

Searching for Model Migration Strategies

James R. Williams, Richard F. Paige, Fiona A. C. Polack

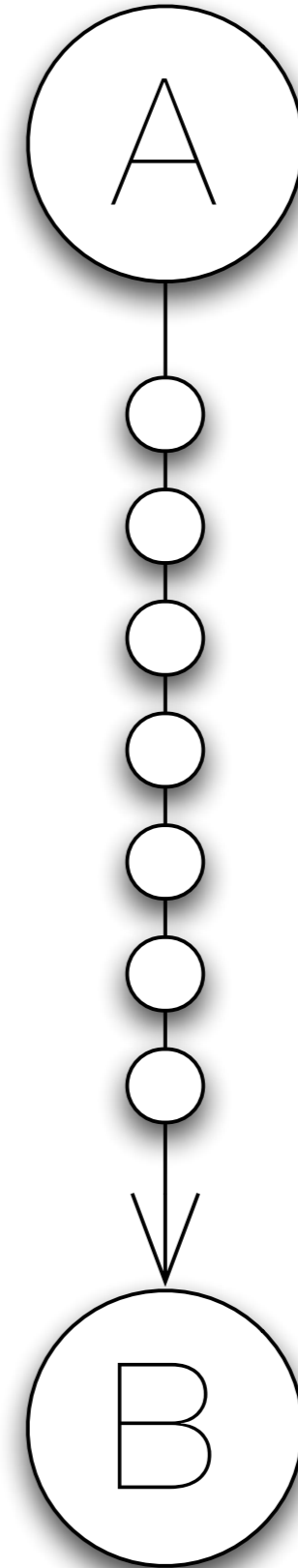
University of York

Reformulating model migration as an optimisation problem

A brief departure...

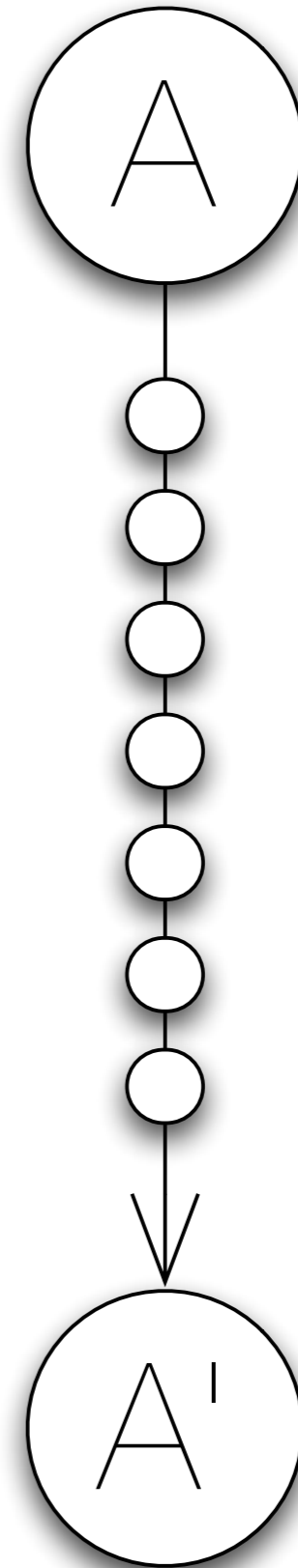
What is a Model Transformation?

A sequence of steps that turns A into B



What is Metamodel Evolution?

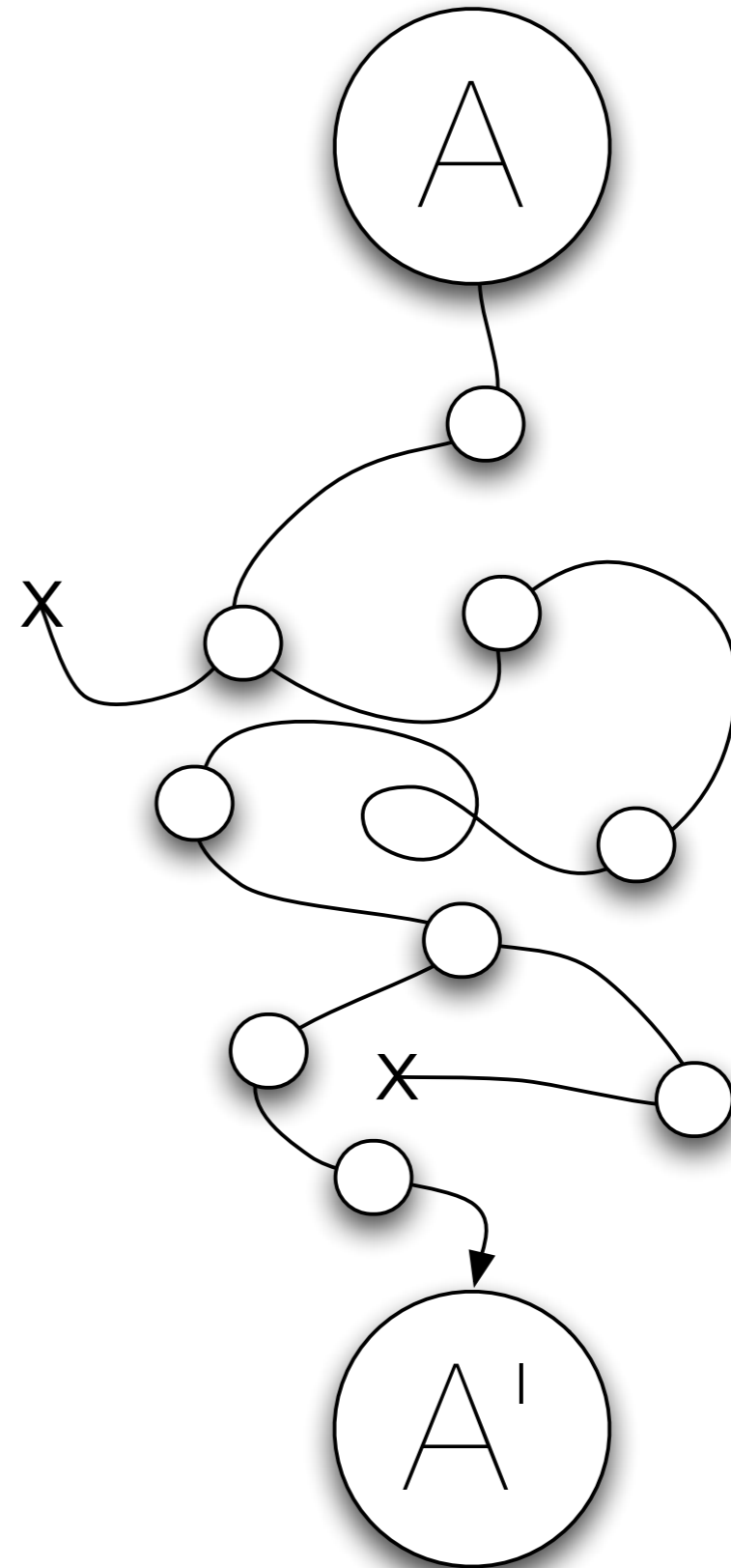
A model transformation



What is Metamodel Evolution?

