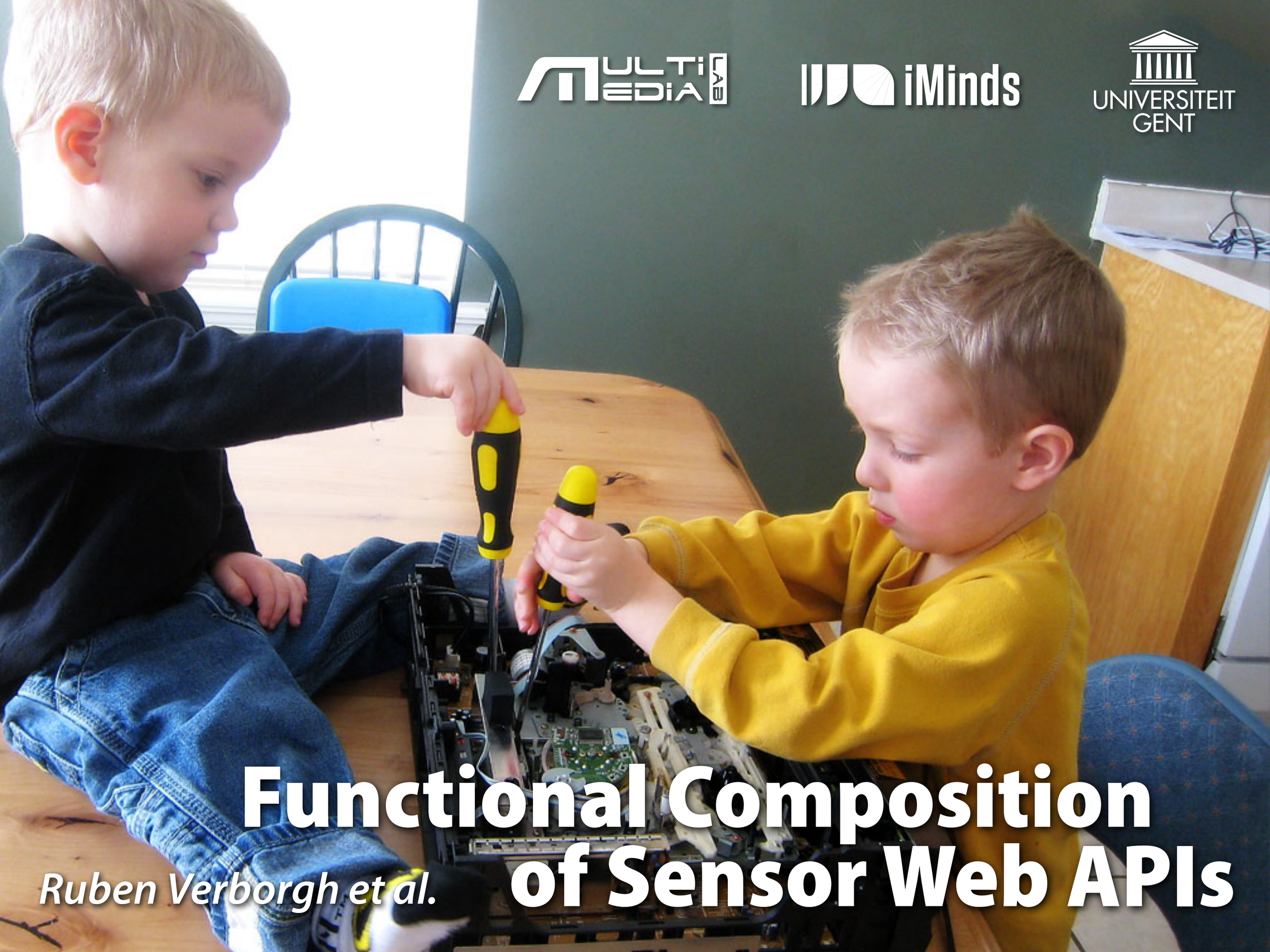


Functional Composition of Sensor Web APIs

Ruben Verborgh et al.

What
makes people
SMART?

Collaboration.

What makes sensors SMART?

Collaboration.

Smart collaborations run themselves.

manual sensor composition

intelligence comes from humans

automatic sensor composition

intelligence comes from the system

My research is about intelligent Web APIs.

Ruben Verborgh, PhD Student

Ghent University / iMinds

My dream: intelligent agents

browsing the Web *for* us

Bridging between people and things

bringing things to the Web

Functional composition of sensor Web APIs

- Capturing functionality
- Creating compositions
- Evaluating feasibility

Functional composition of sensor Web APIs

- **Capturing functionality**
- Creating compositions
- Evaluating feasibility

Why describe functionality?

Only functionality tells the whole story.

How to capture the functionality of these sensors?

GPS device

determines current location

temperature sensor

reads current temperature

pressure sensor

reads current air pressure

We model sensors as Web APIs.

