

NOPT042 Constraint programming: Tutorial 6 – Scheduling

What was in Lecture 4

Consistency techniques

- use constraints *actively*
- remove inconsistent values (or combinations thereof) from the domains
- **node consistency**: intersect domain with all unary constraints
- **arc consistency**: ensure that every value of x is compatible with some value y via every binary constraint
- naive implementation: AC-1 (revise all arcs, repeat until no change); improvement AC-2
- **AC-3**: most widely used, keep a queue of arcs to revise (reduction of one domain triggers revision of neighboring domains)
- AC-4 (best worst-case time complexity), AC-5, AC-6, AC-7, AC-3.1, AC-2001
- directional arc consistency: DAC-1

Exercise:

- Explain why consistency techniques cannot destroy solutions
- Give an example of an instance where
 - not node consistent
 - node consistent but not arc consistent
 - arc consistent but not solvable

```
In [1]: %load_ext ipicat
```

Picat version 3.7

```
In [2]: %%picat
import cp.
main => not_nc(X), solve([X]).

not_nc(X) =>
    X :: 0..9,
    X #> 2,
    X #< 8.

nc_not_ac(Y,Z) =>
    [Y,Z] :: 0..9,
    Y + Z #= 5.

ac_not_solvable(U,V,W) =>
```

```
[U,V,W] :: 0..1,  
U #!= V,  
V #!= W,  
W #!= U.
```

Beware of time2/1!

```
In [3]: %%picat  
import cp.  
main =>  
    pigeonhole(L),  
    time(solve(L)), print(L).  
    % time2(solve(L)), print(L).  
  
pigeonhole(L) =>  
    L = new_list(11),  
    L :: 1..10,  
    all_different(L).
```

```
*** error(failed,main/0)
```

Scheduling

Example: moving

A simple scheduling problem: Four friends are moving. The table shows how much time and how many people are necessary to move each item. Schedule the moving to minimize total time. (Adapted from R. Barták's tutorial; check the SICStus Prolog model.)

Item	Time (min)	People
piano	45	4
chair	10	1
bed	25	3
table	15	2
couch	30	3
cat	15	1

```
In [4]: !cat moving/instance.pi
```

```
instance(NumPeople, Items, Duration, People) =>  
    NumPeople = 4,  
    Items = ["piano", "chair", "bed", "table", "couch", "cat"],  
    Duration = [45, 10, 25, 15, 30, 15],  
    People = [4, 1, 3, 2, 3, 1].
```

In [5]: `#!/cat moving/.solution/moving.pi`

How to improve the model?

The `cumulative` global constraint

For the above problem we can use the following global constraint:

```
cumulative(StartTimes, Durations, Resources, Limit)
```

which means that we have `Limit` of resource available, each item starts at `StartTimes[i]`, takes `Durations[i]` time and consumes `Resources[i]` of the resource.

More about the constraint `cumulative`:

- [Picat on GitHub \(unofficial\)](#)
- [Global Constraint Catalog](#): the `cumulative` constraint - see the references