HW 4 Solution - ISE 754 Fall 2020

Contents

Question 1

(see Basic Concepts)

Question 2

Apply Majority Theorem conditions

```
W = [5 0 0; 0 6 0; 0 0 0; 0 0 8];
V = zeros(4); V(1,3) = 8; V(2,3) = 2; V(3,4) = 9;
type applyMajorityTh
applyMajorityTh(W,V)
```

```
function applyMajorityTh(W,V)
% Apply multifacility Majority Theorem conditions.
% applyMajorityTh(W,V), where W = NF-EF and V = NF-NF monetary weights

mdisp(W), mdisp(V)
V = V + V';
[n m] = size(W);
idxEF = nan(n,1);
idxCoLoc = num2cell((1:n)');
done = false;
```

```
% Check for NF-NF co-location
while ~done
   mdisp([W V],[],[],'WV')
   [iv,jv] = find(V > 0 & V >= sum([W V],2)/2,1,'first');
   if isempty(iv)
      done = true;
   else
      fprintf('NF%d co-located with NF%d\n',iv,jv)
      idxCoLoc{iv} = [idxCoLoc{iv} idxCoLoc{jv}];
      W(iv,:) = W(iv,:) + W(jv,:); W(jv,:) = 0;
      V(iv,:) = V(iv,:) + V(jv,:); V(:,iv) = V(:,iv) + V(:,jv);
      V(jv,:) = 0; V(:,jv) = 0; V(iv,iv) = 0;
   end
end
% Check if NF can be located at EF
[iw,jw] = find(W > 0 & W >= sum([W V],2)/2);
if ~isempty(iw)
   for i = 1:length(iw)
      idxEF(idxCoLoc{iw(i)}) = jw(i);
   end
end
for i = 1:length(idxEF)
   if(~isnan(idxEF(i)))
      fprintf('NF%d located at EF%d\n',i,idxEF(i))
   end
end
```

```
W:  1  2  3
-:---------
1:  5  0  0
2:  0  6  0
3:  0  0  0
4:  0  0  8

V:  1  2  3  4
-:------------
1:  0  0  8  0
2:  0  0  2  0
3:  0  0  0  9
4:  0  0  0  0

WV:  1  2  3  4  5  6  7
--:----------------------
 1:  5  0  0  0  0  8  0
 2:  0  6  0  0  0  2  0
 3:  0  0  0  8  2  0  9
 4:  0  0  8  0  0  9  0
NF1 co-located with NF3

WV:  1  2  3  4  5  6  7
--:----------------------
 1:  5  0  0  0  2  0  9
 2:  0  6  0  2  0  0  0
 3:  0  0  0  0  0  0  0
 4:  0  0  8  9  0  0  0
NF4 co-located with NF1
```

```
WV:  1  2  3  4  5  6  7
--:--------------------
 1:  0  0  0  0  0  0  0
 2:  0  6  0  0  0  0  2
 3:  0  0  0  0  0  0  0
 4:  5  0  8  0  2  0  0
NF1 located at EF3
NF2 located at EF2
NF3 located at EF3
NF4 located at EF3
```

Check Numeric Solution

```
W = [5 0 0; 0 6 0; 0 0 0; 0 0 8];
V = zeros(4); V(1,3) = 8; V(2,3) = 2; V(3,4) = 9;
P = [0 1; 0 0; sqrt(1 -.5^2) .5]  % All 3 pts dist = 1
[X,TC,XFlg,X0] = minisumloc(P,W,2,V)
```

```
P =

         0    1.0000
         0         0
    0.8660    0.5000


X =

    0.8660    0.5000
    0.0045    0.0026
    0.8660    0.5000
    0.8660    0.5000


TC =

    7.0207


XFlg =

     2


X0 =

    0.7056    0.6324
    0.7844    0.0975
    0.1100    0.2785
    0.7910    0.5469
```

