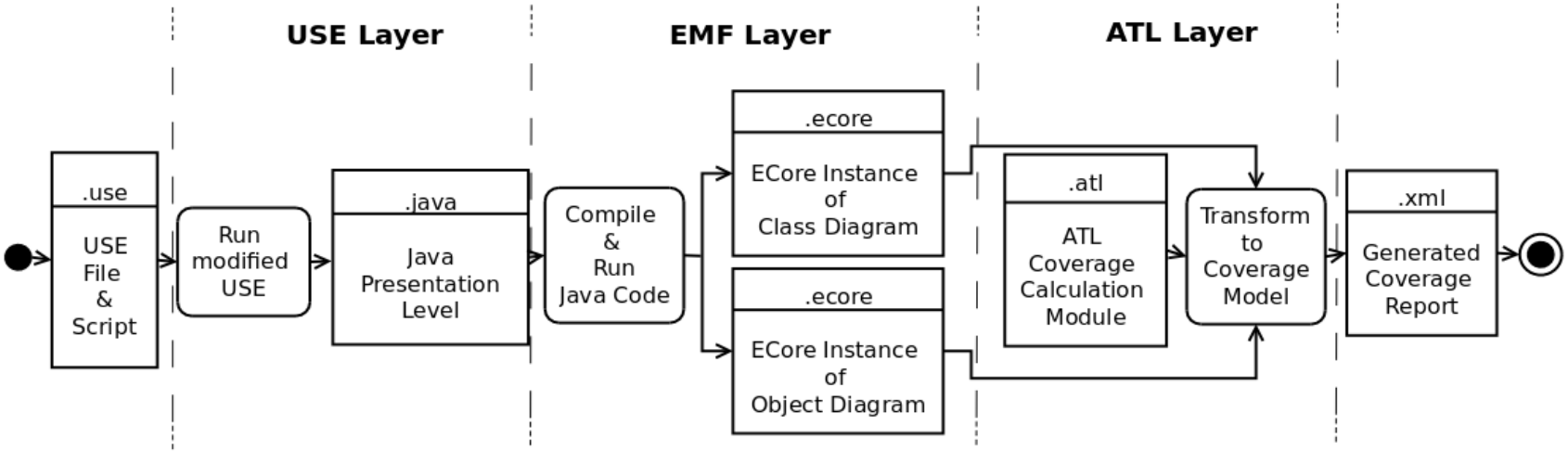
Our Tool-chain

The overall picture of combing three tools together.



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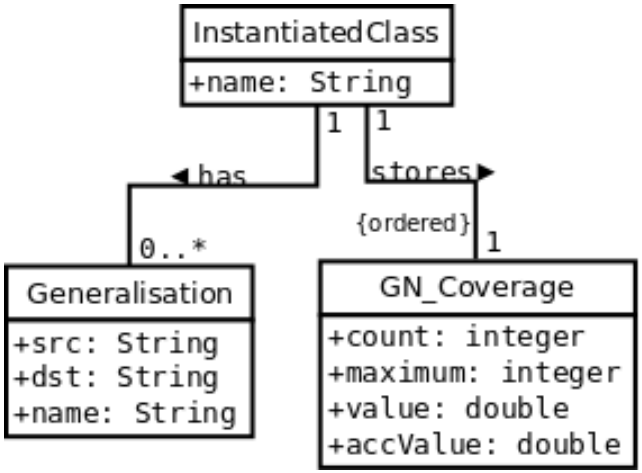
A Coverage Metamodel

- A coverage metamodel for generlisations has been designed.



- Association-end Multiplicity (AEM) and Class Attribute (CA) coverage criteria will be added to this metamodel.

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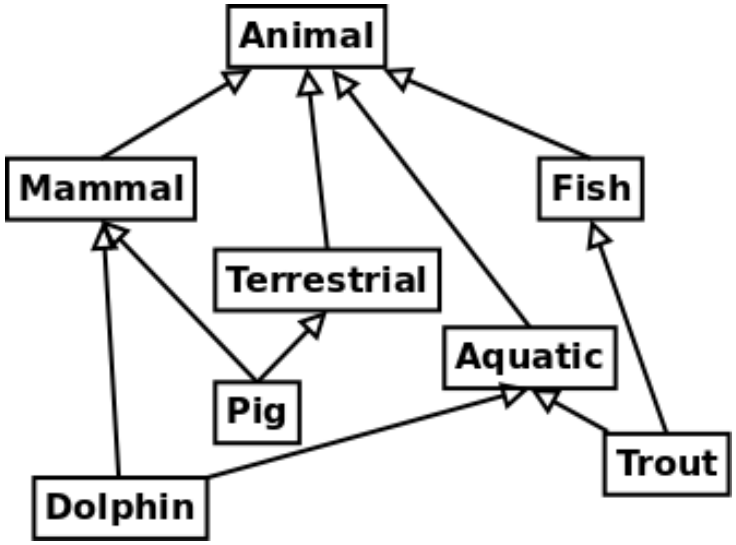
An Animal Example