In practice; organic, trial and error,
manual

Rarely written as a model
transformation



Background

Model Migration
as a Search
Problem

Searching over
Coupled
Operators

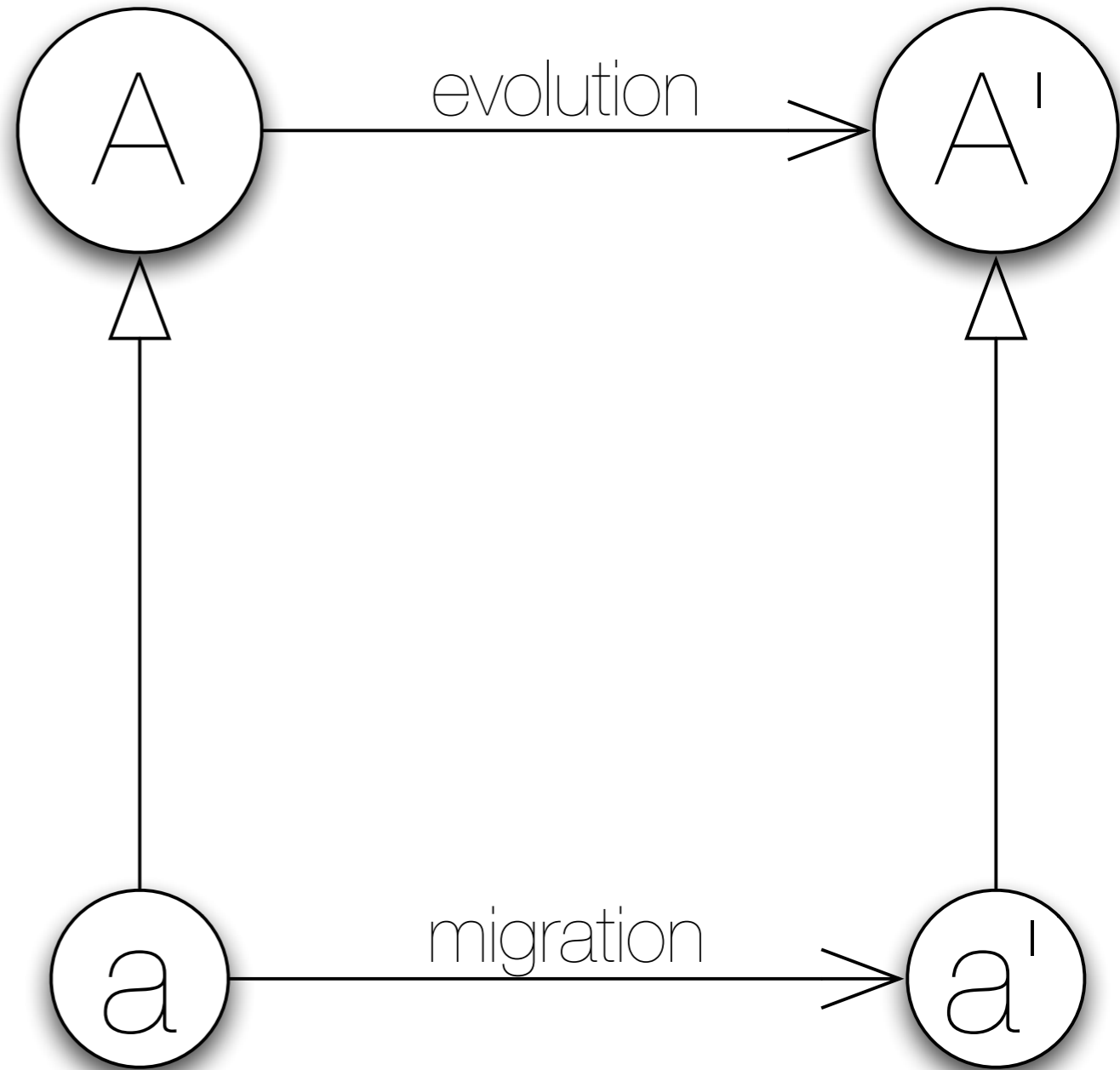
Background

Model Migration
as a Search
Problem

Searching over
Coupled Operators

Model Migration

Realigning conformance of models in response to metamodel evolution



Model Migration Approaches:

