

Annex 1

(Programes utilitzats)

Enunciat

enunciat

```
clear all
%entrada de dades(punts aleatoris)
l1=input('longitud de la superfície \n');
l2=input('amplada de la superfície \n');
n=input('numero de nodes inicial \n');
tol=input('tolerancia reducció de punts \n');
dia=l1+l2;
A=l1*l2;
[x,y]=puntsaleatoris(l1,l2,n);
%reduccio punts propers
xx=x;
yy=y;
[val,pos,D]=matriudistancies(x,y,n,dia);
[pesos,xdef,ydef]=reducciodepunts(x,y,D,n,dia,tol);
%separacio per pesos(nomes de cara al dibuix)
[xdef1,ydef1,xdef2,xdef3,xdef4,ydef2,ydef3,ydef4]=dib
uixcolors(xdef,ydef,pesos);
%centre de gravetat del conjunt final
[xcg1,ycg1,xcg2,ycg2]=centredegravetat(x,y,xdef,ydef,
pesos);
subplot(2,1,1);plot(x,y,'o')
hold on
subplot(2,1,1);plot(xcg1,ycg1,'*')
hold off
axis([0 l1 0 l2]);
legend('60                                punts
inicials','cg',3,'Orientation','horizontal','Location','SO');
subplot(2,1,2);plot(xcg2,ycg2,'*')
hold on
subplot(2,1,2);plot(xdef1,ydef1,'ro')
hold on
subplot(2,1,2);plot(xdef2,ydef2,'go')
hold on
subplot(2,1,2);plot(xdef3,ydef3,'mo')
hold on
subplot(2,1,2);plot(xdef4,ydef4,'ko')
hold off
axis([0 l1 0 l2]);
legend('cg','pes=1','pes=2','pes=3','pes>3',5,'Orientatio
n','horizontal','Location','NO');
fprintf('%3.0f punts finals.\n',length(xdef1))
dcg=sqrt((xcg1-xcg2)^2+(ycg1-ycg2)^2);
fprintf('%3.5f %3.5f centre de gravetat.\n',xcg1,ycg1)
fprintf('%3.5f %3.5f centre de gravetat.\n',xcg2,ycg2)
fprintf('%3.5f m de distancia entre centres de
gravetat.\n',dcg)
%creacio de la topografia i de la xarxa de carreteres
Z=peaks(l1+l2);
coef1=rand;
coef2=rand;
coef3=rand;
coef4=rand;
for i=1:l2
    for j=1:l1
        ZZ(i,j)=(coef1*Z(i+30,j+30)+coef2*Z(i+32,j+33)-
coef3*Z(i+31,j+32)-coef4*Z(i+35,j+38))/160;
        ZZZ(j,i)=(-
coef2*Z(i+20,j+20)+coef2*Z(i+22,j+23)+coef3*Z(i+21,j
+22)-coef1*Z(i+25,j+28))/160;
        ZZZZ(j,i)=(coef4*Z(i+15,j+30)-coef2*Z(i+12,j+23)-
coef2*Z(i+21,j+32)+coef4*Z(i+39,j+31))/160;
        ZZZZ(i,j)=(coef1*Z(i+10,j+34)-coef3*Z(i+32,j+39)-
coef3*Z(i+1,j+12)-coef4*Z(i+25,j+35))/160;
        ZZZZZZ(i,j)=(-coef3*Z(i+21,j+39)-
coef4*Z(i+5,j+32)-
coef3*Z(i+36,j+39)+coef1*Z(i+3,j+8))/160;
        ZZZZZZ(j,i)=(-
coef1*Z(i+23,j+13)+coef2*Z(i+3,j+13)+coef4*Z(i+17,j+
33)-coef4*Z(i+5,j+9))/160;
        topo(i,j)=1*(1.05+(ZZ(i,j)+ZZZ(j,i)+ZZZZ(j,i)+ZZZZZ(i,j)
+ZZZZZ(j,i)+ZZZZZZ(i,j)+10*ZZ(i,j)*ZZZ(j,i)+19*ZZZ
Z(j,i)*ZZZZZ(i,j)+14*ZZZZZ(i,j)*ZZZZZZZ(i,j))/2);
    end
end
```

```
end
for i=1:length(xdef)
    xdefent(i)=fix(xdef(i));
    ydefent(i)=fix(ydef(i));
    zdefent(i)=topo(ydefent(i),xdefent(i));
end
figure (2)
subplot(2,1,1);meshz(topo)
subplot(2,1,2);contour(topo)
hold on
subplot(2,1,2);plot(0,0)
hold off
figure (3)
subplot(2,1,1);meshz(topo)
hold on
subplot(2,1,1);plot3(xdefent,ydefent,zdefent,'ko')
hold off
subplot(2,1,2);contour(topo)
hold on
subplot(2,1,2);plot(xdefent,ydefent,'ko')
hold off
[transport]=centredegravetat(topo(l1,l2,xdefent,ydefent,
pesos,topo));
[val,pos]=min(transport);
[va,po]=min(val);
fprintf('%3.0f %3.0f centre de
gravetat.\n',pos(po),po)
```