Question 3

Apply Majority Theorem conditions

Apply Majority Theorem conditions

```
n = 3; m = 5;
W = zeros(n,m); W(1,1) = 2; W(1,2) = 1; W(2,3) = 3;
W(3,4) = 2; W(3,5) = 1;
V = zeros(n); V(1,2) = 1; V(2,3) = 1;
type applyMajorityTh
applyMajorityTh(W,V)
```

```
function applyMajorityTh(W,V)
% Apply multifacility Majority Theorem conditions.
% applyMajorityTh(W,V), where W = NF-EF and V = NF-NF monetary weights

mdisp(W), mdisp(V)
V = V + V';
[n m] = size(W);
idxEF = nan(n,1);
idxCoLoc = num2cell((1:n)');
done = false;
% Check for NF-NF co-location
while ~done
   mdisp([W V],[],[],'WV')
   [iv,jv] = find(V > 0 & V >= sum([W V],2)/2,1,'first');
   if isempty(iv)
      done = true;
   else
      fprintf('NF%d co-located with NF%d\n',iv,jv)
      idxCoLoc{iv} = [idxCoLoc{iv} idxCoLoc{jv}];
      W(iv,:) = W(iv,:) + W(jv,:); W(jv,:) = 0;
      V(iv,:) = V(iv,:) + V(jv,:); V(:,iv) = V(:,iv) + V(:,jv);
      V(jv,:) = 0; V(:,jv) = 0; V(iv,iv) = 0;
   end
end
% Check if NF can be located at EF
[iw,jw] = find(W > 0 & W >= sum([W V],2)/2);
if ~isempty(iw)
   for i = 1:length(iw)
      idxEF(idxCoLoc{iw(i)}) = jw(i);
   end
end
for i = 1:length(idxEF)
   if(~isnan(idxEF(i)))
      fprintf('NF%d located at EF%d\n',i,idxEF(i))
   end
end
```

```
W:  1  2  3  4  5
-:---------------
1:  2  1  0  0  0
2:  0  0  3  0  0
3:  0  0  0  2  1

V:  1  2  3
-:---------
1:  0  1  0
2:  0  0  1
```

```
3:  0  0  0

WV:  1  2  3  4  5  6  7  8
--:------------------------
 1:  2  1  0  0  0  0  1  0
 2:  0  0  3  0  0  1  0  1
 3:  0  0  0  2  1  0  1  0
NF1 located at EF1
NF2 located at EF3
NF3 located at EF4
```

Question 4

(a)

```
city2lonlat = @(city,st) ...
   uscity('XY',mand(city,uscity('Name'),st,uscity('ST')));
Psupp = city2lonlat({'Gainesville','Warren'},{'FL','OH'});
Pcust = uszip5('XY',...
   mand([10020 17112 27707 32606 48234 56123],uszip5('Code5')));
fcust = [10 40 35 15 30 25];
fsupp = [1600 250]*sum(fcust)/2000
rsupp = [0.012 0.025];
rcust = 0.06;
w = [fsupp.*rsupp fcust*rcust]
[XYa,TCa] = minisumloc([Psupp; Pcust],w,'mi')
lonlat2city(XYa)
```

```
fsupp =

  124.0000   19.3750


w =

  Columns 1 through 7

    1.4880    0.4844    0.6000    2.4000    2.1000    0.9000    1.8000

  Column 8

    1.5000


XYa =

  -79.8088   38.7757


TCa =

   4.6055e+03
```

```
XYa is 100.71 mi N of Lynchburg, VA
```

(b)

```
W = zeros(3,8);
W(1,1:2) = w(1:2);
W(2,3:6) = w(3:6);
W(3,7:8) = w(7:8)
V = zeros(3);
V(1,2) = .04*sum(fcust(1:4));
V(1,3) = .04*sum(fcust(5:6))
[XYb,TCb] = minisumloc([Psupp; Pcust],W,'mi',V)
lonlat2city(XYb)
```

```
W =

  Columns 1 through 7

    1.4880    0.4844         0         0         0         0         0
         0         0    0.6000    2.4000    2.1000    0.9000         0
         0         0         0         0         0         0    1.8000

  Column 8

         0
         0
    1.5000


V =

         0    4.0000    2.2000
         0         0         0
         0         0         0


XYb =

  -79.1036   38.3627
  -79.1036   38.3627
  -83.0395   42.4312


TCb =

   4.3211e+03


XYb 1 is 66.71 mi N of Lynchburg, VA
XYb 2 is 66.71 mi N of Lynchburg, VA
XYb 3 is 4.32 mi S of Warren, MI
```

