Week 6 Homework

Submit your homework as a MS Word or PDF document this week. Solve the 4 problems below. In each case cut and paste the model and results into this document.

1. Problem 1 (7 pts) – use CP in OPL to solve textbook problem 12.9-2. This is very similar to one of the examples in the presentation this week. Paste your model and results here:

using CP;

int x[1..6] = [3,6,9,12,15,18];

dvar int p[1..5] in 1..6;

maximize 5\*x[p[1]] - 1\*x[p[1]]^2 + 8\*x[p[2]] - 1\*x[p[2]]^2 + 10\*x[p[3]] - x[p[3]]^2 + 15\*x[p[4]]

-x[p[4]]^2+20\*x[p[5]]-x[p[5]]^2;

subject to {

ct1:

allDifferent(p);

ct2:

//x[p[1]] + x[p[3]] + x[p[4]] <= 25;

p[1] + p[3] + p[4] <= 25;

ct3:

p[2] == 1 || p[2] == 2;

ct4:

p[3] == 1 || p[3] == 2 || p[3] == 3 || p[3] == 4;

ct5:

p[4] == 1 || p[4] == 4;

ct6:

p[5] == 3 || p[5] == 4 || p[5] == 5 || p[5] == 6;

}

// Optimal x1 = 3, x2 = 6, x3 = 9, x4 = 12, x5 = 15, x6 = 16

1. Problem 2 (8 pts) – use CP in OPL to solve textbook problem 12.9-5. You’ll need to create a “dummy” race as a place to assign the fifth swimmer. Paste your model and results here:
2. using CP;
3. // Swimmers
4. //[Carl-1, Chris-2, David-3, Tony-4, Ken-5]
5. // backstroke
6. //float x[1..5] = [37.7,32.9,33.8,37.0,35.4];
7. // breaststroke
8. //float x[1..5] = [43.4,33.1,42.4,34.7,41.8];
9. // butterfly
10. //float x[1..5] = [33.3,28.5,38.9,30.4,33.6];
11. // freestyle
12. float x[1..5] = [29.2,26.4,29.6,28.5,31.1];
13. dvar int p[1..4] in 1..5;
14. minimize x[p[1]] + x[p[1]] + x[p[3]] + x[p[4]];
15. subject to {
16. ct1:
17. allDifferent(p);
18. }
19. // Optimal backstroke Chris-2, Carl-1, Ken-5, David-3
20. // Optimal breaststroke Chris-2, David-3, Tony-4, Ken-5
21. // Optimal butterfly Chris-2, David-3, Tony-4, Carl-1
22. // Optimal freestyle Chris-2, David-3, Tony-4, Carl-1
23. Problem 3 (7 pts) – solve the Traveling Salesman Problem using CP as discussed in the presentation and in problem 12-9.8. Write a CP program in OPL to solve the TSP introduced on page 621 of your book. You can start with the file tsp\_cp\_skeleton.mod in the download packet. The model file includes the cost matrix associated with the graph in figure 14.4. Note that we are using a very large value of $M$ as the cost between cities which are not connected to prevent the solution from using those connections. Paste your model and results here:

using CP;

int n = 7;

int M = 1000;

int c[1..n][1..n] =

[ [ 0, 12, 10, M, M, M, 12],

[12, 0, 8, 12, M, M, M],

[10, 8, 0, 11, 3, M, 9],

[ M, 12, 11, 0, 11, 10, M],

[ M, M, 3, 11, 0, 6, 7],

[ M, M, M, 10, 6, 0, 9],

[12, M, 9, M, 7, 9, 0]];

range R = 2..n;

dvar int x[R] in R;

minimize c[1][x[2]] + c[x[2]][x[3]] +

c[x[3]][x[4]] + c[x[4]][x[5]] +

c[x[5]][x[6]] + c[x[6]][x[7]] + c[x[7]][1];

subject to {

ct1:

allDifferent(x);

