LATE BHAUSAHEB HIRAY S.S. TRUST'S INSTITUTE OF COMPUTER APPLICATION, MUMBAI

Artificial Intelligence and Machine Learning

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Faculty, Master of Computer Application (M.C.A.) Late Bhausaheb Hiray S.S. Trust's Institute of Computer Application



ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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First Edition, 2023

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Paperback ISBN: 978-81-19221-07-3 eBook ISBN: 978-81-19221-19-6 WebPDF ISBN: 978-81-19221-13-4

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Chapter 1 Logic Programming with Prolog and AI Problems

What is GNU:

- 1. GNU Prolog is a free Prolog compiler with constraint solving over finite domains developed by Daniel Diaz.
- 2. GNU Prolog accepts Prolog+constraint programs and produces native binaries (like gcc does from a C source). The obtained executable is then stand-alone. The size of this executable can be quite small since GNU Prolog can avoid to link the code of most unused built-in predicates. The performances of GNU Prolog are very encouraging (comparable to commercial systems).
- **3.** Beside the native-code compilation, GNU Prolog offers a classical interactive interpreter (top-level) with a debugger.
- **4.** The Prolog part conforms to the ISO standard for Prolog with many extensions very useful in practice (global variables, OS interface, sockets,...).
- **5.** GNU Prolog also includes an efficient constraint solver over Finite Domains (FD). This opens contraint logic programming to the user combining the power of constraint programming to the declarativity of logic programming.

Prolog: (Programming in logic)

- **1.** It is a logic programming language.
- 2. Logic means Facts and Rules. And based on Facts and Rules we go to the conclusion.
- **3.** Prolog is a declarative programming language.
- 4. Prolog was designed by Alain Colmerauer and Robert Kowaski. It was first implemented in 1973.

How does GNU Prolog work?

The GNU Prolog compiler is based on the Warren Abstract Machine (WAM). It first compiles a Prolog program to a WAM file which is then translated to a low-level machine independent language called mini-assembly specifically designed for GNU Prolog. The resulting file is then translated to the assembly language of the target machine (from which an object is obtained). This allows GNU Prolog to produce a native stand alone executable from a Prolog source (similarly to what does a C compiler from a C program). The main advantage of this compilation scheme is to produce native code and to be fast. Another interesting feature is that executables are small. Indeed, the code of most unused built-in predicates can be excluded from the executables at link-time.

GNU Prolog also includes an efficient constraint solver over Finite Domains (FD). The key feature of the GNU Prolog solver is the use of a single (low-level) primitive to define all (high-level) FD constraints. There are many advantages of this approach: constraints can be compiled, the user can define his own constraints (in terms of the primitive), the solver is open and extensible (as opposed to black-box solvers like CHIP),...Moreover, the GNU Prolog solver is rather efficient, often more than commercial solvers.

Installation of GNU Prolog:

Step 1: Search "download gnu prolog for windows" in google.



Step 2: Go to "GNU prolog website".

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\leftarrow	\rightarrow	C		Not	secure	gpr	olog.org
м	Gmail	9	Maps	G	Google	- 60	bkhmct.edusprint.in

The GNU Prolog web site



Table of contents

- What is GNU Prolog 2
 Ecatures
- Eeatures How does GNU Prolog work 2 History Supported Platforms & last changes Manual
- Download Contributio ns and related developments

Step 3: Click on the following link:

Download

We provide both source and binary distributions for GNU Prolog.

Source distributions:

the main source distribution <u>gprolog-1.5.0.tar.gz</u>.

Binary distributions:

- Mac OS X installer package created on Big Sur using MacPorts by Paulo Moura (installs GNU Prolog in /opt/local/ and /opt/local/bin)
- <u>Windows intel 32 bits auto-install setup</u> (compiled under ix86 / Windows 10 with MSVC++).
 <u>Windows intel 32 bits auto-install setup</u> (compiled under ix86 / Windows 10 with MinGW gcc under MSys2).

Windows intel 64 bits auto-install setup (compiled under x86_64 / Windows 10 with MSVC++). Windows intel 64 bits auto-install setup (compiled under x86_64 / Windows 10 with MinGW64 gcc under MSys2).