puntsaleatoris

```
function [x,y]=puntsaleatoris(l1,l2,n);
for i=1:n
    x(i)=1+rand*l1;
end
for j=1:n
    y(j)=1+rand*l2;
end
```

matriudistancies

```
function [val,pos,D]=matriudistancies(xx,yy,n,dia);
for i=1:n
    D(i,i)=dia;
    for j=i+1:n
        D(i,j)=sqrt((xx(i)-xx(j))^2+(yy(i)-yy(j))^2);
        D(j,i)=D(i,j);
    end
    [val(i),pos(i)]=min(D(i,:));
end
```

reducciodepunts

```
function
[pesos,xdef,ydef]=reducciodepunts(x,y,D,n,dia,tol);
xx=x;
yy=y;
[distmin,posmin]=min(D);
[distmintot,posmintot]=min(distmin);
pes=ones(1,n);
if distmintot<tol
    xx(posmintot)=0.5*(x(posmintot)+x(posmin(posmintot))
);
    yy(posmintot)=0.5*(y(posmintot)+y(posmin(posmintot))
);
    xx(posmin(posmintot))=0;
    yy(posmin(posmintot))=0;
    pes(posmintot)=2;
    pes(posmin(posmintot))=0;
end
[val,pos,D]=matriudistancies(xx,yy,n,dia);
D(posmin(posmintot),:)=dia;
D(:,posmin(posmintot))=dia;
while distmintot<tol
    [distmin,posmin]=min(D);
```

```
[distmintot, posmintot]=min(distmin);
if distmintot<tol
xx(posmintot)=(1/(pes(posmintot)+pes(posmin(posmintot))))*(pes(posmintot)*x(posmintot)+pes(posmin(posmintot))*x(posmin(posmintot)));
yy(posmintot)=(1/(pes(posmintot)+pes(posmin(posmintot))))*(pes(posmintot)*y(posmintot)+pes(posmin(posmintot))*y(posmin(posmintot)));
xx(posmin(posmintot))=0;
yy(posmin(posmintot))=0;

pes(posmintot)=pes(posmintot)+pes(posmin(posmintot));
pes(posmin(posmintot))=0;
end
[val, pos, D]=matriudistancies(xx, yy, n, dia);
for i=1:n
if xxx(i)==0
D(i,:)=dia;
D(:,i)=dia;
end
end
k=0;
xxx=xx;
yyy=yy;
pess=pes;
xxx(n+1)=0;
yyy(n+1)=0;
pess(n+1)=0;
for i=1:n
j=i;
while (xxx(i)==0 & j<n+1)
j=j+1;
xxx(i)=xxx(j);
yyy(i)=yyy(j);
pess(i)=pess(j);
end
if j>i;
xxx(j)=0;
yyy(j)=0;
pess(j)=0;
end
end
for i=1:n
if xxx(i)==0
k=k+1;
end
end
for i=1:n-k
xdef(i)=xxx(i);
ydef(i)=yyy(i);
pesos(i)=pess(i);
end
```

