A MetaChecker for pyGK

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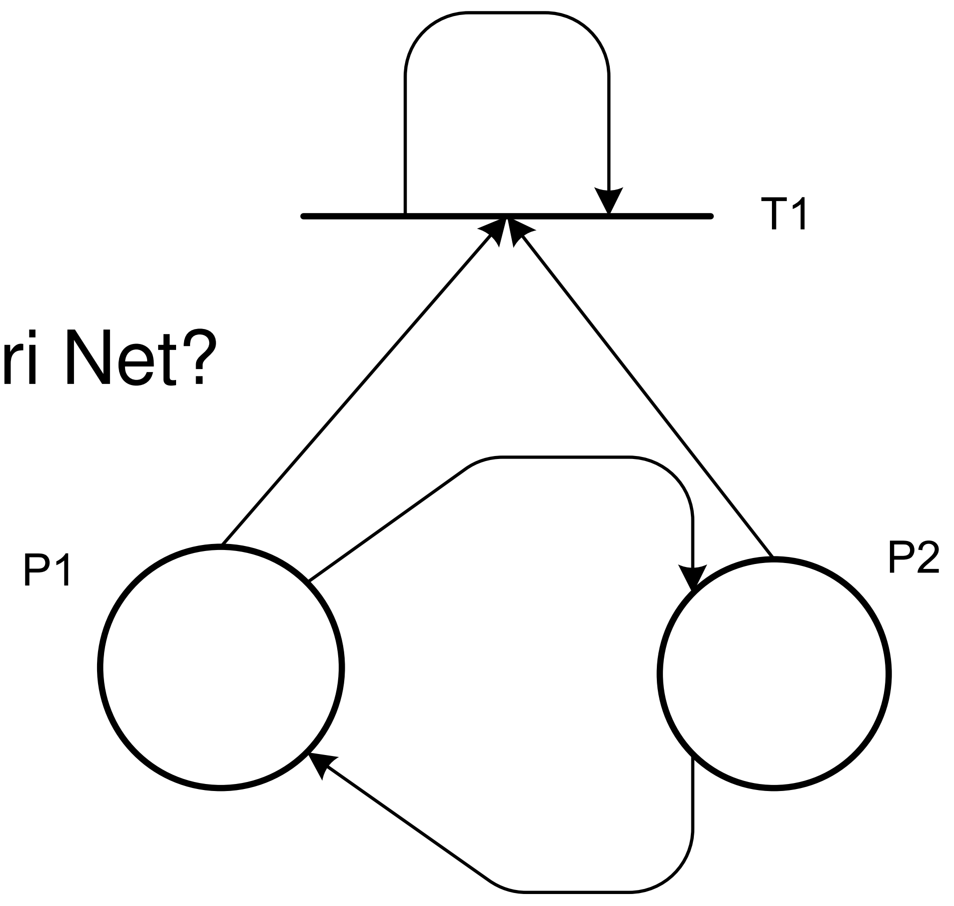
Overview

- The Problem
- Solution Approach
- pyGK Intro
- Petri Net Example and Demo

Problem

- Does a model adhere to its metamodel?
- e.g. Is this a valid Petri Net?



Define (Meta) Model

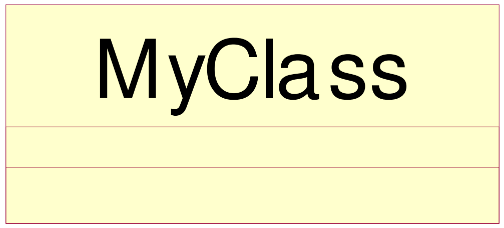
- A model is a collection of model elements.
- Each element can have attributes.
- Each element can be connected to other elements (or itself).

Approach

- Function that checks a model against its metamodel.
- Has 3 Phases:
  - Phase I: Check types of elements.
  - Phase II: Check attributes of elements
  - Phase III: Check connections of elements
- Identifies major problems faster but runs slower than a single phase checker.

Phase I: Elements

- Ensure every element is an instance of something in the metamodel?
  - e.g. Does “MyClass” belong in a Petri Net?



- Checked automatically in the latest version of pyGK.

Phase I Check

- Implemented it anyways
- For each element check if its type exists as a meta element
  - e.g. Does the concept Class exist in the metamodel of Petri Nets?

