MATH2390 Week 11 Hand in Lab

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Question 1

```
% First, let's model the situation and then later convert the model into
% the appropriate format. The seperation of steps will help avoid mistakes.

% Let C_{ij} be the 6x4 matrix of financial costs given already, loaded up
% Let CombinationsEq_{ij} be the appropriate 6x4 constraint matrix for
% equalities
% Let CombinationsInEq_{ij} be the appropriate 6x4 constraint matrix for
% inequalities

% a)
%   Forall j, CombinationsEq_{1j} - CombinationsEq_{3j} = 0

% b)
%   CombinationsInEq_{21} - CombinationsInEq_{51} <= 0

% c)
%   CombinationsEq_{43} +
%   CombinationsEq_{44} +
%   CombinationsEq_{53} +
%   CombinationsEq_{54} = 0

% d)
%   Forall j, CombinationsInEq_{2j} + CombinationsInEq_{6j} <= 1

% e)
%   C_{*,1} <= 300

% There are two additional constraints, that are in the initial paragraph:
% let's call them constraints f, g;

% f)
%   Forall j, forall i, sum over CombinationsEq_{ij} = 4
```

```
% g)
%   This one forces locations to have at most one project, see Question 2b
%   code to understand the logic
```

Question 2 a)

```
load("data_platypus.mat");

CostL = reshape(transpose(Cost), [1, 24]);
```

Question 2 b)

```
type question2b.m

[Aeq, beq, A, b] = question2b(CostL);


function [Aeq, beq, A, b] = question2b(CostL)

    % It's neater to make inequalities for pairs of locations
    % and then compose them at the end into their final matrix form

    % constr a)
    % = 0
    AirleeBeachGoldCoastEq = [eye(4), zeros([4,4]), -eye(4), zeros([4,12])];

    % constr b)
    % <= 0
    BrisbaneSydneyIneq = [zeros([1,4]),1,zeros([1,6]),-1,zeros(1,12)];

    % constr c)
    % = 0
    MelbourneSydneyEq = [zeros([1,14]), ...
                         ones([1,2]), ...
                         zeros([1,2]), ...
                         ones([1,2]), ...
                         zeros([1,4])];

    % constr d)
    % <= 1
    BrisbanePerthIneq = [zeros([4,4]), eye(4), zeros([4,12]), eye(4)];

    % constr e)
    % <= 300
    Year1Ineq = repmat([1,zeros([1,3])],[1,6]) .* CostL;

    % constr f)
    % This one was added to force at most one project per location

    years=4;
    locations=6;

    UniqueLocationIneq = zeros(locations, years*locations);
```

```
    for i=1:locations
        newRow = [repmat(zeros([1,4]), [1,i-1]), ...
                         ones([1,4]), ...
                         repmat(zeros([1,4]), [1,locations-i])];
        UniqueLocationIneq(i,:) = newRow;
    end

    % Now, combine all results

    Aeq = [AirleeBeachGoldCoastEq;
           MelbourneSydneyEq;
           ones([1,24])];

    beq = [zeros([5,1,]);
           4];


    A = [BrisbaneSydneyIneq;
         BrisbanePerthIneq;
         Year1Ineq;
         UniqueLocationIneq];
    b = [0;
         ones([4,1]);
         300;
         ones(6,1)];

end
```

Question 2 c)

```
type question2c.m

x = question2c(CostL, Aeq, beq, A, b);


function x = question2c(CostL, Aeq, beq, A, b)
    ub = ones([1,24]);
    lb = zeros([1,24]);
    intVars = 1:24;

    x = intlinprog(CostL, intVars, A, b, Aeq, beq, lb, ub);
end
LP:                Optimal objective value is 519.642857.


Cut Generation:    Applied 1 Gomory cut.

                   Lower bound is 525.000000.

                   Relative gap is 0.00%.
```

```
Optimal solution found.

Intlinprog stopped at the root node because the objective value is within a
 gap
tolerance of the optimal value, options.AbsoluteGapTolerance = 0. The intcon
variables are integer within tolerance, options.IntegerTolerance = 1e-05.
```

Question 2 d)

```
% The way to interpret the result is to get the optimal values (currently
% a vector) back to the order it was. It is ordered such that each location
% iterates through the four years. So therefore, convert it to a
% 4x6 matrix, and then transpose it to get this back to the original order
% locations x years

locationsYears = transpose(reshape(x, [4,6]));
disp(locationsYears);

% The optimum solution is to build 4 projects:

% Each of the constraints is met:
% - a) Gold Coast and Airlee Beach will not proceed
% - b) Brisbane doesn't start on year 1
% - c) Melbourne and Sydney are built but not years 3 or 4
% - d) Brisbane starts year 2 and Perth year 1
% - e) Sydney and Perth in year 1 are < $300M
% - f) all locations have no more than one project
% - g) there are 4 projects scheduled
```

```
     0     0     0     0
     0     1     0     0
     0     0     0     0
     0     1     0     0
     1     0     0     0
     1     0     0     0
```

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