Step 4: Double-click on the "exe" file and install gnu as follows:

Setup - GNU Prolog version 1.5.0 -	<
Select Destination Location Where should GNU Prolog be installed?	2
Setup will install GNU Prolog into the following folder.	
To continue, click Next. If you would like to select a different folder, click Browse.	
At least 19.3 MB of free disk space is required.	
<u>N</u> ext Cancel	
Setup - GNU Prolog version 1.5.0 - X	
Select Start Menu Folder Where should Setup place the program's shortcuts?	3
Setup will create the program's shortcuts in the following Start Menu folder.	
To continue, click Next. If you would like to select a different folder, click Browse.	
Don't create a Start Menu folder	
Back Next Cancel	

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Back Install Cancel			. /	
Back Install Cancel Setup - GNU Prolog version 1.5.0 – × Completing the GNU Prolog Setup Wizard Setup has finished installing GNU Prolog on your computer. The application may be launched by selecting the installed shortcuts. Click Finish to exit Setup.	4		-	
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1.1: Demonstration of basic commands in prolog (Facts, Rule, and queries)

Facts: Facts can be defined as explicit relationships between objects and properties of objects. Facts are unconditionally true in nature.

Example:

- **1.** Tom is a cat. \rightarrow **cat(tom)** \rightarrow This factual expression is called as clause.
- 2. Harry is a student.

Note: Anything that is within the parameter that we pass is called as argument and that argument is an object.

<u>Relation</u>: Relation defines the way in which a collection of objects or variables belong together.

Example: student(harry) \rightarrow here student is a relation with harry.

We can define more than one objects as: relation (object1, object2, object3,.....)

Rules: Rules can be defined as explicit relationship between objects. Rules are conditionally true.

Example: Seema is happy if she sings.

We can write above rules as: happpy(seema):-sings(seema)

Create one file in notepad with.pl extension and file type =All type.

```
      Image: Set of the set o
```

Go to GNU \rightarrow File \rightarrow Change dir \rightarrow Select the folder where notepad file is saved.



GNU Prolog console
 File Edit Terminal Prolog Help
 GNU Prolog 1.4.5 (64 bits)
 Compiled Jul 14 2018, 12:58:46 with cl
 By Daniel Diaz
 Copyright (C) 1999-2018 Daniel Diaz
 compiling D:/Documents/Sem-2/AI & ML/lab/p1.pl for byte code...
D:/Documents/Sem-2/AI & ML/lab/p1.pl compiled, 5 lines read - 953 bytes written, 301 ms
 | ?- |

Code:-

→[p1].

 \rightarrow Student(X).

\rightarrow Intelligent(Y).

```
Sonu Prolog console
File Edit Terminal Prolog Help
GNU Prolog 1.4.5 (64 bits)
Compiled Jul 14 2018, 12:58:46 with cl
By Daniel Diaz
Copyright (C) 1999-2018 Daniel Diaz
| ?- change_directory('D:/AI & ML').
yes
| ?- [pl].
compiling D:/AI & ML/pl.pl for byte code...
D:/AI & ML/pl.pl:1: warning: singleton variables [Sameer] for student/1
D:/AI & ML/pl.pl:3: warning: singleton variables [Krishna] for love=_to_eat/2
D:/AI & ML/pl.pl compiled, 5 lines read - 826 bytes written, 390 ms
yes
| ?- student(X).
yes
| ?- intelligent(Y)
.
yes
| ?-
```

1.2: Demonstration of AND & OR Function in Prolog:

AND function(;)

OR function(,)

Create new notepad file.

→likes(pooja,geeta).

likes(geeta,pooja).

likes(neha,aliya).

freindship(X,Y):- likes(X,Y);likes(Y,X).

```
?- [p2].
compiling D:/AI & ML/p2.pl for byte code...
D:/AI & ML/p2.pl compiled, 5 lines read - 884 bytes written, 17 ms
yes
[ ?- freindship(X,Y).
X = pooja
Y = geeta ? ;
X = geeta ? ;
X = neha
Y = aliya ? ;
X = geeta ? ;
X = pooja ? ;
X = pooja ? ;
X = neha
Y = geeta ? ;
X = aliya ? ;
X = aliya ? ;
X = neha
(46 ms) yes
[ ?- ]
```

