Challenge July 2023
Rules as Preferences (Miss Manners Advanced)

A solution with OPL by Alex Fleischer afleischer@fr.ibm.com

OPL (Optimization Programming Language) is an abstract modeling language that helps model easily optimization problems that can be solved both with IBM CPLEX linear programming and IBM CPLEX constraint programming CPOptimizer (CPO)

I slightly changed the OPL model I used in June 2023. I turned all constraints from hard constraints to soft constraints and added the objective to maximize the number of constraints that are true.

The same OPL model works for the 4 data sets:

.mod

```
using CP;

execute
{
  cp.param.timelimit=600;

}

tuple guest
{
  string name;
  string gender;
  int hobby1;
  int hobby2;
  int hobby3;
  int hobby4;
  int hobby5;
}

{string} genders={"m","f","m "," m "," f ","f "};

{guest} guests with gender in genders=...;

int nbGuests=card(guests);
range seats=1..nbGuests;

int isMale[i in seats]=(item(guests,i-1).gender=="m")
|| (item(guests,i-1).gender=="m ") || (item(guests,i-1).gender==" m ");

int nbMen=sum(i in seats) isMale[i];


int nbHobbies=max(g in guests) maxl(g.hobby1,g.hobby2,g.hobby3,g.hobby4,g.hobby5);
```

```
int hobbyPerGuest[g in guests][h in 1..nbHobbies]=
(g.hobby1==h) || (g.hobby2==h) || (g.hobby3==h) || (g.hobby4==h)
 || (g.hobby5==h);

int hobby[i in seats][h in 1..nbHobbies]=hobbyPerGuest[item(guests,i-1)][h];

// decision variable who seats at a given seat
dvar int whoSeatsThere[seats] in seats;

dvar int+ nbOkBoyGirl in 0..nbGuests-2*maxl(nbGuests div 2 - nbMen,nbGuests div 2-
(nbGuests-nbMen));
dvar int+ nbOkHobbies;
dvar int+ satisfactionLevel; // what we want to maximize

// Let us first try to have man woman and then the hobbies
//maximize staticLex(nbOkBoyGirl,nbOkHobbies);
// Let us maximize satisfaction
maximize satisfactionLevel;

subject to
{
  allDifferent(whoSeatsThere);

  satisfactionLevel==nbOkBoyGirl+nbOkHobbies;

  // boy girl

  //forall(i in seats) (i mod 2==0) == isMale[whoSeatsThere[i]];
  nbOkBoyGirl==
  sum(i in seats:i!=1) (isMale[whoSeatsThere[i-1]]!=isMale[whoSeatsThere[i]])
  +(isMale[whoSeatsThere[1]]!=isMale[whoSeatsThere[nbGuests]]);

  // hobby

//  forall(i in 1..nbGuests-1)
//    or(h in 1..nbHobbies)
hobby[whoSeatsThere[i],h]==hobby[whoSeatsThere[i+1],h];
//  or(h in 1..nbHobbies)
hobby[whoSeatsThere[1],h]==hobby[whoSeatsThere[nbGuests],h];

  nbOkHobbies==sum(i in 1..nbGuests-1)
    (1==or(h in 1..nbHobbies)
(hobby[whoSeatsThere[i],h]==hobby[whoSeatsThere[i+1],h]))+
  (1==or(h in 1..nbHobbies)
(hobby[whoSeatsThere[1],h]==hobby[whoSeatsThere[nbGuests],h]));

  // break sym
  whoSeatsThere[1]==1;

}

// display result

execute
{
  writeln("satisfaction level = ",cp.getObjValue());
  writeln("This took ",cp.info.TotalTime, " seconds");
  writeln();
  for(var i in seats)
```

```
        writeln(Opl.item(guests,whoSeatsThere[i]-1));
}
```

And then to link this to the Excel file we use 4 .dat files.

```
SheetConnection s("MissMannersAdvancedData.xls");

guests from SheetRead(s,"'Data-16'!B4:H19");
```

and

```
SheetConnection s("MissMannersAdvancedData.xls");

guests from SheetRead(s,"'Data-32'!B4:H35");
```

and

```
SheetConnection s("MissMannersAdvancedData.xls");

guests from SheetRead(s,"'Data-64'!B4:H67");
```

and

```
SheetConnection s("MissMannersAdvancedData.xls");

guests from SheetRead(s,"'Data-128'!B4:H131");
```