Manual

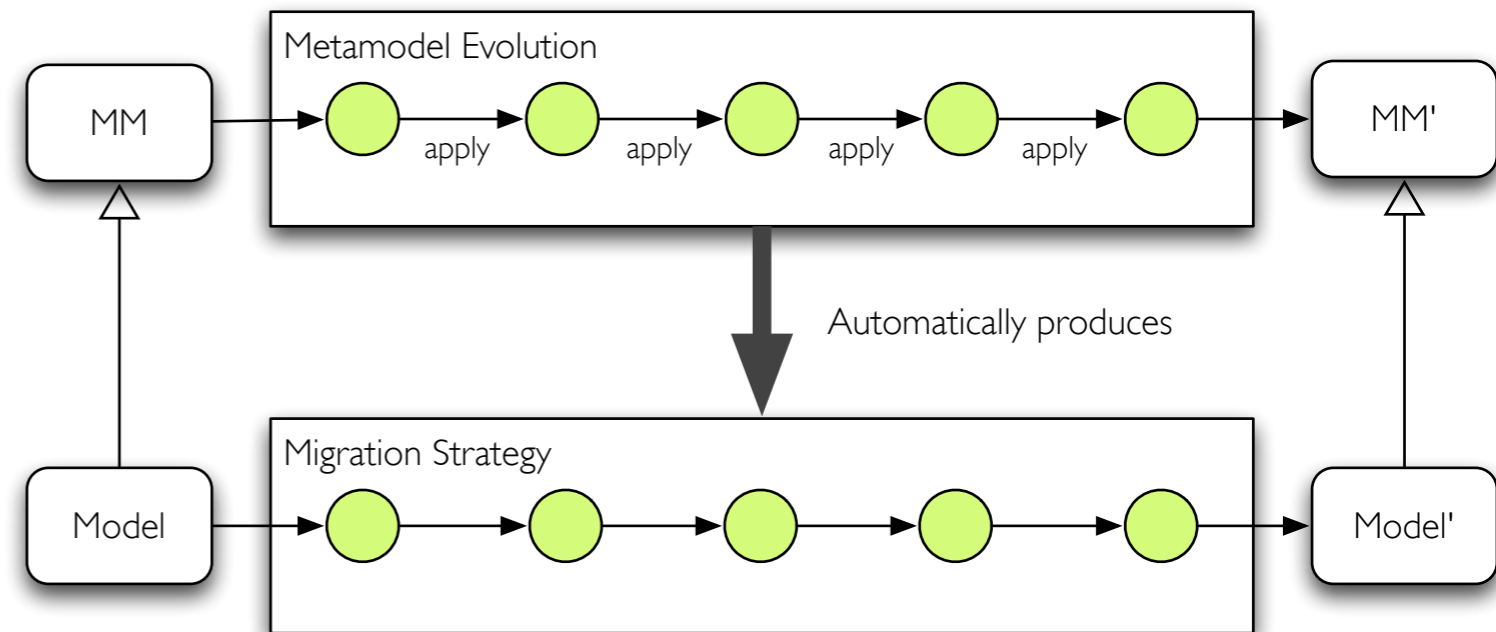
- + Fine grained control
- time consuming
- integration challenge

```
migrate Transition {  
    for (source in original.src) {  
        var arc = new Migrated!PTArc;  
        arc.src = source.equivalent();  
        arc.dst = migrated;  
        arc.net = migrated.net;  
    }  
  
    for (destination in original.dst) {  
        var arc = new Migrated!TPArc;  
        arc.src = migrated;  
        arc.dst = destination.equivalent();  
        arc.net = migrated.net;  
    }  
}
```

Model Migration Approaches:

Operator-based co-evolution

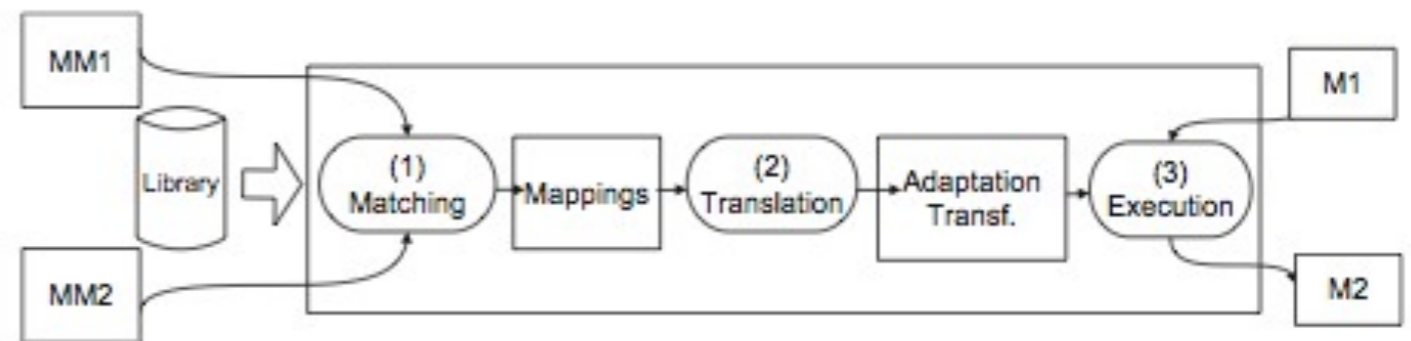
- + migration strategy is “free”
- tool lock in
- operator set completeness
- reverse engineering challenging



Model Migration Approaches:

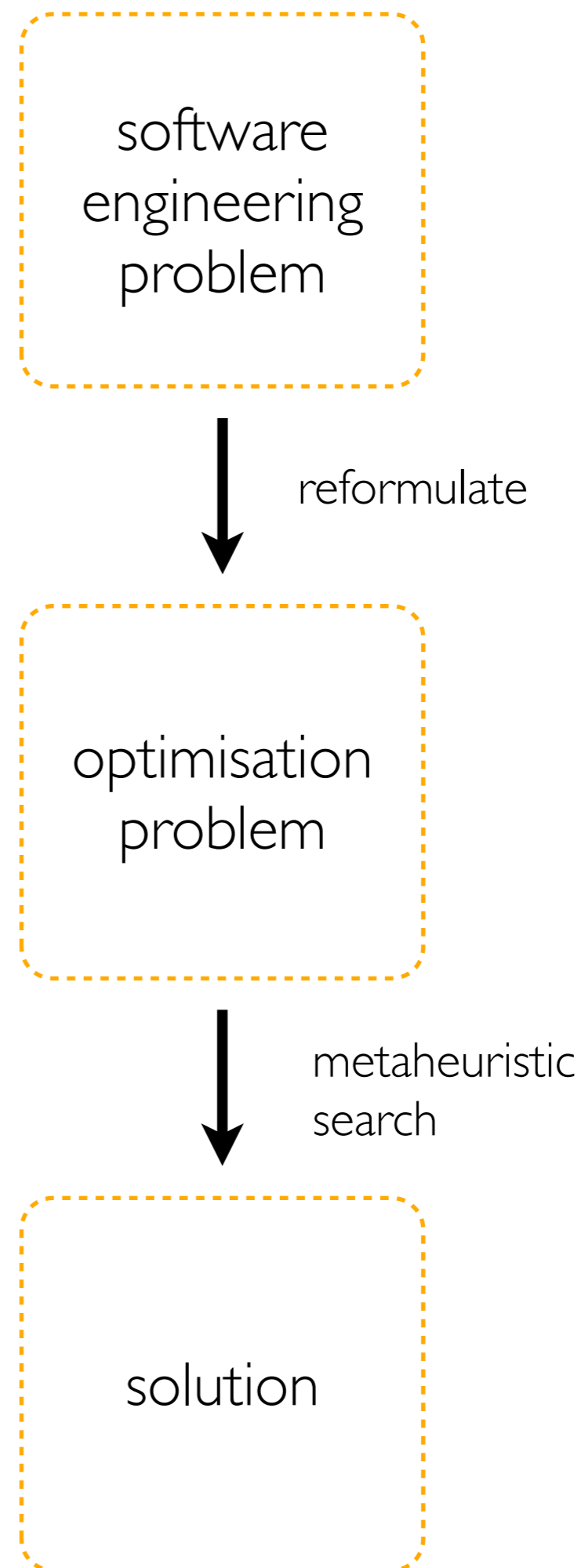
Metamodel matching

- + simple
- non-deterministic
- semantics may not be preserved



Search-Based Software Engineering

Consider an engineering task as an optimisation problem, and apply a metaheuristic search algorithm to solve it