dibuixcolors

```
function
[xdef1, ydef1, xdef2, xdef3, xdef4, ydef2, ydef3, ydef4]=dibuixcolors(xdef, ydef, pesos);
k=max(pesos);
xdef1=0;
ydef1=0;
xdef2=0;
ydef2=0;
xdef3=0;
ydef3=0;
xdef4=0;
ydef4=0;
for j=1:k
for i=1:length(pesos)
if pesos(i)==j
DC(j,i)=xdef(i);
CD(j,i)=ydef(i);
end
end
end
```

```
end
xdef1=DC(1,:);
ydef1=CD(1,:);
if k>1
xdef2=DC(2,:);
ydef2=CD(2,:);
end
if k>2
xdef3=DC(3,:);
ydef3=CD(3,:);
end
if k>3
xdef4=xdef-xdef1-xdef2-xdef3;
ydef4=ydef-ydef1-ydef2-ydef3;
end
```

centregravetat

```
function
[xcg1, ycg1, xcg2, ycg2]=centregravetat(x, y, xdef, ydef, pesos)
xcg1=(1/(length(x)))*sum(x);
ycg1=(1/(length(y)))*sum(y);
for i=1:length(xdef)
xdeff(i)=pesos(i)*xdef(i);
ydeff(i)=pesos(i)*ydef(i);
end
xcg2=(1/(sum(pesos)))*sum(xdeff);
ycg2=(1/(sum(pesos)))*sum(ydeff);
```

centregravetattopo

```
function
[transport]=centregravetattopo(l1, l2, xdefent, ydefent, pesos, topo)
for i=1:l1
for j=1:l2
for t=1:length(xdefent)
dist(t)=sqrt((i-xdefent(t))^2+(j-ydefent(t))^2);
for k=min(i, xdefent(t)):max(i, xdefent(t))
for p=min(j, ydefent(t)):max(j, ydefent(t))
beta(p, k)=topo(p, k);
end
end
a=size(beta);
coefbeta=sum(sum(beta))/((a(1))*a(2));
trans(t)=dist(t)*pesos(t)*coefbeta;
end
transport(i, j)=sum(trans);
end
end
```

localitzacio de hubs

vehicles

```
clear all
capv1=1500;
capv2=3000;
capv3=9000;
capv4=16000;
capv5=25000;
costv1=0.15*80;
costv2=0.188*80;
costv3=0.26*80;
costv4=0.393*80;
costv5=0.388*80;
costd1=17.75;
costd2=18.72;
costd3=21.51;
costd4=26.3;
costd5=29;
for i=0:500:500000
cant(i/500+1)=i;
```

```

costtt1(i/500+1)=costd1+costv1*(1+fix((cant(i/500+1)+
1)/capv1));
costtt2(i/500+1)=costd2+costv2*(1+fix((cant(i/500+1)+
1)/capv2));
costtt3(i/500+1)=costd3+costv3*(1+fix((cant(i/500+1)+
1)/capv3));
costtt4(i/500+1)=costd4+costv4*(1+fix((cant(i/500+1)+
1)/capv4));
costtt5(i/500+1)=costd5+costv5*(1+fix((cant(i/500+1)+
1)/capv5));
end
costtt1(1)=0;
costtt2(1)=0;
costtt3(1)=0;
costtt4(1)=0;
costtt5(1)=0;
for i=0:500:500000
cant(1+i/500)=i;
costt1=costd1+costv1*(1+fix((cant(1+i/500)-
1)/capv1));
costt2=costd2+costv2*(1+fix((cant(1+i/500)-
1)/capv2));
costt3=costd3+costv3*(1+fix((cant(1+i/500)-
1)/capv3));
costt4=costd4+costv4*(1+fix((cant(1+i/500)-
1)/capv4));
costt5=costd5+costv5*(1+fix((cant(1+i/500)-
1)/capv5));
costos=[costt1 costt2 costt3 costt4 costt5];
tra(1+i/500)=min(costos);
end
tra(1)=0;
cant(1)=0;
subplot(2,2,1),plot(cant,tra)
subplot(2,2,2),plot(cant,tra)
axis([0 50000 0 100])
subplot(2,2,3),plot(cant,costtt1,'b')
hold on
subplot(2,2,3),plot(cant,costtt2,'r')
hold on
subplot(2,2,3),plot(cant,costtt3,'g')
hold on
subplot(2,2,3),plot(cant,costtt4,'c')
hold on
subplot(2,2,3),plot(cant,costtt5,'m')
hold off
subplot(2,2,4),plot(cant,costtt1,'b')
hold on
subplot(2,2,4),plot(cant,costtt2,'r')
hold on
subplot(2,2,4),plot(cant,costtt3,'g')
hold on
subplot(2,2,4),plot(cant,costtt4,'c')
hold on
subplot(2,2,4),plot(cant,costtt5,'m')
hold off
axis([0 50000 0 100])

dades

clear all
%entrada de dades
l1=300;
l2=150;
puf=2;
puc=1;
pesos=[40000    20000    40000    10000
        20000    30000    60000    40000
        10000    50000    40000    30000
        10000    10000    70000    20000
        30000    40000    30000    50000
    
```