which give and prove optimality

after 0.03 s , 0.04 s , 3 s and 129 s for the 16, 32, 64 and 128 examples:

```
satisfaction level = 24
This took 0.026 seconds

 <"1"  "f" 2 1 3 0 0>
 <"14" "f" 1 2 0 0 0>
 <"10" "m" 3 2 1 0 0>
 <"16" "f" 2 3 0 0 0>
 <"12" "f" 3 1 2 0 0>
 <"2"  "f" 2 1 3 0 0>
 <"9"  "f" 2 3 1 0 0>
 <"8"  "m" 3 1 0 0 0>
 <"15" "f" 2 3 1 0 0>
 <"4"  "m" 3 2 1 0 0>
 <"3"  "f" 3 2 0 0 0>
 <"11" "f" 1 3 2 0 0>
 <"5"  "m" 2 1 3 0 0>
 <"7"  "f" 1 2 3 0 0>
 <"13" "f" 2 3 0 0 0>
 <"6"  "f" 2 3 1 0 0>
```

And

```
satisfaction level = 62
This took 0.042 seconds
```

```
<"dave " "m " 1 3 2 0 0>
<"jill " "f " 1 2 0 0 0>
<"l " "m " 1 3 0 0 0>
<"kate " "f " 3 1 0 0 0>
<"tim " "m " 3 1 0 0 0>
<"alex " "f " 1 3 0 0 0>
<"q " "m " 1 3 0 0 0>
<"pam " "f " 1 3 0 0 0>
<"g " "f " 3 1 0 0 0>
<"doug " "m " 3 1 2 0 0>
<"n " "f " 1 2 0 0 0>
<"dan " "m " 2 3 0 0 0>
<"f " "f " 2 1 0 0 0>
<"s " "m " 3 1 0 0 0>
<"i " "f " 3 2 0 0 0>
<"scott " "m " 2 3 0 0 0>
<"ann " "f " 2 1 3 0 0>
<"e " "m " 3 1 2 0 0>
<"j " "f " 2 1 3 0 0>
<"o " "m " 2 3 0 0 0>
<"carol " "f " 2 1 3 0 0>
<"h " "m " 2 3 0 0 0>
<"sue " "f " 3 2 0 0 0>
<"d " "m " 1 3 2 0 0>
<"m " "f " 2 1 3 0 0>
<"r " "f " 1 3 0 0 0>
<"chuck " "m " 1 3 0 0 0>
<"hope " "f " 2 1 3 0 0>
<"k " "m " 1 2 0 0 0>
<"jane " "f " 2 1 0 0 0>
<"john " "m " 1 2 0 0 0>
<"p " "f " 2 1 3 0 0>
```

And


```
satisfaction level = 124
This took 3.157 seconds

<"1" " m " 2 1 3 0 0>
<"16" " f " 2 3 0 0 0>
<"32" " m " 1 2 0 0 0>
<"7" " f " 1 2 3 0 0>
<"55" " f " 1 2 3 0 0>
<"50" " m " 2 3 0 0 0>
<"46" " f " 1 2 3 0 0>
<"39" " m " 3 1 2 0 0>
<"20" " f " 1 3 2 0 0>
<"31" " m " 1 2 3 0 0>
<"48" " f " 3 2 0 0 0>
<"27" " f " 2 3 1 0 0>
<"13" " m " 2 3 0 0 0>
<"61" " f " 3 2 1 0 0>
<"45" " m " 1 2 0 0 0>
<"38" " f " 1 3 2 0 0>
<"44" " m " 3 1 2 0 0>
```

<"12" " f " 3 1 2 0 0>
<"49" " m " 3 2 0 0 0>
<"54" " f " 1 2 3 0 0>
<"9" " m " 2 3 1 0 0>
<"64" " f " 3 2 0 0 0>
<"42" " m " 3 1 0 0 0>
<"23" " f " 1 2 0 0 0>
<"14" " m " 1 2 0 0 0>
<"56" " f " 2 1 3 0 0>
<"33" " m " 2 3 1 0 0>
<"53" " f " 2 1 0 0 0>
<"47" " m " 1 2 0 0 0>
<"5" "f" 2 1 3 0 0>
<"41" " m " 2 1 3 0 0>
<"25" " f " 3 1 2 0 0>
<"8" " m " 3 1 0 0 0>
<"40" " f " 1 2 3 0 0>
<"26" " m " 2 1 3 0 0>
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<"28" " m " 1 2 0 0 0>
<"62" " f " 2 3 0 0 0>
<"11" " m " 1 3 2 0 0>
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<"35" " f " 2 3 0 0 0>
<"15" " m " 2 3 1 0 0>
<"19" " f " 3 1 0 0 0>
<"51" " f " 2 1 3 0 0>
<"22" " m " 2 3 0 0 0>
<"60" " f " 3 1 0 0 0>
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<"4" "f" 3 2 1 0 0>
<"3" " m " 3 2 0 0 0>
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<"34" " f " 2 1 3 0 0>
<"21" " m " 2 3 0 0 0>
<"24" " f " 3 1 2 0 0>
<"6" " m " 2 3 1 0 0>
<"57" " f " 3 2 1 0 0>
<"37" " m " 2 1 0 0 0>
<"30" " f " 2 1 3 0 0>
<"18" " m " 1 3 2 0 0>
<"29" " f " 2 3 1 0 0>
<"52" " m " 1 2 3 0 0>
<"17" " f " 3 2 0 0 0>

