Theory of Answer Set Programming

More about clingo Programs

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Objectives

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Use several directives of clingo programs

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Represent definitions related to arithmetic in the language of clingo

Directives and Comments

Comment

> **Any text between the symbol % and the end of a line is a comment, disregarded by clingo.**

```
% This is comment blah, blah, blah…
```

#show

A #show directive instructs clingo to show some elements of the stable model and suppress the others

```
#show large/1.
```

/n refers to the arity of the predicate symbol

```
p. p(a).  p(a,b).
#show p/0. #show p/2.
```

#const

A #const directive allows us to use a symbolic constant as a placeholder

```
large(C) :- size(C,S1), size(uk,S2), S1 > S2.

#const c0=uk.
large(C) :- size(C,S1), size(c0,S2), S1 > S2.
```

Alternatively, the command line option `-c` can be used

- add in the command line

```
-c c0=uk
```

#include

```
% large.lp
large(C) :- size(C,S1), size(c0,S2), S1 > S2.
#show large/1.

% large_input.lp
#const c0=uk.
size(france,65; germany,83; italy,61; uk,64).
```

Multiple input files to clingo are concatenated

```
% clingo large.lp large_input.lp
```

Alternatively, we can include another file using #include

```
#include "large_input.lp".
```

Arithmetic in Clingo

Arithmetic

Complex terms can be built from constants and variables using the symbols

+ (addition) * (multiplication) ** (exponentiation)

/ (integer division) \ (remainder) | | (absolute value)

p(N,N*N+N+41) :- N=0..3.

reads

N and $N^2 + N + 41$ are in the relation p/2 if N is one of the numbers $0, \ldots, 3$.

Command: `clingo quadratic.lp`

Stable models: `p(0,41) p(1,43) p(2,47) p(3,53)`

Placeholders

```
p(N,a*N*N+b*N+c) :- N=0..n.
```

reads

N and $aN^2 + bN + c$ are in the relation p/2 if N is one of the numbers $0, \ldots, n$.

a,b,c,n are placeholders for any values that can be specified in the command

Command: `clingo -c a=1 -c b=1 -c c=41 -c n=10 quadratic.lp`

Alternatively, put in the file

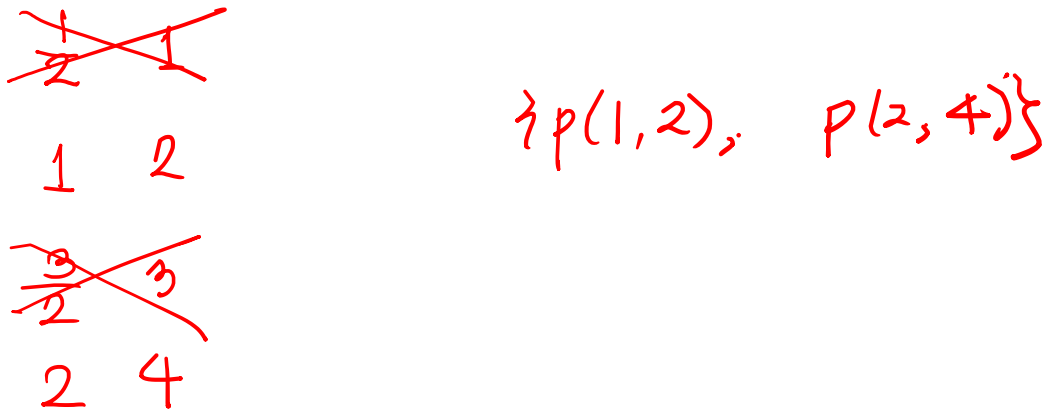
```
#const a=1. #const b=1. #const c=41. #const n=10.
```

Integer Arithmetic

The numbers that clingo knows about are integers

Q: What is the stable model of

```
p(M,N) :- N=1..4, N=2*M.
```



Intervals in Head

Intervals may be used not only in the bodies of rules but in the heads as well. For instance, a program may include the fact

```
p(0..3).
```

which has the same meaning as the set of 4 facts

```
p(0).  p(1).  p(2).  p(3).
```

This group of facts can be also abbreviated using pooling:

```
p(0; 1; 2; 3).
```

EXERCISE

Write a one-rule program that does not contain pooling and has the same stable model as

```
p(1,2; 2,4; 4,8; 8,16).
```

```
p(2**N, 2**(N+1)) :- N=0..3
```

EXERCISE

Write one-rule program that has the stable model

```
p(1,1)
p(2,1) p(2,2)
p(3,1) p(3,2) p(3,3)
p(4,1) p(4,2) p(4,3) p(4,4).
```

p(M, N) :- M=1..4, N=1..4, M >= N

Definitions Related to Arithmetic

Definition: Composite Numbers

An integer N is composite if

- it is divisible by some numbers from {2, …, N-1}

```
composite(N) :- N=1..n, I=2..N-1, N\I=0.
```

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composite(5) :- T, I=2..4. 5\I=0

composite(4) :- T, I=2..3, 4\I=0

Definition: Fibonacci Numbers

Fibonacci Numbers

Fib(0) = 0

Fib(1) = 1

Fib(n+2) = Fib(n) + Fib(n+1) for $n \geq 0$

Fib(2) = Fib(0) + Fib(1) = 0 + 1 = 1

Fib(3) = Fib(1) + Fib(2) = 1 + 1 = 2

Fib(4) = = 3

Fib(5) = = 5

```
% fib(i,m): i-th Fibonacci number is m
fib(0,0).
fib(1,1).
fib(N+2,F1+F2) :- fib(N,F1),fib(N+1,F2), N=0..(n-2).
```

Definition: Factorials

Factorials

Fac(0) = 1

Fac(n+1) = (n+1) × Fac(n)

$0! = 1$

$(n+1)! = (n+1) \times n!$

```
% fac(i,m) : i-th factorial is m
fac(0,1).
fac(N+1,(N+1)*F) :- fac(N,F), N=1..n.
fac(F) :- fac(N,F).
#show fac/1.
```

should be N=0..n.

Lecture Wrap-Up