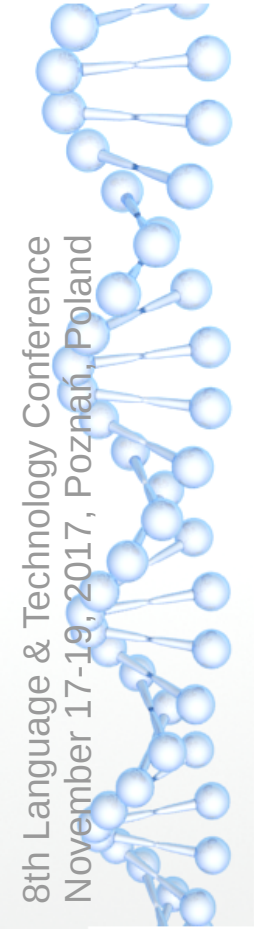

8th Language & Technology Conference
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A second life for Prolog

What went wrong and how we fixed it

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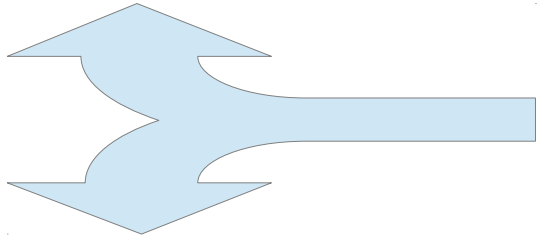
Overview

- Now: invited talk
  - WWW: **W**hy Prolog, **W**hy not and **W**hy again
- Afternoon (17:50 – 19:10) Tutorial 1
  - Introducing Prolog, the simple stuff, beyond SLD



- Tomorrow morning (08:00 – 10:00) Tutorial 2
  - Handling data, interface to the outside world

Why Prolog for language?

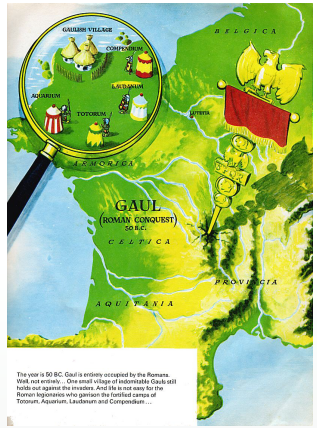
- DCG: A powerful grammer formalism
  - Unlimited look-ahead
  - Non-deterministic (can provide multiple parses)
- We can capture the semantics of language in logic
  - This allows us to reason about language
  - Translate, ...
- https://swish.swi-prolog.org/example/grammar.pl

Does it work?

- To some extend
  - Artificial languages (document formats, computer languages)
  - Controlled natural language (e.g., ACE)
  - Natural language in limited domains (e.g., Watson)

Real natural language?

- We all know it doesn‘t. Why not?
  - Top-down parsing comes with too many choicepoints (slow)
  - Long sentences produce too many possible parses (choose)
  - Languages with free word ordering are hard to express (expressivity)
- Or does it?
  - Alpino (Dutch parser) is still one of the best parsers for Dutch.
  - Hybrid: A Prolog representation is compiled into a finite state machine and a statistical model is used for disambiguation. Overall control is again in Prolog.



Graph exploration

```
daughter(Daugther, Parent) :-
    parent(Parent, Daugther),
    female(Daugther).
```

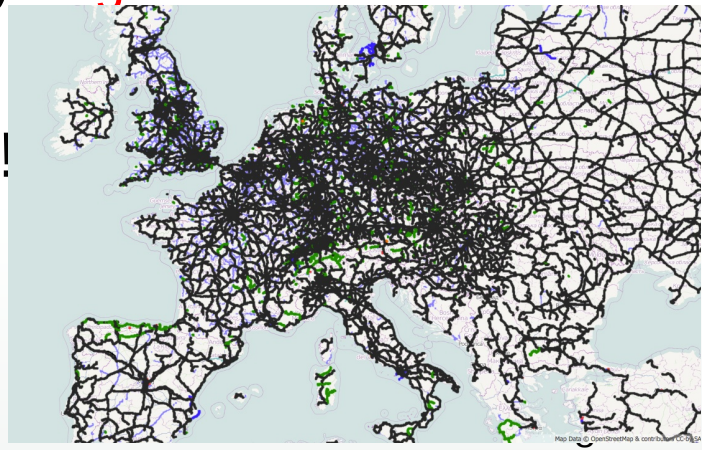
Great!