Phase II: Attributes

- Use symbol table of attributed node in pyGK
  - Associate a predefined type with a name
- e.g. Number of tokens represented as an entry in symbol table of type Integer.

Phase II Checks

- Check:
  - Do all attributes have matching meta attributes (name and type)?
  - Are all uninstantiated meta attributes passed down as attributes?
  - Do any attribute override instantiated meta attributes?

Phase III: Connections

- Elements of a model are connected to other elements.
  - e.g. Place can by connected to a Place2Trans connector element.
- Are directed connections
- Note: these connections are not connectors in a model
  - e.g. Not: Association, Relationship, Trans2Place

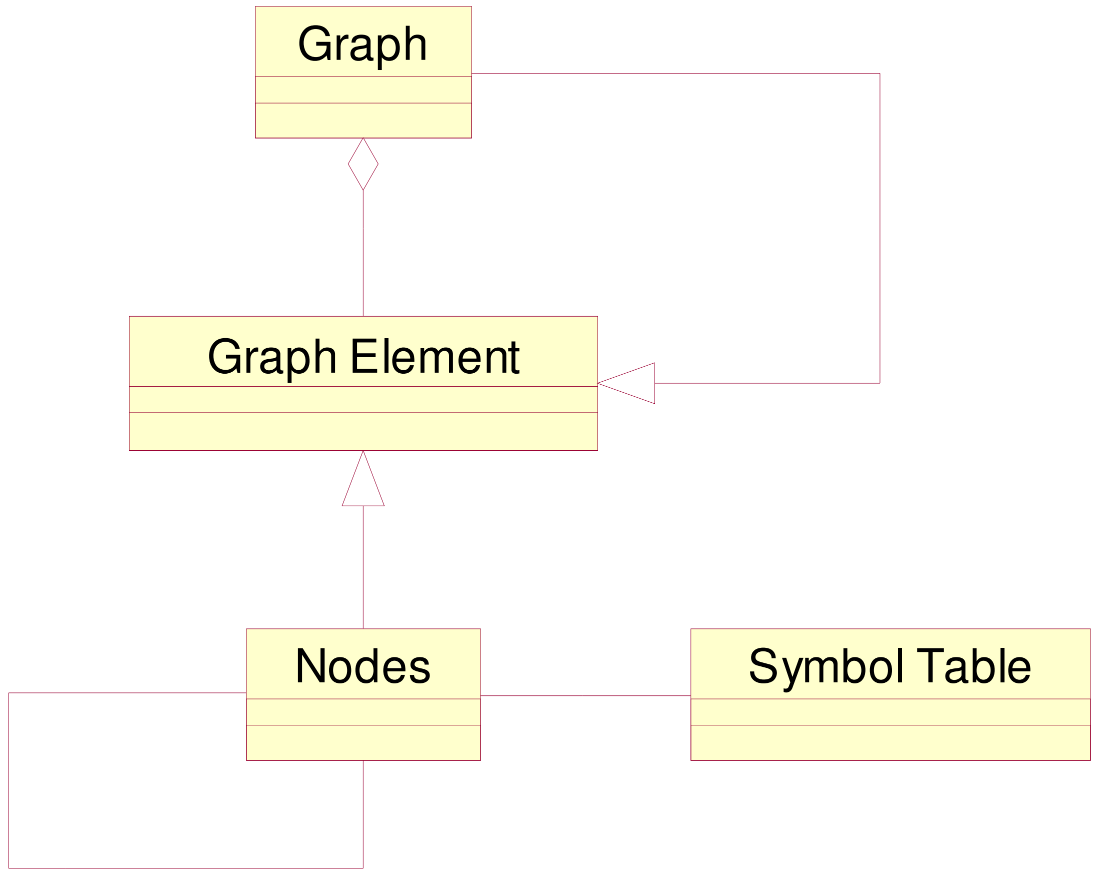
Phase III Checks

- Are the meta elements of connected elements connected?
- e.g. If Place: p1 and Place2Trans: p2t1 are connected, are Place and Place2Trans connected?

pyGK

- Developed by Marc Provost
- Hi-Graph kernel for metamodeling
- Optimized for metamodeling
- Extended for graph rewriting/transformation system