Practice I.I:

 \rightarrow likes(pooja,geeta).

likes(geeta,pooja).

likes(neha,aliya).

freindship(X,Y):- likes(X,Y),likes(Y,X).

```
[ ?- [p2].
compiling D:/AI & ML/p2.pl for byte code...
D:/AI & ML/p2.pl compiled, 5 lines read - 763 bytes written, 16 ms
yes
| ?- freindship(X,Y).
X = pooja
Y = geeta ? ;
X = geeta
Y = pooja ? ;
no
| ?- |
```

Practice 1.2:

 \rightarrow next_to(mumbai,pune).

```
next_to(pune,satara).
```

```
next_to(mumbai,nashik).
```

```
travel(A,C):- next_to(A,B),next_to(B,C).
```

```
//- [p2].
compiling D:/AI & ML/p2.pl for byte code...
D:/AI & ML/p2.pl compiled, 5 lines read - 738 bytes written, 16 ms
yes
| ?- freindship(X,Y).
X = pooja
Y = geeta ? ;
X = geeta
Y = pooja ? ;
(31 ms) no
```

1.3: Relationship in prolog: - Specify relationship between object and properties of objects.

Relationship can also be a rule.



Example:



<u>→ p3.pl</u>

female(scarlet).

female(alice).

female(katherine).

female(fiona).

male(bob).

male(sean).

male(chris).

male(dravis).

parent(bob, alice).

parent(bob, sean).

parent(scarlet,alice).

parent(scarlet, sean).

parent(alice, katherine).

parent(sean, chris).

parent(katherine,fiona).

parent(chris,dravis).

granparent(X,Y):- parent(X,Z),parent(Z,Y).

sister(X,Y):- parent(Z,X), parent(Z,Y), female(X), X\=Y.

brother(X,Y):- parent(Z,X), parent(Z,Y), male(X), female(Y).

uncle(X,Y):- parent(Z,Y), brother(X,Z).

aunt(X,Y):- parent(Z,Y),sister(X,Z).

daughter(X,Y):- parent(Y,X), female(X).

son(X,Y):- parent(Y,X), male(X).

mother(X,Y):- parent(X,Y), female(X).

father(X,Y):- parent(X,Y), male(X).

```
SOLUTION CONSTRUCTION STATES STATE
      File Edit Terminal Prolog Help
  GNU Prolog 1.4.5 (64 bits)
Compiled Jul 14 2018, 12:58:46 with cl
   By Daniel Diaz
  Copyright (C) 1999-2018 Daniel Diaz
| ?- change_directory('D:/AI & ML').
  yes
 /°-
compiling D:/AI & ML/p3.pl for byte code...
D:/AI & ML/p3.pl compiled, 38 lines read - 4475 bytes written, 354 ms
  (31 ms) yes
| ?- parent(X,Y)
 X = bob
Y = alice ? ;
X = bob
Y = sean ? ;
 X = scarlet
Y = alice ? ;
 X = scarlet
Y = sean ? ;
 X = alice
Y = katherine ? ;
 X = sean
Y = chris ? ;
 X = katherine
Y = fiona ? ;
   X = chris
  Y = dravis
```

```
Π
  ?- brother(X,Y).
X = sean
Y = alice ? ;
X = sean
Y = alice ?;
no
| ?- sister(X,Y).
X = alice
Y = sean ?;
X = alice
Y = sean ?;
(16 ms) no
?- grandparent(X,Y).
X = bob
Y = katherine ? ;
X = bob
Y = chris ? ;
X = scarlet
Y = katherine ? ;
X = scarlet
Y = chris ?;
X = alice
Y = fiona ? ;
X = sean
Y = dravis ? ;
```

```
?- uncle(X,Y).
X = sean
Y = katherine ?;
X = sean
Y = katherine ? ;
(15 ms) no
| ?- aunt(X,Y).
X = alice
Y = chris ?;
X = alice
Y = chris ?;
(31 ms) no
?- mother(X,Y).
X = scarlet
Y = alice ? ;
X = scarlet
Y = sean ? ;
X = alice
Y = katherine ? ;
X = katherine
Y = fiona ? ;
(47 ms) no
```