Reformulating SE Problems

Three things to consider

solution
representation

+

search
operators

+

objective
function

Background

Model Migration
as a Search
Problem

Searching over
Coupled
Operators

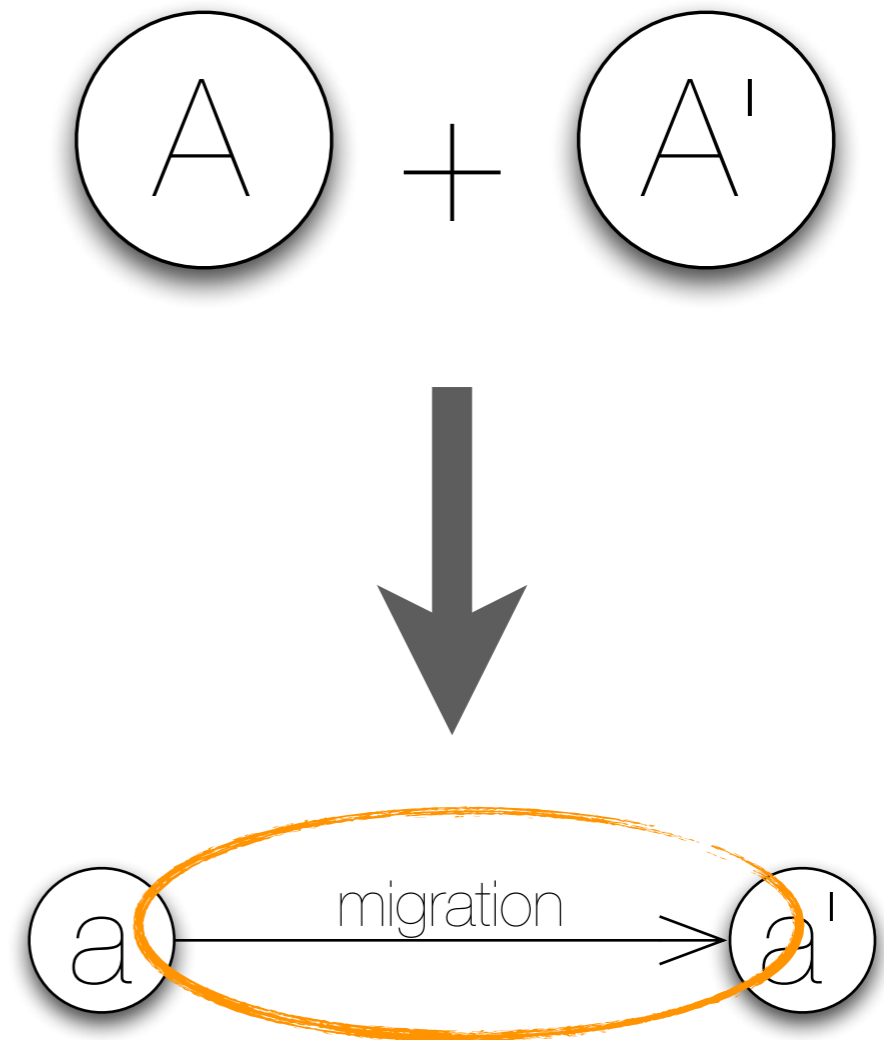
Background

Model Migration as a Search Problem

Searching over
Coupled Operators

Searching for Migration Strategies

When?



Manual

Genetic programming

```
migrate Transition {  
    for (source in original.src) {  
        var arc = new Migrated!PTArc;  
        arc.src = source.equivalent();  
        arc.dst = migrated;  
        arc.net = migrated.net;  
    }  
  
    for (destination in original.dst) {  
        var arc = new Migrated!TPArc;  
        arc.src = migrated;  
        arc.dst = destination.equivalent();  
        arc.net = migrated.net;  
    }  
}
```

Operator-Based Co-Evolution

See later...