}

// Optimal path 1,3,5,7,6,4,2,1

1. Problem 4 (8 pts) – use CP in OPL to solve the Reliable Construction Company construction scheduling problem described in the supplemental textbook section 22.1 (in download packet). You’ll want to study the example sched\_intro.mod that is included with OPL (File -> New -> Example …) which is also in the download packet for convenience (we deleted some stuff in the version in the download packet for simplicity). Paste your model and results here:

using CP;

dvar interval a\_excavate size 2;

dvar interval b\_lay\_the\_foundation size 4;

dvar interval c\_put\_up\_rough\_wall size 10;

dvar interval d\_put\_up\_roof size 6;

dvar interval e\_install\_exterior\_plumbing size 4;

dvar interval f\_install\_interior\_plumbing size 5;

dvar interval g\_put\_up\_the\_exterior\_siding size 7;

dvar interval h\_exterior\_painting size 9;

dvar interval i\_electrical\_work size 7;

dvar interval j\_wallboard size 8;

dvar interval k\_flooring size 4;

dvar interval l\_interior\_painting size 5;

dvar interval m\_exterior\_fixtures size 2;

dvar interval n\_interior\_fixtures size 6;

subject to {

endBeforeStart(a\_excavate, b\_lay\_the\_foundation);

endBeforeStart(b\_lay\_the\_foundation, c\_put\_up\_rough\_wall);

endBeforeStart(c\_put\_up\_rough\_wall, d\_put\_up\_roof);

endBeforeStart(c\_put\_up\_rough\_wall, e\_install\_exterior\_plumbing);

endBeforeStart(e\_install\_exterior\_plumbing, f\_install\_interior\_plumbing);

endBeforeStart(e\_install\_exterior\_plumbing, h\_exterior\_painting);

endBeforeStart(d\_put\_up\_roof, g\_put\_up\_the\_exterior\_siding);

endBeforeStart(h\_exterior\_painting, m\_exterior\_fixtures);

endBeforeStart(c\_put\_up\_rough\_wall, i\_electrical\_work);

endBeforeStart(f\_install\_interior\_plumbing, j\_wallboard);

endBeforeStart(j\_wallboard, k\_flooring);

endBeforeStart(j\_wallboard, l\_interior\_painting);

endBeforeStart(k\_flooring, n\_interior\_fixtures);

}

execute {

writeln("excavate : " + a\_excavate.start + ".." + a\_excavate.end);

writeln("lay\_the\_foundation: " + b\_lay\_the\_foundation.start + ".." + b\_lay\_the\_foundation.end);

writeln("put\_up\_rough\_wall : " + c\_put\_up\_rough\_wall.start + ".." + c\_put\_up\_rough\_wall.end);

writeln("put\_up\_roof : " + d\_put\_up\_roof.start + ".." + d\_put\_up\_roof.end);

writeln("install\_exterior\_plumbing : " + e\_install\_exterior\_plumbing.start + ".." + e\_install\_exterior\_plumbing.end);

writeln("install\_interior\_plumbing : " + f\_install\_interior\_plumbing.start + ".." + f\_install\_interior\_plumbing.end);

writeln("put\_up\_the\_exterior\_siding : " + g\_put\_up\_the\_exterior\_siding.start + ".." + g\_put\_up\_the\_exterior\_siding.end);

writeln("exterior\_painting : " + h\_exterior\_painting.start + ".." + h\_exterior\_painting.end);

writeln("electrical\_work : " + i\_electrical\_work.start + ".." + i\_electrical\_work.end);

writeln("wallboard : " + j\_wallboard.start + ".." + j\_wallboard.end);

writeln("flooring : " + k\_flooring.start + ".." + k\_flooring.end);

writeln("interior\_painting : " + l\_interior\_painting.start + ".." + l\_interior\_painting.end);

writeln("exterior\_fixtures : " + m\_exterior\_fixtures.start + ".." + m\_exterior\_fixtures.end);

writeln("interior\_fixtures : " + n\_interior\_fixtures.start + ".." + n\_interior\_fixtures.end);

}

// solution

excavate : 0..2

lay\_the\_foundation: 2..6

put\_up\_rough\_wall : 6..16

put\_up\_roof : 16..22

install\_exterior\_plumbing : 16..20

install\_interior\_plumbing : 20..25

put\_up\_the\_exterior\_siding : 22..29

exterior\_painting : 20..29

electrical\_work : 16..23

wallboard : 25..33

flooring : 33..37

interior\_painting : 33..38

exterior\_fixtures : 29..31

interior\_fixtures : 37..43