Web APIs = HTTP APIs = REST APIs

as opposed to "Big" Web services

resource-oriented

Sensor measurements are resources

location

temperature

air pressure

We capture the functionality of Web APIs with RESTdesc.

RESTdesc describes the functionality of hypermedia-driven APIs

with Notation3 (an RDF superset)**.**

RESTdesc can describe a temperature sensor.

```
{
  ?sensor a ex:TemperatureSensor;
          ex:location ?location.
}
=>
{
  _:request http:methodName "GET";
            http:requestURI ?sensor;
            http:resp [ http:body ?temperature ].

  ?location ex:hasTemperature ?temperature.
}.
```

RESTdesc can describe a temperature sensor.

```
{
  ?sensor a ex:TemperatureSensor;
          ex:location ?location.
}
=>
{
  _:request http:methodName "GET";
            http:requestURI ?sensor;
            http:resp [ http:body ?temperature ].

  ?location ex:hasTemperature ?temperature.
}.
```

RESTdesc can describe a temperature sensor.

```
{
  ?sensor a ex:TemperatureSensor;
          ex:location ?location.
}
=>
{
  _:request http:methodName "GET";
            http:requestURI ?sensor;
            http:resp [ http:body ?temperature ].

  ?location ex:hasTemperature ?temperature.
}.
```

RESTdesc can describe a temperature sensor.

```
{
  ?sensor a ex:TemperatureSensor;
          ex:location ?location.
}
=>
{
  _:request http:methodName "GET";
            http:requestURI ?sensor;
            http:resp [ http:body ?temperature ].

  ?location ex:hasTemperature ?temperature.
}.
```

RESTdesc provides simple functional descriptions.

Hypermedia-driven

no inputs or outputs, just links

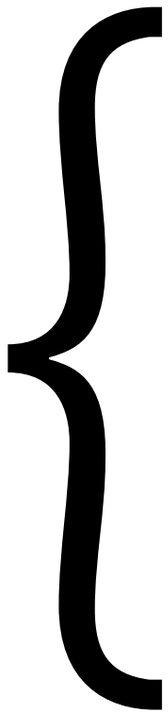
Capture functionality

relationship between resources

Rule-based

logic implication

Functional composition of sensor Web APIs



Capturing functionality

Creating compositions

Evaluating feasibility

Why compose Web APIs?

To answer a query

by combining multiple APIs.

Queries can be complex,

APIs not necessarily known in advance.

“Reserve a table in a nearby restaurant.
If weather allows, I want to sit outside.”

What APIs do we have at our disposition?

Suppose we have many APIs, including:

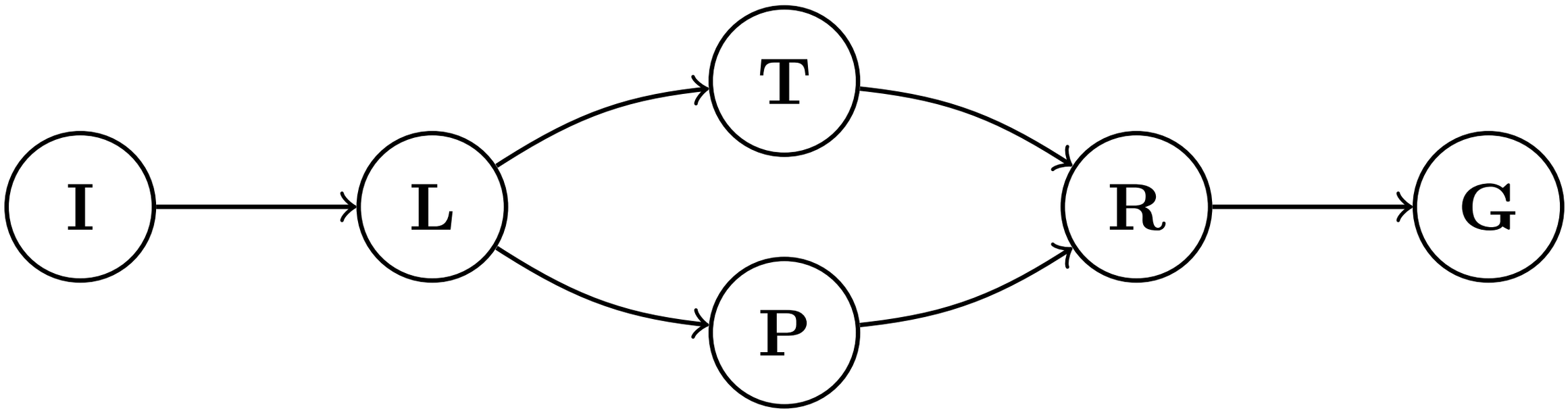
Location API

Temperature API

Pressure API

Restaurant API

What would a candidate solution look like?