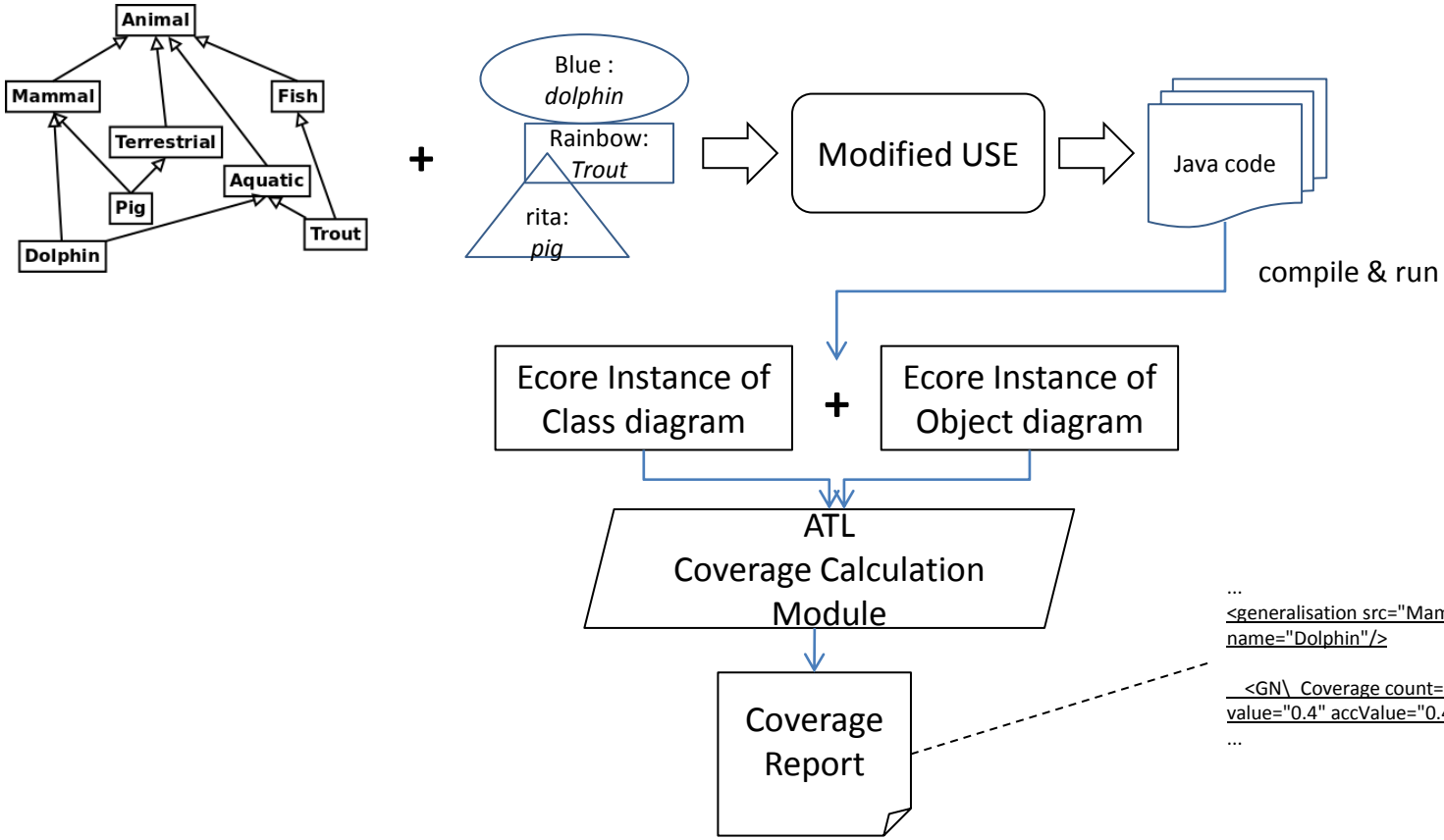


Blue : Dolphin

Rainbow : Trout

Rita : Pig

An Animal Example



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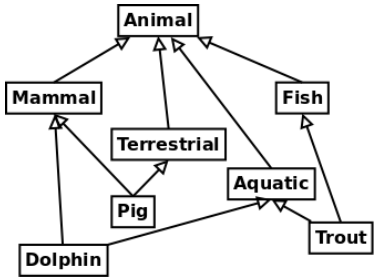
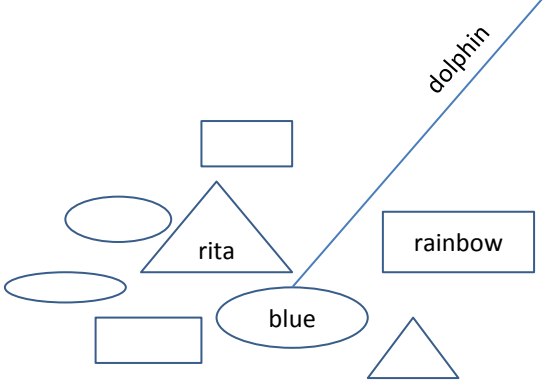
Measurable Entities



build a set of pairs

Mammal	{(Mammal, Animal)}
Terrestrial	{(Terrestrial, Animal)}
Dolphin	{(Dolphin, Mammal), (Mammal, Animal), (Dolphin, Aquatic), (Aquatic, Animal)}



See a dolphin called blue.

4 transitions have been covered!!!

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3. Conclusion

3.1 Future Directions

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Conclusion & Future Work

- This prototype demonstrates the feasibility of the approach.
- Implement the other two coverage criteria.
  1. Association-end Multiplicity (AEM)
  2. Class Attribute (CA)
- Harness Object Constraint Language (OCL) constraints.

  invariants, pre/post cond.
- Extend to the Java programming metamodel.
- Implement test case generation to cover generalisation, association, and class attribute in a model.

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Thank You!!!

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Questions ?

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