	20000	20000	40000	30000
	10000	10000	20000	20000
	10000	20000	20000	20000
	30000	30000	20000	10000
	10000	10000];		
xdef=[93.303	195.03	213.79	222.07	
277.27	186.31	54.154	85.916	
244.73	117.84	210.08	294.58	
173.97	290.99	151.12	265.08	
60.659	266.96	295.81	241.51	
14.567	18.612	226.72	184.26	
160.14	91.889	174.3	141.92	
118.67	15.459	292.57	119.28	
270.41	73.541	48.611	297.47	
234.09	19.392];			
ydef=[32	127.51	31.86	103.65	142.36
59.102	108.71	72.153	58.389	
87.545	72.322	99.176	110.05	
1.5512	129.76	107.36	13.549	
22.063	128.14	144.4	50.33	
142.53	9.5586	8.4296	1.921	
138.28	35.433	28.685	135.77	
111.51	71.265	51.692	57.542	
91.844	45.774	43.934	84.006	
4.6346];				

localitzaciodehubs

```

%1 hub a cada punt
i=0;
hubsx=xdef;
hubsy=ydef;
for k=1:length(hubsx)
cant=pesos(k);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
cost(k)=costdiari+tra*(sqrt((hubsx(k)-
0.5*l1)^2+(hubsy(k)-0.5*l2)^2));
pesos_hubs(k)=pesos(k);
end
[costhubs]=cost_hubs(pesos_hubs);
coste(1)=sum(cost)+sum(costhubs);
%matriu de distancies
dist=100000*ones(length(hubsx));
for p=1:length(hubsx)
for q=p+1:length(hubsx)
dist(p,q)=sqrt((hubsx(p)-hubsx(q))^2+(hubsy(p)-
hubsy(q))^2);
dist(q,p)=dist(p,q);
end
end
%calcul dels estalvis
for s=1:length(hubsx)
for g=1:length(hubsx)
cdg=[(1/(pesos_hubs(s)+pesos_hubs(g)))*(pesos_hubs(s)*hubsx(s)+pesos_hubs(g)*hubsx(g))
(1/(pesos_hubs(s)+pesos_hubs(g)))*(pesos_hubs(s)*hubsy(s)+pesos_hubs(g)*hubsy(g))];
cant=pesos_hubs(g)+pesos_hubs(s);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
costcam=costdiari+tra*(sqrt((cdg(1)-0.5*l1)^2+((cdg(2)-
0.5*l2)^2)));
cant=pesos_hubs(s);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
costfurgo1=costdiari+2*tra*(sqrt((cdg(1)-
hubsx(s))^2+(cdg(2)-hubsy(s))^2));
cant=pesos_hubs(g);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
    
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costfurgo2=2*tra*(sqrt((cdg(1)-hubsx(g))^2+(cdg(2)-
hubsy(g))^2));
costfurgo(s,g)=costfurgo1+costfurgo2;
costt=costfurgo(s,g)+costcam;
[cosst,cosstt]=cost_hub(pesos_hubs,g,s);
ahorro(s,g)=cost(g)+cost(s)-costt+cosst(g)+cosst(s)-
cosstt;
end
ahorro(s,s)=0;
end
[aahorro,posii]=max(ahorro);
[val,posi]=max(aahorro);
costfurgos=0;
while val>0.00*coste
nn1=posii(posi);
nn2=posi;
if nn1<nn2
n2=nn1;
n1=nn2;
end
if nn1>nn2