Metamodel Matching

Combination of heuristics (*matching strategy*) is problem specific

Search for the matching strategy

Fitness function is a big challenge

Background

Model Migration
as a Search
Problem

Searching over
Coupled
Operators

Background

Model Migration
as a Search
Problem

Searching over Coupled Operators

Proposed Solution

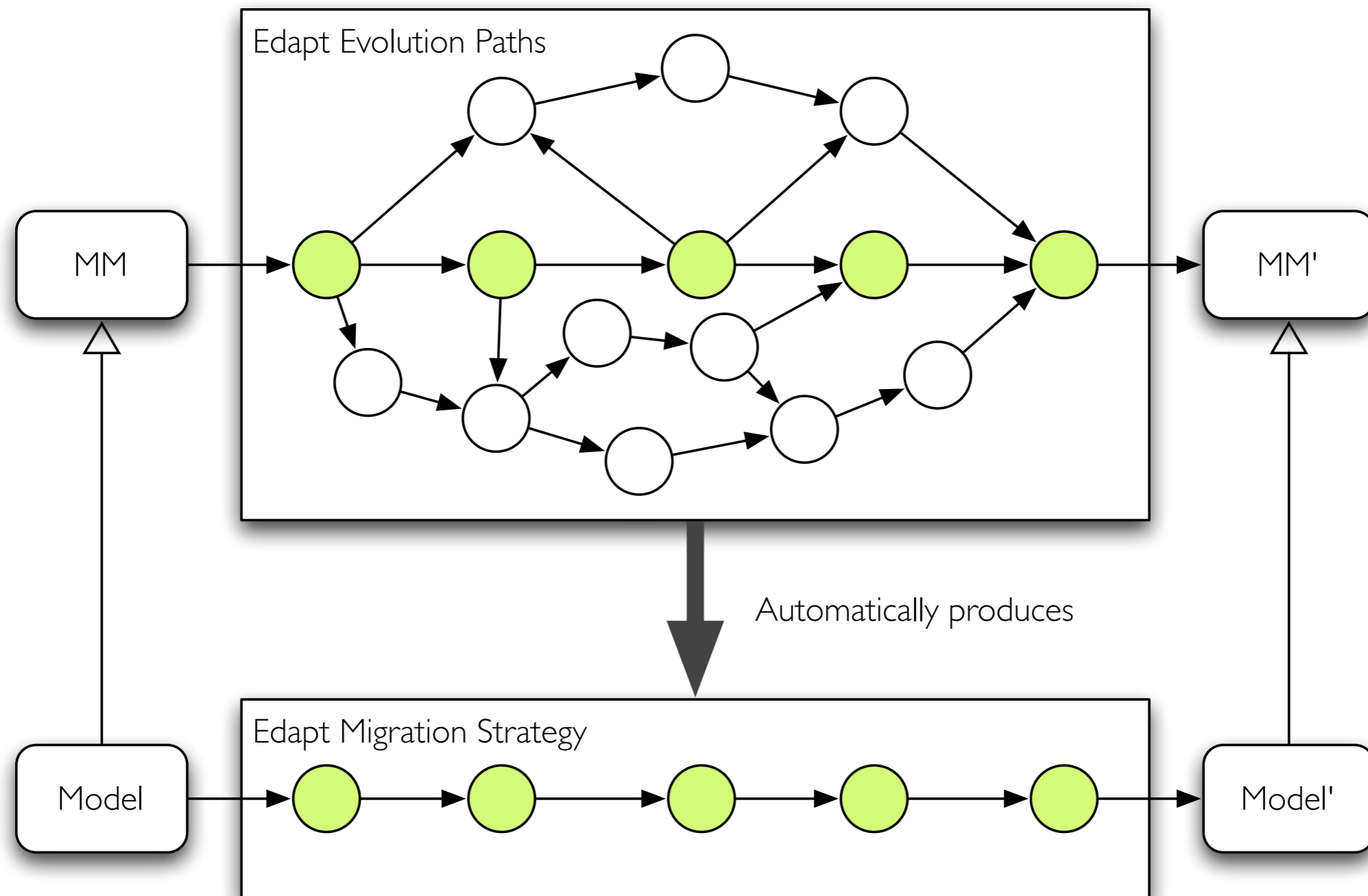
Edapt

Operator-Based Co-evolution Tool

CREPE

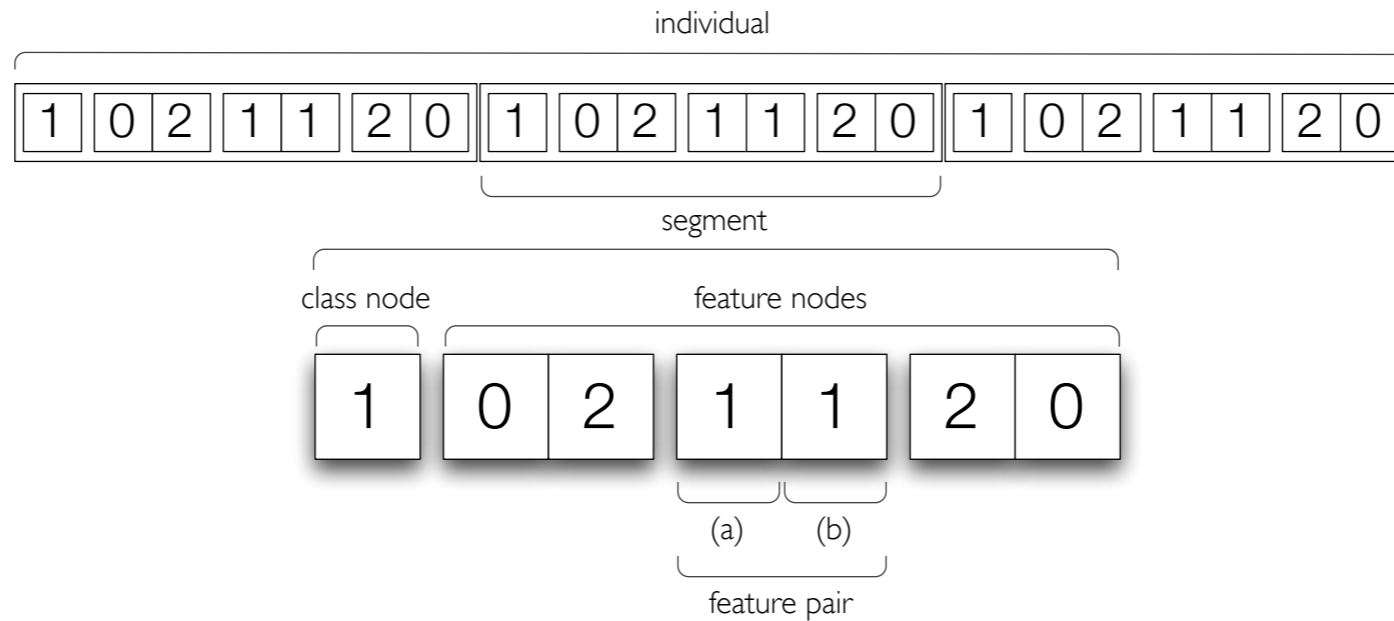
Model Search Tool

Edapt



Edapt : history model

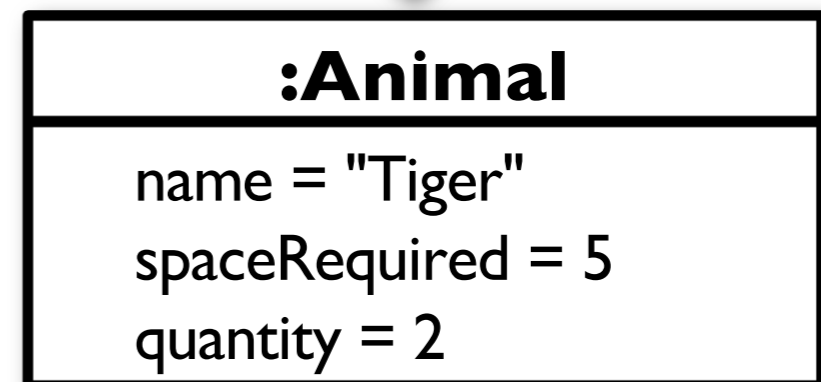
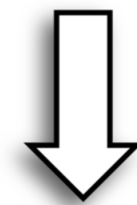
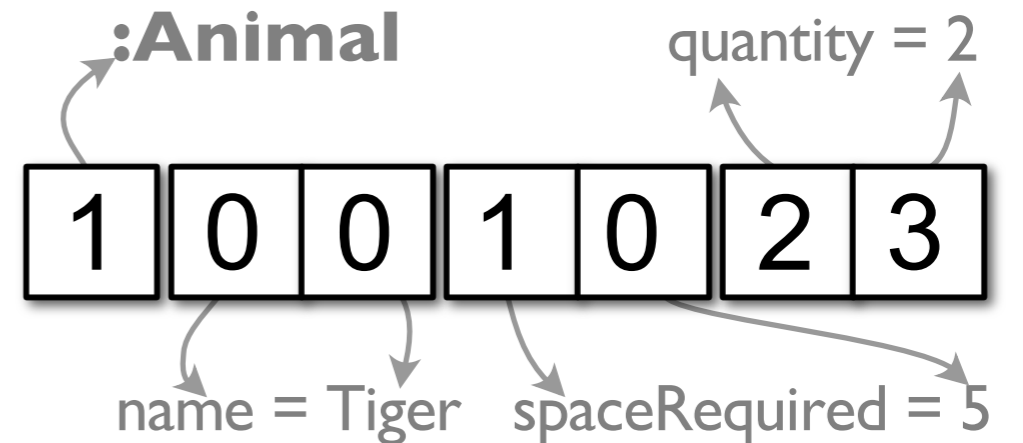