- Concise description
- Works in all directions:
  - Create a table of all daugthers and their parents
  - Find the daugthers of a parent
  - Find the parents of a daugther
  - Verify a specific daugther is the daugther of a specific parent
- Is pretty fast

But ...

- Now we do travel planning, traditionally by railway!
  - You can use a connection in two directions
  - You can travel around in circles without ever reaching your destination
  - The number of connected tracks is pretty huge

➔Prolog looses its declarative beauty!



What to do?

- Prolog is a programming language, so we can code a proper solution!
- Extend the inference mechanism of Prolog, so we can still use the declarative version!
- Restrict ourselves to domains that do not suffer too much from this issue (special purpose language)

Coding using SLD resolution

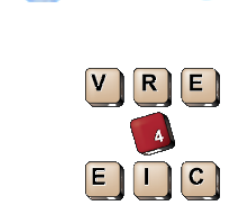
```
travel(S1, S2, Route) :-
    travel_bf(S2, [S1-[S1]], Route).

travel_bf(To, [To-Route|_], Route).
travel_bf(To, [S-Route0|T], Route) :-
    findall(S1-[S1|Route0], (adjacent(S,S1),\+member(S1,T)), New),
    append(T, New, Agenda),
    travel_bf(To, Agenda, Route).
```

Break cycle

```
adjacent(S1, S2) :- connected(S1, S2).
adjacent(S1, S2) :- connected(S2, S1).
```

```
connected('Warshau', 'Poznań').
...
```



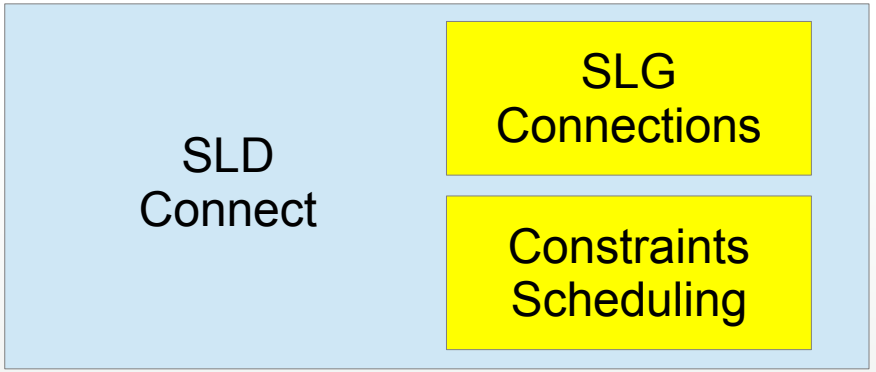
Coding using SLD resoluton

- ✔ Can implement any algorithm
- ✔ Is typically still compact compared to alternatives
- (Debugging)
  - ✔ We can retry (time machine)
  - ✗ Harder to follow control flow
- ✗ Steep learning curve if you come from an imperative background

Beyond SLD

- SLG (Tabling)
  - Terminates provided finite data structures are used
  - In some sense comparable to DataLog
- Constraint Logic Programming
  - Use domain knowledge to reorder search and be smarter than generate-and-test for finding possible values