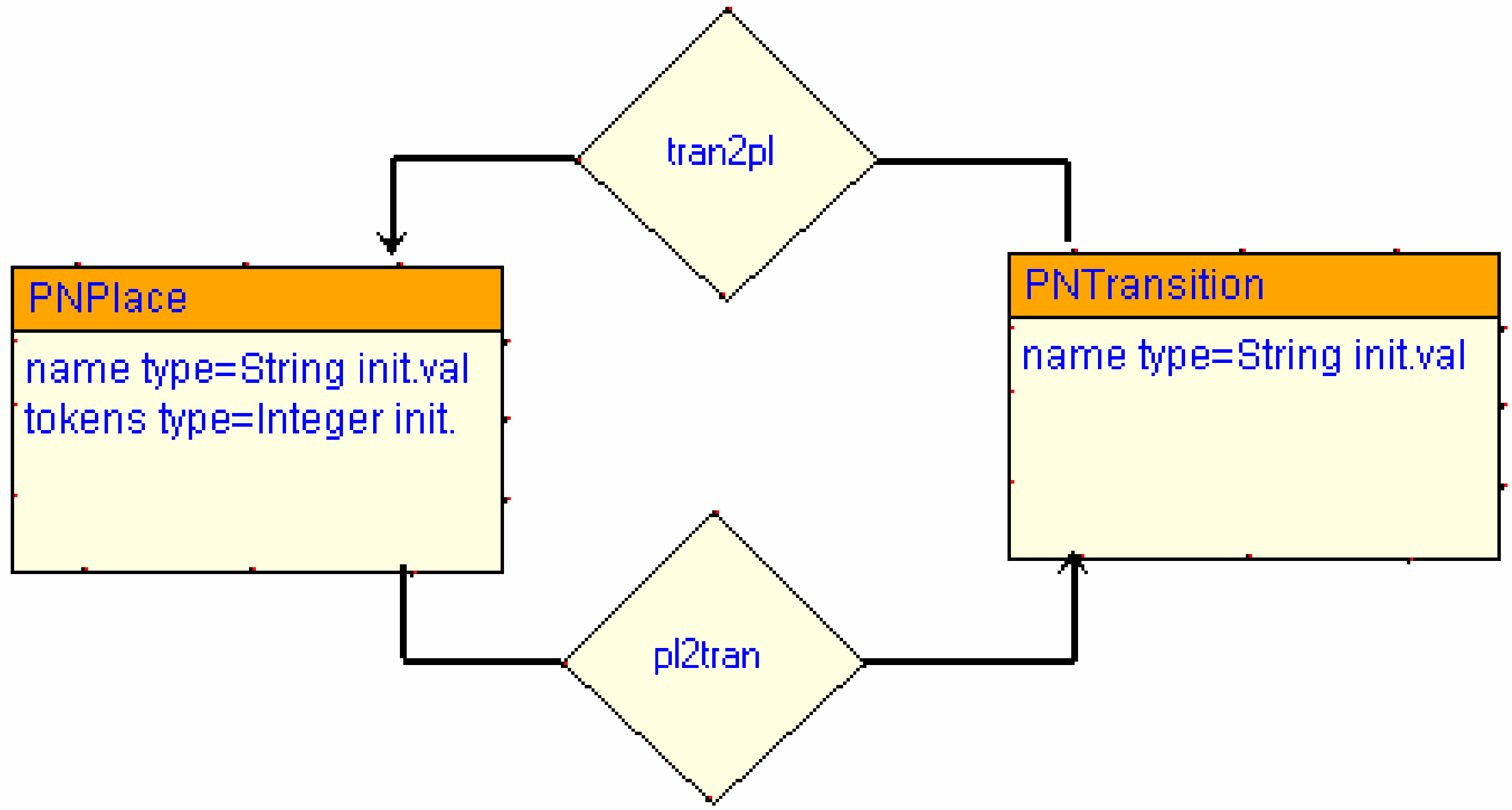
Hi-Graph in pyGK



Defining (Meta)Models

- Text based description - pyGK has no GUI (yet)
- Build a foundational metamodel (ER) using Hi-Graph formalism supported by pyGK kernel.
- Build other models as instances of foundational metamodel.