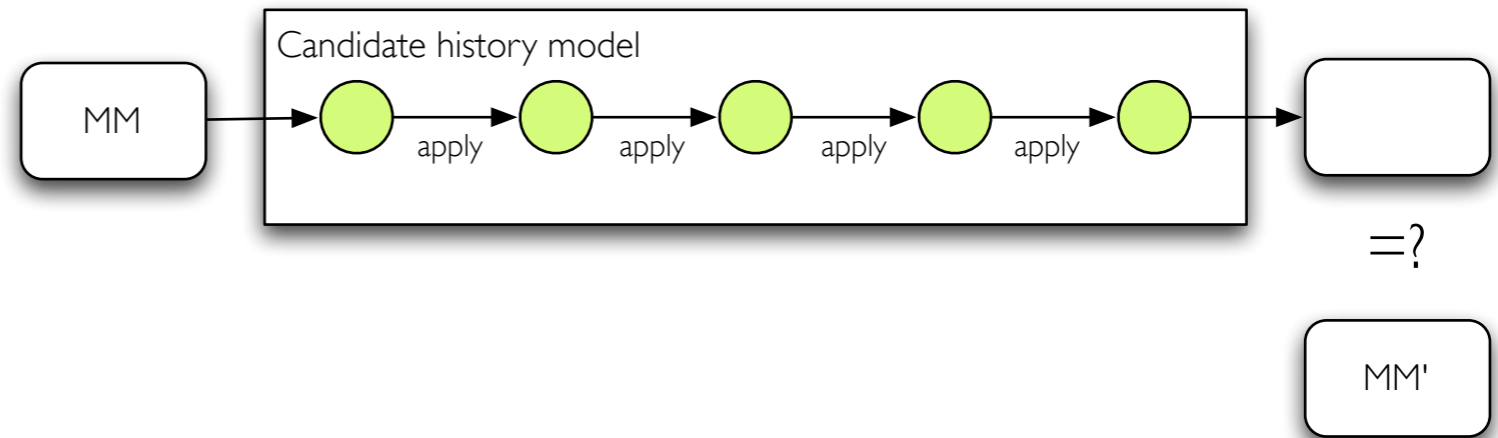


CREPE

Models represented as a structured string of integers

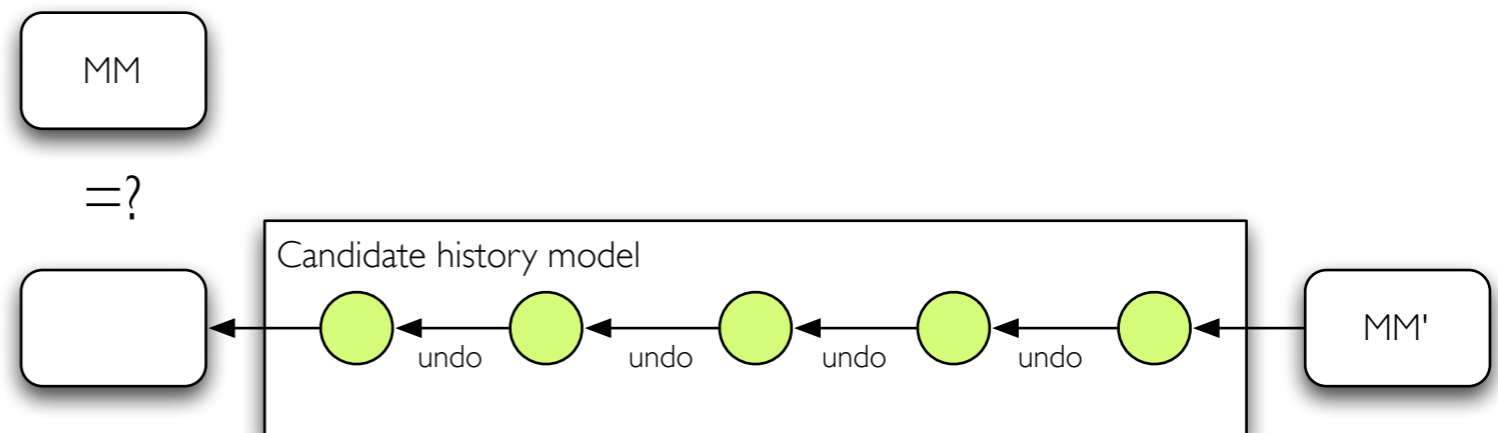
Two-way transformation between integer string and model wrt a given metamodel





Fitness Evaluation

How do we evaluate candidate history models?



Fitness Evaluation

How do we evaluate candidate history models?



=?



MM'

Syntax is (possibly) not the top priority.