"Reserve a table in a nearby restaurant. If weather allows, I want to sit outside."

Location API
Temperature API
Pressure API
Restaurant API

RESTdesc descriptions enable automated composition.

RESTdesc descriptions are rules

Rules support inference

Rules can be chained

Does this composition satisfy the goal?

{ } **Since descriptions are rules,**

=>

{ } **success is defined as entailment.**

If success is entailment,
the proof is the composition.

=>

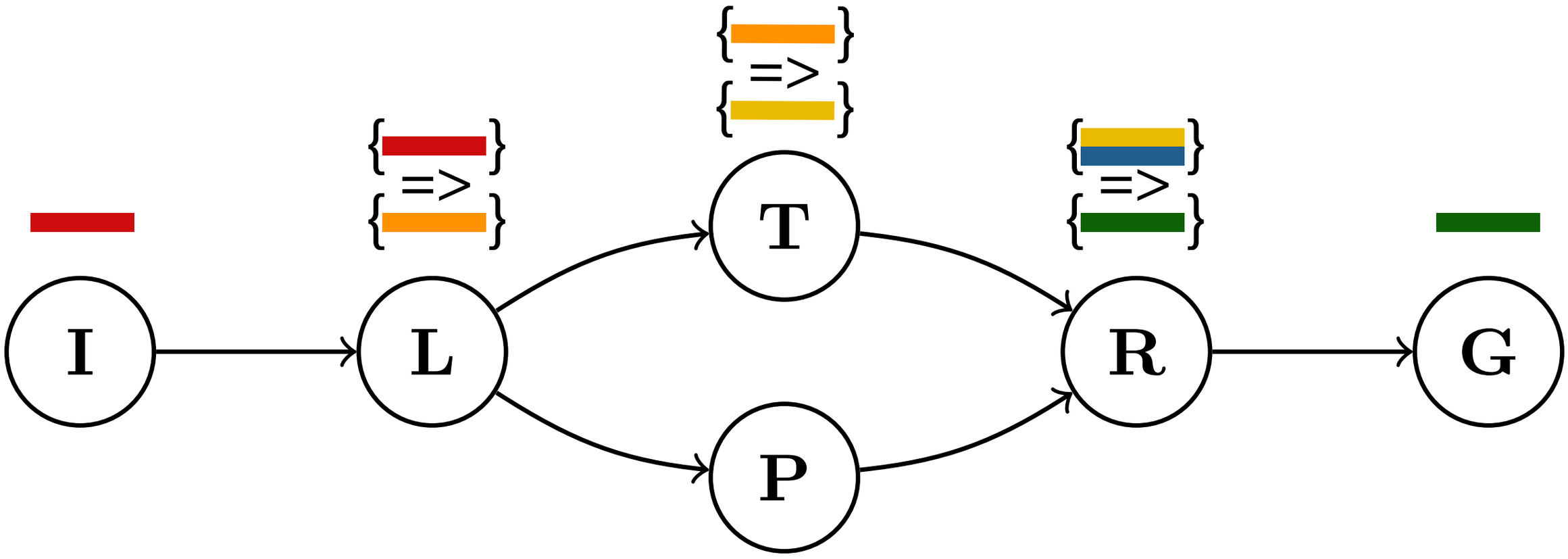
The proof of the entailment

contains the used rules,

=>

thus the needed API requests.

A semantic Web reasoner can create the composition.



"Reserve a table in a nearby restaurant. If weather allows, I want to sit outside."

Location API
Temperature API
Pressure API
Restaurant API

RESTdesc composing behaves as a good Semantic Web citizen.

works with generic semantic reasoners

RESTdesc descriptions are rules

no specific knowledge needed

ontologies fill gaps

domain-independent

Functional composition of sensor Web APIs

{

Capturing functionality

Creating compositions

Evaluating feasibility

Does it scale?

Reasoner-based methods are often thought of as slow.

partly perception

limit reasoner experience

partly the method

translation into reasoner domain

We tested composition chains for performance.

_n_ APIs with 1/2/3 dependencies

to test chaining speed

32 APIs in presence of _n_ dummies

to test discrimination speed

RESTdesc composition is so fast that it works on Web scale.

chain of 512 APIs with 1 dependency

in 0.4 seconds

chain of 512 APIs with 3 dependencies

in 1.6 seconds

chain of 32 APIs with 512 dummies

in 0,01 seconds

Efficient implementations on Arduino boards.

simple sensors as Web APIs

described with RESTdesc

central composer

RESTdesc is an automated solution for sensor Web API composition.

Describe REST Web APIs

Use Semantic Web logic

Compose with generic reasoners

RESTdesc automatically composes sensor Web APIs.

Curious? Let's get in touch!

Visit restdesc.org and

connect to @RubenVerborgh on Twitter.

iMinds

UNIVERSITEIT GENT

MULTIMEDIA LAB