CSI 747 – HW6 – Submission

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Exercise 7.4: PET Image reconstruction Problem:

The model used to solve this problem is as follows:

PET_Model.mod

```
param n;  param N;
set voxels := {1..n}; set lines := {1..N};
param y{lines};
param C{voxels,lines};

var x{voxels} >=0, :=0.001;                    #Constraint & Initial guess
var y_cap{j in lines} = sum {i in voxels} C[i,j]*x[i];
var logy{j in lines} = log(y_cap[j]);

maximize X_cap: sum{j in lines} (-(y_cap[j])+y[j]*logy[j]);
```

(I) The model was run on a problem with 9 variables and with N=33 detector pairs. The data file used was the following:

```
param n := 9;
param N := 33;
param C :
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 :=
1 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0
2 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0
3 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0
4 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0
5 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0
```

6 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0

7 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0

8 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0

9 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18 0 0 0 0 0 0 0 0 0.18 0.017 0.18;

param y:= 0 0 1 19 27 30 40 50 35 15 1 0 0 1 7 20 38 56 55 38 20 7 1 0 1 3 17 38 40 20 7 1 0;

The run yielded the following result:

Output:

ampl: model PET_Model.mod;

MINOS 5.51: optimal solution found.

35 iterations, objective 1395.000296

Nonlin evals: obj = 81, grad = 80.

ampl: display x;

x [*] :=

1 1.68482

2 0

3 3.89696

4 51.3017

5 109.66

6 142.701

7 128.025

8 67.9574

9 14.6668

;

---

2. The model was run on a problem with n=1080 variables and N = 2164 detector pairs. The matrix C was constructed using MATLAB as specified in the problem with a = 0.15 and b = 0.05. The resulting first few lines of the output obtained is as follows:

x [*] :=

1	0.001	217	0.001	433	0.001	649	0.001	865	0.001		
2	0.001	218	0.001	434	0.001	650	0.001	866	0.001		
3	0.001	219	0.001	435	0.001	651	0.001	867	0.001		
4	0.001	220	0.001	436	0.001	652	0.001	868	0.001		
5	0.001	221	0.001	437	0.001	653	0.001	869	0.001		
6	0.001	222	0.001	438	0.001	654	0.001	870	0.001		
7	0.001	223	0.001	439	0.001	655	0.001	871	0.001		
8	0.001	224	0.001	440	0.001	656	0.001	872	0.001		
9	0.001	225	0.001	441	0.001	657	0.001	873	0.001		
10	0.001	226	0.001	442	0.001	658	0.001	874	0.001		
11	0.001	227	0.001	443	576.569	659	0.001	875	0.001		
12	0.001	228	0.001	444	0.001	660	0.001	876	0.001		
13	0.001	229	0.001	445	0.001	661	0.001	877	0.001		
14	0.001	230	0.001	446	0.001	662	0.001	878	0.001		
15	0.001	231	0.001	447	0.001	663	0.001	879	0.001		
16	0.001	232	0.001	448	0.001	664	0.001	880	0.001		
17	0.001	233	0.001	449	0.001	665	0.001	881	0.001		
18	423.426	234	0.001	450	0.001	666	0.001	882	0.001		
19	0.001	235	0.001	451	0.001	667	0.001	883	0.001		
20	0.001	236	0.001	452	0.001	668	0.001	884	0.001		
21	0.001	237	0.001	453	0.001	669	0.001	885	0.001		
22	0.001	238	0.001	454	0.001	670	0.001	886	0.001		
23	0.001	239	0.001	455	0.001	671	0.001	887	369.998		
24	0.001	240	0.001	456	0.001	672	0.001	888	0.001		
25	0.001	241	0.001	457	0.001	673	0.001	889	0.001		
26	0.001	242	0.001	458	0.001	674	0.001	890	0.001		
27	0.001	243	0.001	459	544.283	675	0.001	891	0.001		
28	0.001	244	0.001	460	0.001	676	0.001	892	0.001		
29	0.001	245	0.001	461	0.001	677	0.001	893	0.001		

3. The image obtained after processing the output from AMPL using MATLAB was as follows:

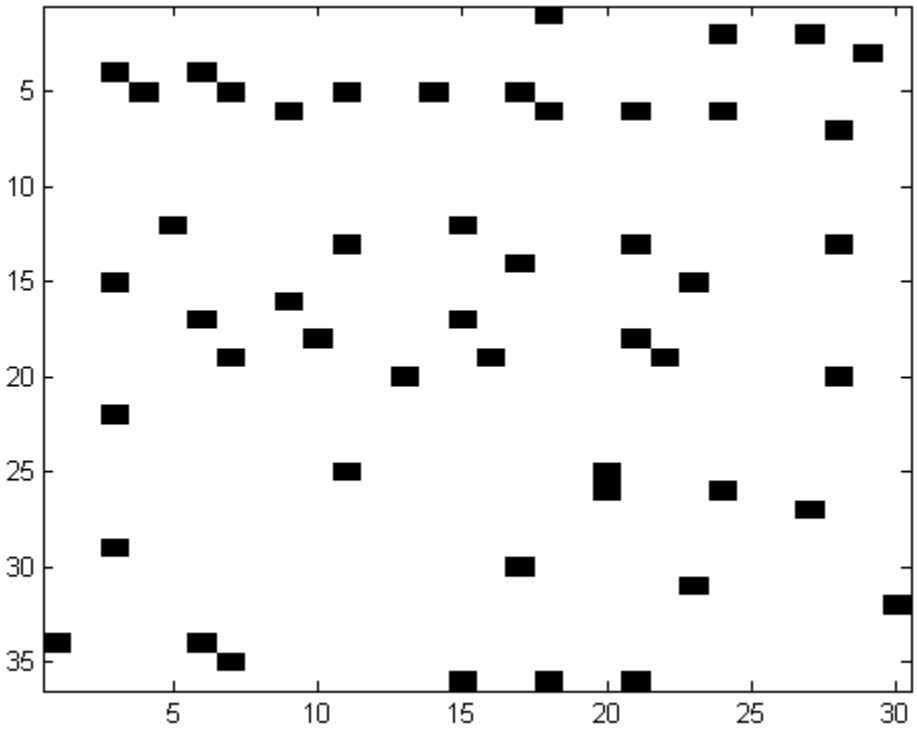

Illustration 1: PET Image - Constructed from Problem 2