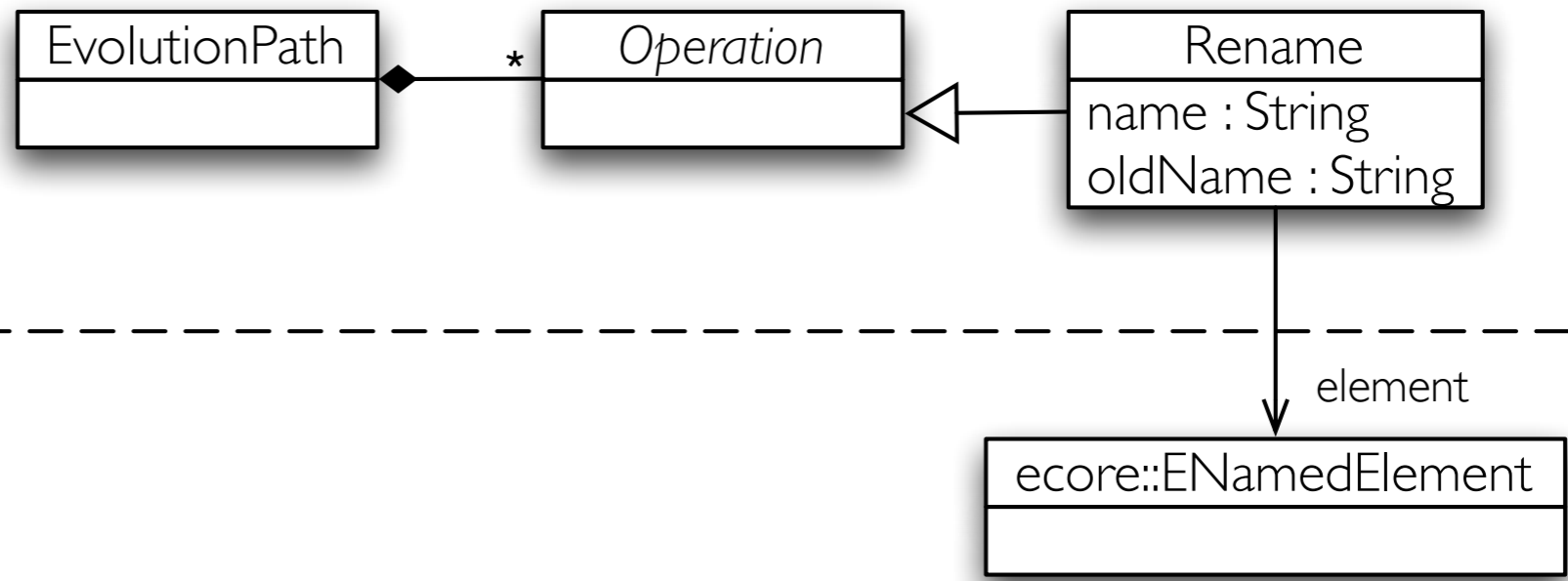
Semantics is (possibly).

BUT...

Edapt history model is very complicated

Tiny needle in a giant haystack

```
<changes xsi:type="history:OperationChange">
  <changes xsi:type="history:Create" target="petri
    element="petrinet.ecore#//PTArc">
    <changes xsi:type="history:Set" element="petri
      dataValue="PTArc"/>
  </changes>
  <changes xsi:type="history:Set" element="petrinet
    oldReferenceValue="petrinet.ecore#//Place/ou
  ...
  <changes xsi:type="history:Create" target="petri
    element="petrinet.ecore#//PTArc/dst">...</ch
  <changes xsi:type="history:Set" element="petrinet
    referenceValue="petrinet.ecore#//PTArc/dst"/
  <operation name="introduceReferenceClass">
    <parameters name="reference">
      <referenceValue element="petrinet.ecore#//P
    </parameters>
    <parameters name="className">
      <dataValue>PTArc</dataValue>
    </parameters>
    <parameters name="sourceReferenceName">
      <dataValue>src</dataValue>
    </parameters>
    <parameters name="targetReferenceName">
      <dataValue>dst</dataValue>
    </parameters>
  </operation>
</changes>
```



