Continuous Model Validation using Reference Attribute Grammars

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**State-of-the-Art Using RAGs and jastAdd [2]**

| Region | Route : \text{Sensor} => Sensor; \\
|--------|--------------------------------|
| \text{SwitchPosition} | \text{TinkerGraph} => \text{Position} \text{Sensor} \text{region}; \\
| \text{Sensor} | \text{Requirement} \text{region}; \\
| \text{abstract} \text{TrackElement} | \text{TinkerGraph} => \text{Position} \text{Sensor} \text{region}; \\

**Named Lookup**

```java
@Region
public class Map<Integer, Sensor> sensors = ...;
```

**Introducing Relations**

```java
public void Route.addRefToSensor(Sensor sensor) {
    ...;
} public void Route.removeRefToSensor(Sensor sensor) {
    ...;
}
```

**Grammar Extension**

```java
public void Route.addRefToSensor(Sensor sensor) {
    ...;
}
```

**Evaluation within the Trainbenchmark**

![Graph showing evaluation results](image)

**Problem: Efficient Navigation of Non-containment References**

- **RAGs [1]** can be used for models@runtime providing some advantages
  - Separation of structure and computation
  - Shortcuts for navigation and computation on trees
  - Efficiency through memoization of computed values
  - Incremental computation, i.e., invalidating of outdated cached values
- **Major issue**: Non-containment references cannot be encoded efficiently w.r.t. performance and consistency

**Advantages of our Grammar Extension**

- Less boilerplate code to write
- More consistency
- Better performance

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