Petri Net in ER (Graphical)

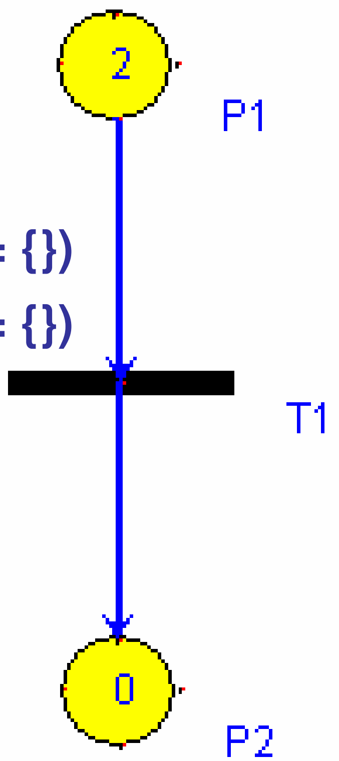

tran2pl
PNPlace
name type=String init.val
tokens type=Integer init.
PNTransition
name type=String init.val
pl2tran

Petri Net in ER (pyGK)

```
PN = Graph(ID = "PetriNet" , typeId = "ER")
PN.addElement(SymbolTable(ID = "Place" , typeId = "Entity" , value = {}))
PN.addElement(SymbolTable(ID = "Transition" , typeId = "Entity" , value = {}))
PN.addElement(SymbolTable(ID="Place2Trans",typeId="Relationship",value={}))
PN.addElement(SymbolTable(ID="Trans2Place",typeId ="Relationship",value={}))
PN.getElement("Place")["Tokens"] = Int()
PN.getElement("Place2Trans")["Weight"] = Int()
PN.getElement("Trans2Place")["Weight"] = Int()
PN.connect("Place", "Place2Trans")
PN.connect("Place2Trans", "Transition")
PN.connect("Transition", "Trans2Place")
PN.connect("Trans2Place", "Place")
```

Petri Net Model in Petri Net

```
PNm1 = Graph(ID = "PNm1" , typeId = "PetriNet")
p1 = SymbolTable(ID = "p1" , typeId = "Place" , value = {})
p2 = SymbolTable(ID = "p2" , typeId = "Place" , value = {})
t1 = SymbolTable(ID = "t1" , typeId = "Transition")
p2t1 = SymbolTable(ID = "p2t1" , typeId = "Place2Trans" , value = {})
t2p2 = SymbolTable(ID = "t2p2" , typeId = "Trans2Place" , value = {})
p1["Tokens"] = Int(value = 2)
p2["Tokens"] = Int(value = 0)
p2t1["Weight"] = Int(value = 2)
t2p2["Weight"] = Int(value = 2)
PNm1.addElement(p1) … PNm1.addElement(t2p2)
PNm1.connect("p1" , "p2t1") … PNm1.connect("t2p2" , "p2")
```



Faulty Petri Net

```
PNm1 = Graph(ID = "PNm1" , parent = root , typeId = "PetriNet")
p1 = SymbolTable(ID = "p1" , typeId = "Place" , value = {})
p2 = SymbolTable(ID = "p2" , typeId = "Place" , value = {})
t1 = SymbolTable(ID = "t1" , typeId = "Transition")
p2t1 = SymbolTable(ID = "p2t1" , typeId = "Place2Trans" , value = {})
t2p2 = SymbolTable(ID = "t2p2" , typeId = "Trans2Place" , value = {})
p1["Faulty Attribute"] = Int(value = 2)
p2["Tokens"] = Int(value = 0)
# p2t1["Weight"] = Int(value = 2)
t2p2["Weight"] = Float(value = 2)
PNm1.addElement(p1) … PNm1.addElement(t2p2)
PNm1.connect("p1" , "p2t1") … PNm1.connect("t2p2" , "p2")
PNm1.connect("p1", "p2")
```

Future Work

- Support more complex connections
  – e.g. Inheritance, Aggregation
- Difficulty: augment Graph or Interpreter?
  – Graph: flexible user defined checking
  – Interpreter: cleaner developer defined checking

Future Work (2)

- Extend attribute types
  - User defined attributes
  - Metamodel Elements (necessary?)
  - Indirectly supported via subclassing nodes

Questions?

References

- C. Atkinson, T. Kühne. *Rearchitecting the UML Infrastructure,* ACM Journal: Transactions on Modeling and Computer Simulation, Vol. 12, No. 4, 2002.
- C. Atkinson, T. Kühne. *The Essence of Multi-Level Metamodeling*. Proceedings of the 4th International Conference on the Unified Modeling Language, 2001.