(c)

```
fprintf('Pct reduction transport cost using two DCs = %.2f%%\n',...
   100*((TCa - TCb)/TCa))
```

```
Pct reduction transport cost using two DCs = 6.17%
```

Question 5

```
city = {'Asheville','Statesville','Winston-Salem','Greensboro',...
   'Durham','Raleigh','Wilmington'};  % City name cell array
P = [50 150 190 220 270 295 420]';    % I-40 mile marker
X0 = [60 125 130]'
w = ones(1,length(P))
[X,TC,W] = ala(X0,w,P,1); X,TC,full(W)
```

```
X0 =

    60
   125
   130


w =

     1     1     1     1     1     1     1


X =

   50.0000
  295.0000
  190.0000


TC =

  220.0000


ans =

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

Question 6

Determine Store Locations and Weights

```
city2lonlat = @(city,st)
```

```
city2lonlat = @(city,st) ...
   uscity('XY',mand(city,uscity('Name'),st,uscity('ST')));
xyRichmond = city2lonlat('Charlottesville','VA');
XY = uscity('XY');
[Name,ST,P,w] = uscity('Name','ST','XY','Pop',...
   mor({'NC','SC','VA'},uscity('ST')) & ...
   uscity('Pop') >= 5000 & XY(:,2) <= xyRichmond(2));
w = w(:)';
```

Determine Transport Rate (in $/person-mi)

```
DC0 = P(mand('Roanoke Rapids',Name,'NC',ST),:)
TD0 = sum(w.*dists(DC0,P,'mi'))
TC0 = 5.7e6
r = TC0/TD0
```

```
DC0 =

  -77.6486   36.4460


TD0 =

   1.3681e+09


TC0 =

     5700000


r =

    0.0042
```

(a)

```
DC = minisumloc(P,w,'mi')
TCa = r * sum(w.*dists(DC,P,'mi'))
fprintf('Annual reduction in TC = $%d\n',round(TC0 - TCa))
```

```
DC =

  -79.2871   35.7704


TCa =

   4.5511e+06


Annual reduction in TC = $1148870
```

```
Annual reduction in TC = $1148870
```

(b)

```
nruns = 5; TC = Inf; rng(222009)
for i=1:nruns
   [DCi,TCi,Wi] = ala(randX(P,3),w,P,'mi');
   if TCi < TC, TC = TCi; DC = DCi; W = Wi; end
end
TCb = full(r * sum(sum(W.*dists(DC,P,'mi'))))
fprintf('Annual reduction in TC = $%d\n',round(TC0 - TCb))
```

```
TCb =

   2.1894e+06

Annual reduction in TC = $3510637
```

(c)

```
nruns = 5; TC = Inf; rng(222009)
for i=1:nruns
   [DCi,TCi,Wi] = ala(randX(P,2),w,P,'mi');
   if TCi < TC, TC = TCi; DC = DCi; W = Wi; end
end
TCc = full(r * sum(sum(W.*dists(DC,P,'mi'))))
fprintf('Annual reduction in TC = $%d\n',round(TC0 - TCc))
```

```
TCc =

   2.9767e+06

Annual reduction in TC = $2723344
```

(d)

```
loc_h = @(W,X0) [DC0; minisumloc(P,W(2,:),'mi',[],X0(2,:))];
nruns = 5; TC = Inf; rng(200944)
for i=1:nruns
   [DCi,TCi,Wi] = ala([DC0; randX(P,1)],w,P,'mi',loc_h);
   if TCi < TC, TC = TCi; DC = DCi; W = Wi; end
end
TCd = full(r * sum(sum(W.*dists(DC,P,'mi'))))
fprintf('Annual increase in TC = $%d\n',round(TCd - TCc))
```

```
TCd =

   3.0427e+06
```

```
Annual increase in TC = $65999
```

Published with MATLAB® R2019b