➔Declarative islands

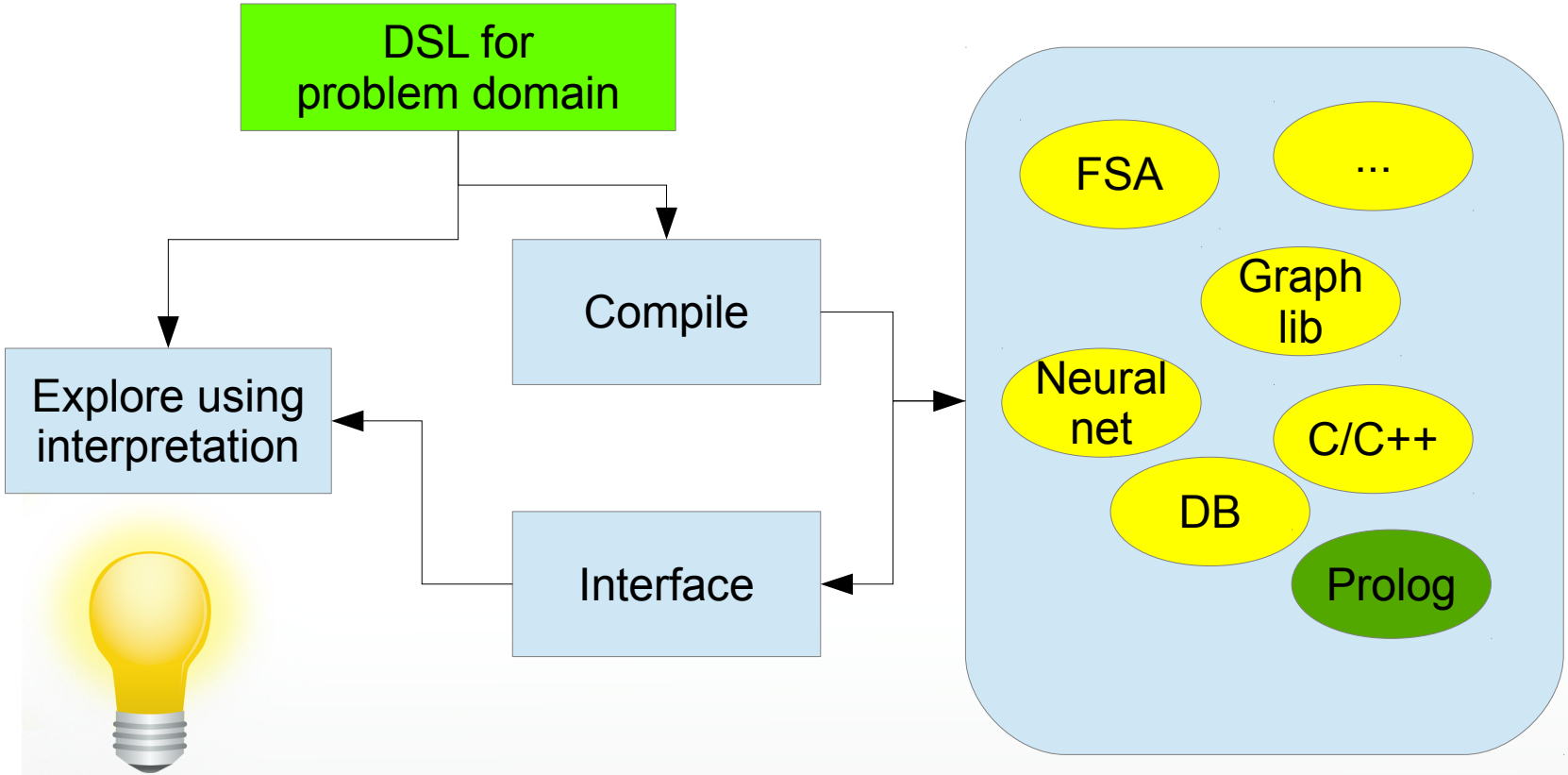


Prolog as a special-purpose language?

- Can solve isolated, relatively small and simple problems
- For many of these, there are subsystems in other languages
  - Parser generators
  - Rule subsystems
  - ...
- Embedding Prolog suffers from the **relational impedence mismatch** that also complicates using relational databases from many languages.

➔ Still, **Amzi!** targets this

Use Prolog as a specification language



Specification language

- Flexible syntax that is targetted at data
- Grammars are great for generating code
- Examples
  - Alpino (we have seen)
  - Weather prediction (university Leiden)
  - Natural language understanding (Kyndi)
  - Business rule management (SecuritEase)
  - ...

Using Prolog as glue

- As we have seen
  - Prolog can accomodate declarative islands
  - Prolog can be used to generate problem specific code
- Prolog has a natural fit with
  - Relational data (RDF and RDBMS)
  - Hierarchical data (XML, JSON, etc)

But ...

- Traditional Prolog is a little autistic
  - Only file I/O
  - Poor representation for text
  - Poor representation for arrays
  - Often painful embedding support

SWI-Prolog

- Language
  - Scalable support for multi-core hardware
  - Unicode support, unlimited length atoms, volatile compact strings
  - Unbounded arity for terms provides arrays
  - Dicts (key-value objects)
  - Scalable dynamic database with lazy indexing
  - Security and garbage collection (atoms, clauses, stack)
- Connections
  - Strong web server and client libraries
  - Connections to languages and databases
  - Parse and write document formats (RDF, XML, HTML, JSON,...)

Take home

- ✗ Classical Prolog as a declarative language has limited value
- ✔ Modern Prolog offers more powerful declarative subsystems that can be used as declarative islands
- ✔ Prolog is a great data representation and specification language
- ✔ Prolog is great in providing a unifying framework for a hybrid technology stack.

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