And

satisfaction level = 250
This took 129.248 seconds

<"1" "m" 2 3 1 4 5>
<"70" "f" 3 5 1 4 2>
<"13" "m" 5 1 0 0 0>
<"111" "f" 3 2 0 0 0>
<"50" "m" 2 4 3 0 0>
<"83" "f" 1 3 4 0 0>
<"78" "m" 5 1 0 0 0>

<"99" "f" 2 5 0 0 0>
<"104" "m" 5 3 4 1 2>
<"91" "f" 2 3 5 1 4>
<"51" "m" 1 2 5 4 0>
<"92" "f" 3 1 2 5 0>
<"49" "m" 1 5 4 3 2>
<"29" "f" 3 5 0 0 0>
<"81" "m" 4 1 0 0 0>
<"60" "f" 4 2 3 5 0>
<"116" "m" 3 4 5 1 0>
<"23" "f" 4 5 2 0 0>
<"9" "m" 3 5 2 4 0>
<"87" "m" 5 4 2 3 0>
<"117" "f" 4 5 2 0 0>
<"22" "m" 1 2 4 0 0>
<"118" "f" 2 4 3 0 0>
<"17" "m" 4 3 0 0 0>
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<"26" "m" 1 2 0 0 0>
<"65" "m" 5 3 2 1 4>
<"101" "f" 2 1 5 3 4>
<"90" "m" 2 4 5 0 0>
<"32" "f" 2 1 5 0 0>
<"8" "m" 3 5 0 0 0>
<"56" "m" 2 3 0 0 0>
<"48" "f" 3 1 0 0 0>
<"45" "m" 2 4 0 0 0>
<"112" "f" 4 3 5 2 1>
<"11" "m" 2 4 5 1 0>
<"67" "f" 1 4 0 0 0>
<"119" "m" 5 3 0 0 0>
<"107" "f" 3 1 2 5 4>
<"40" "m" 2 3 0 0 0>
<"75" "f" 4 2 0 0 0>
<"39" "m" 5 2 0 0 0>
<"41" "f" 5 3 0 0 0>
<"34" "m" 4 5 2 0 0>
<"59" "f" 2 3 5 0 0>
<"122" "m" 1 2 5 0 0>
<"63" "f" 2 3 4 1 5>
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<"126" "f" 2 3 1 4 0>
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<"68" "m" 4 2 1 5 0>
<"30" "m" 2 1 0 0 0>
<"73" "f" 4 1 3 0 0>
<"47" "m" 2 5 4 0 0>
<"95" "f" 3 4 0 0 0>
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<"113" "f" 1 3 5 2 0>
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<"44" "f" 2 4 3 1 0>

<"25" "m" 4 5 0 0 0>
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<"61" "m" 1 2 4 3 0>
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<"7" "f" 1 2 3 5 0>
<"100" "m" 2 3 5 4 0>
<"6" "f" 1 4 2 5 3>
<"3" "m" 5 4 2 0 0>
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<"55" "m" 2 4 0 0 0>
<"128" "f" 2 4 1 3 0>
<"42" "m" 5 4 0 0 0>
<"66" "f" 5 3 4 0 0>
<"16" "m" 2 5 4 0 0>
<"38" "f" 3 1 2 4 0>
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<"54" "f" 1 3 0 0 0>
<"24" "m" 4 3 2 1 5>
<"35" "f" 3 1 4 5 2>
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<"10" "m" 2 3 4 5 1>
<"37" "f" 4 2 1 0 0>
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<"127" "f" 5 1 0 0 0>
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<"43" "m" 3 4 5 0 0>

<"105" "f" 4 2 0 0 0>
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