

Prolog

COMP360

“Logic will get you from A to B. Imagination will take you everywhere.”

Albert Einstein

Prolog Assignment

- A programming assignment in Prolog has been posted on Blackboard
- Upload your .pl file to Blackboard by midnight on Monday, April 17, 2017

Programming Language Paradigms

- Imperative – Program execution changes the state
 - Procedural – Cobol, Fortran, C
 - Object-Oriented – Java, PHP, C++
- Declarative – Explain what instead of how
 - Functional – Haskell, Scala
 - Logical – Prolog
 - Domain specific – SQL, HTML

Logic Programming Languages

- Logic programming languages use first order predicate calculus to determine the truth of a statement
- They can also assign values to variables that will make a statement true
- Logic programming languages have been commonly used in theorem proving and artificial intelligence

Prolog

- Prolog is a general-purpose logic programming language
- Prolog has its roots in formal logic
- Prolog is declarative: the program logic is expressed in terms of relations, represented as facts and rules. A computation is initiated by running a query over these relations.

Prolog Creation

- Prolog was one of the first logic programming languages
- The language was first conceived in Marseille, France, in the early 1970s
- The first Prolog system was developed in 1972 by Alain Colmerauer and Philippe Roussel

Axioms and Goals

- Prolog allows you to state a bunch of axioms
- You pose a query or goal and Prolog tries to find a series of inference steps (and assignments of values to variables) that allows it to prove your query
 - If it can, it says `yes`
 - If it cannot, it says `no`
- If your query contained variables, the interpreter prints the values it had to give them to make the query true

Prolog Terms

- An atom is a general-purpose name with no inherent meaning
 - Atoms always begin with a lower case letter
- Variables begin with upper case letters and are placeholders for arbitrary terms
- A list is [enclosed, in, brackets]
- Strings are enclosed in “double quotes” and are lists of characters

Functor

- Functors specify relationships between values
- Functors look like a function call

`parent (fred, mary) .`

- The **arity** of a function or operation is the number of arguments or operands that the functor has
- Prolog documentation often follows the name of a functor with a slash and the arity, i.e. `parent/2`

Prolog Solution Search

- The Prolog interpreter uses Backward Chaining
- It begins with the thing it is trying to prove and works backwards looking for things that would imply it, until it gets to facts
- It is also possible in theory to work forward from the facts trying to see if any of the things you can prove from them are what you were looking for - that can be very time-consuming
- Some logic languages use both kinds of chaining, with hints from the user to bound the searches

Search Example

- Consider the following data and query
smart(fred).
smart(mary).
motivated(mary).
achiever(X) :- smart(C), motivated(C).

achiever(Who). % goal

Facts

- A clause with an empty body is called a FACT
- A clause with an empty head is a QUERY, or top-level GOAL
- A clause with both sides is a RULE
- The Prolog interpreter has a collection of facts and rules in its Database

Prolog Rules

- A rule in Prolog defines a relationship

Head :- Body

- can be read as “Head is true if Body is true”
- A rule’s body consists of calls to predicates, which are called the rule’s goals

mammal(Goat) :- fourlegs(Goat), furry(Goat)

- The predicates of the body are separated by commas and are logically ANDed

Example

```
parent(alice, bob).  
parent(alice, doug).  
parent(alice, kate).  
parent(kate, larry).  
parent(kate, mark).  
parent(bob, ed).  
parent(bob, fred).  
parent(fred, george).  
parent(fred, harry).  
ancestor(X, Y) :- parent(X, Y).  
ancestor(X, Y) :- parent(Z, Y), ancestor(X, Z).  
grand(A, B) :- parent(A, C), parent(C, B).
```

Write some Prolog

- Create a Prolog query to find a person's sibling, brother or sister
- Assume the database on parents has been loaded

Writing Prolog

- Prolog databases are kept in a text file
- Comments start with a percent sign %
- All prolog statements end with a period.

Using SWI-Prolog

- Prolog has a database of facts and rules kept in a text file with the extension `.pl`
- You can create the database with a text editor
- You can load the database in prolog by putting the filename in brackets ending with a period
`[mystuff].`
- You can change the working directory with
`working_directory(CWD,'/ncat/comp360/prolog').`

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