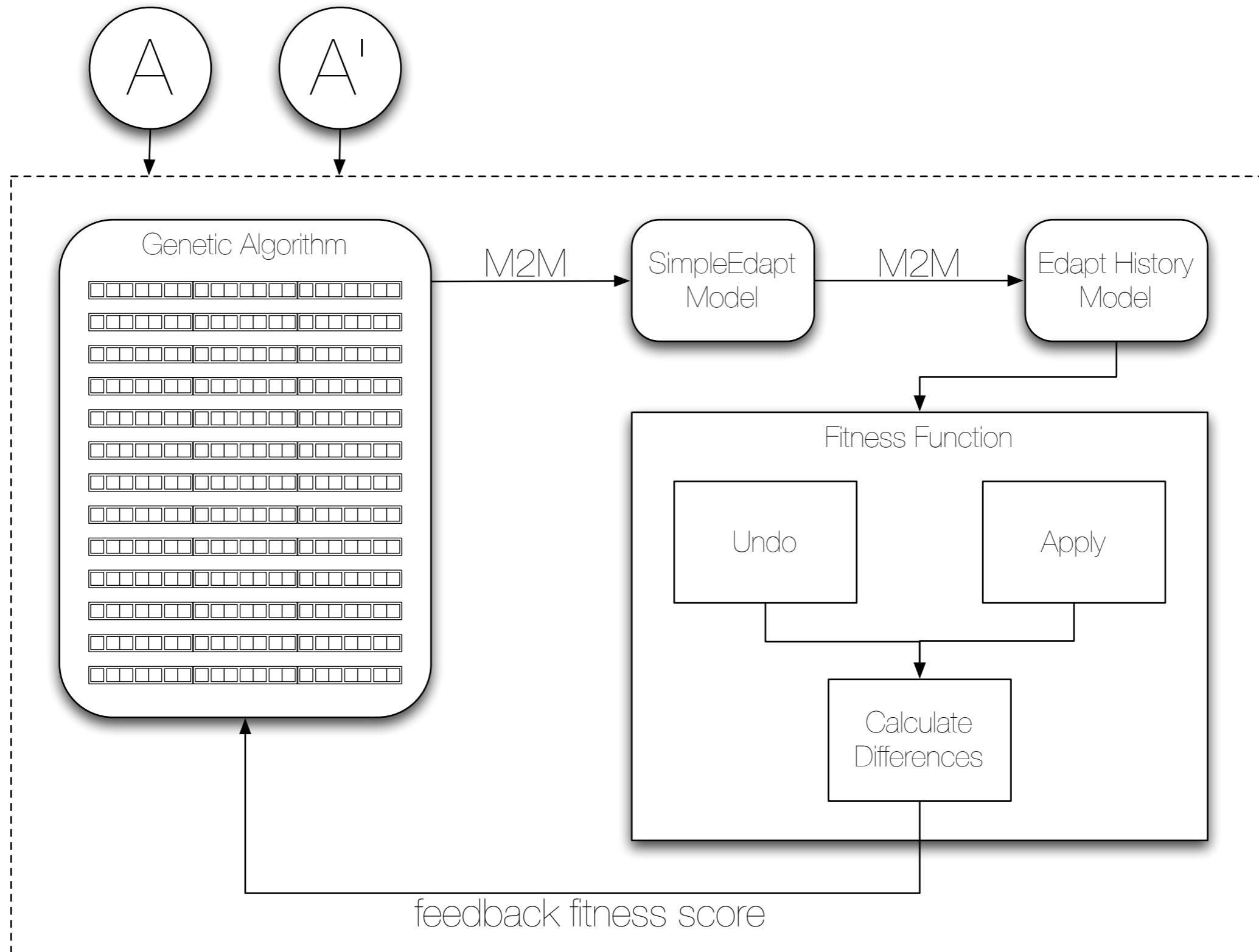
Simplify

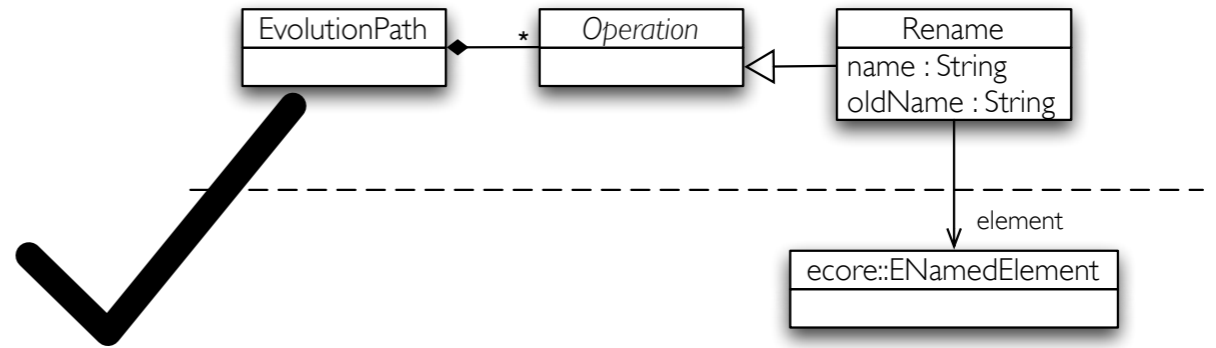
Evolve a simpler model

M2M to create the history model

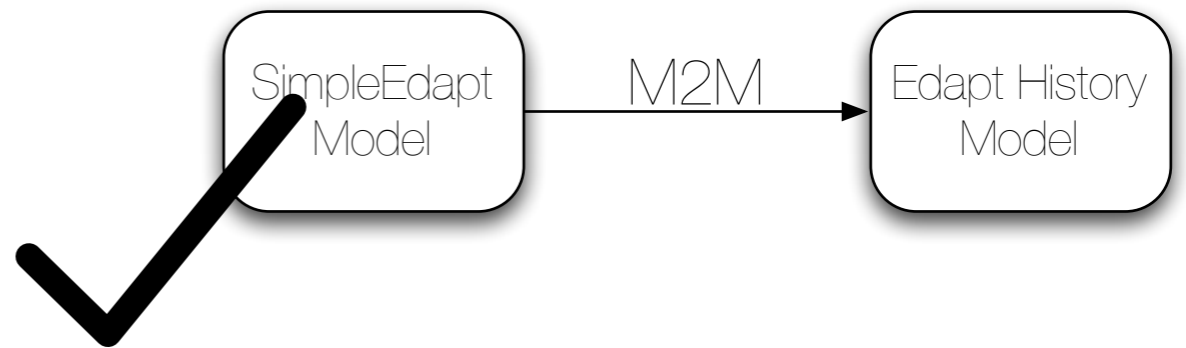


Process





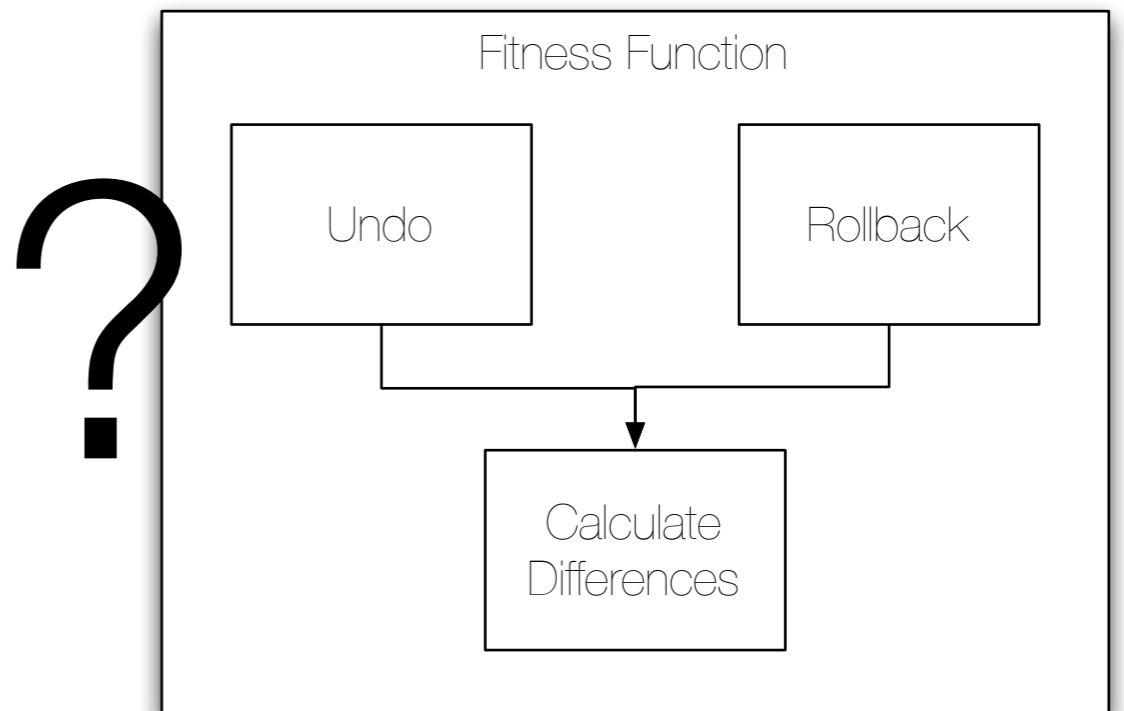
Current Progress



SimpleEdapt metamodel created

Transformations for a small number of Edapt operators

Fitness function challenging



Background

Model Migration
as a Search
Problem

Searching over
Coupled
Operators

Conclusion

Searching for Model Migration Strategies

SBSE techniques can help model migration

Operator-based co-evolution offers an interesting platform to search over

Fitness function very challenging

Thank you