n1=nn1;
n2=nn2;
end
ncdg=[(1/(pesos_hubs(n1)+pesos_hubs(n2)))*(pesos_
hubs(n1)*hubsx(n1)+pesos_hubs(n2)*hubsx(n2))
(1/(pesos_hubs(n1)+pesos_hubs(n2)))*(pesos_hubs(n
1)*hubsy(n1)+pesos_hubs(n2)*hubsy(n2))];
%vector de hubs
hubsx(n1)=hubsx(length(hubsx)-i);
hubsx(n2)=ncdg(1);
hubsy(n1)=hubsy(length(hubsx)-i);
hubsy(n2)=ncdg(2);
pesos_hubs(n2)=pesos_hubs(n1)+pesos_hubs(n2);
pesos_hubs(n1)=pesos_hubs(length(hubsx)-i);
noodes(i+1,1)=n1;
noodes(i+1,2)=n2;
cost(length(hubsx)-i)=0;
%informacio dels hubs
hubsx(length(hubsx)-i)=0;
hubsy(length(hubsx)-i)=0;
pos(length(hubsx)-i)=0;
pesos_hubs(length(hubsx)-i)=0;
i=i+1;
for k=1:length(hubsx)-i
cant=pesos_hubs(k);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
cost(k)=costdiari+tra*(sqrt((hubsx(k)-
0.5*11)^2+(hubsy(k)-0.5*12)^2));
end
[costhubs]=cost_hubs(pesos_hubs);
costfurgos=costfurgos+costfurgo(n2,n1);
coste(i+1)=sum(cost)+sum(costhubs)+costfurgos;
%matriu de distancies
dist=100000*ones(length(hubsx)-i);
for p=1:length(hubsx)
for q=p+1:length(hubsx)-i
dist(p,q)=sqrt((hubsx(p)-hubsx(q))^2+(hubsy(p)-
hubsy(q))^2);
dist(q,p)=dist(p,q);
end
end
%calcul dels estalvis
clear ahorro
for s=1:length(hubsx)-i
for g=1:length(hubsx)-i
cdg=[(1/(pesos_hubs(s)+pesos_hubs(g)))*(pesos_hub
s(s)*hubsx(s)+pesos_hubs(g)*hubsx(g))
(1/(pesos_hubs(s)+pesos_hubs(g)))*(pesos_hubs(s)*h
ubsy(s)+pesos_hubs(g)*hubsy(g))];
cant=pesos_hubs(g)+pesos_hubs(s);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);

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```

costcam=costdiari+tra*(sqrt((cdg(1)-0.5*11)^2+((cdg(2)-
0.5*12)^2)));
cant=pesos_hubs(s);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
costfurgo1=costdiari+2*tra*(sqrt((cdg(1)-
hubsx(s))^2+(cdg(2)-hubsy(s))^2));
cant=pesos_hubs(g);
[tra,veh,costd]= vehicles2(cant,i);
vehicles(i+1)=veh;
costdiari=costd(veh);
costfurgo2=2*tra*(sqrt((cdg(1)-hubsx(g))^2+(cdg(2)-
hubsy(g))^2));
costfurgo(s,g)=costfurgo1+costfurgo2;
costt=costfurgo(s,g)+costcam;
[cosst,cosstt]=cost_hub(pesos_hubs,g,s);
ahorro(s,g)=cost(g)+cost(s)-costt+cosst(g)+cosst(s)-
cosstt;
end
ahorro(s,s)=0;
end
[aahorro,posii]=max(ahorro);
[val,posi]=max(aahorro);
end
%fi bucle while
for j=1:length(hubsx)-i
coordhubsx(j)=hubsx(j);
coordhubsy(j)=hubsy(j);
end
nodess=[1:length(xdef)];
nodess(2,noodes(1,2))=nodess(1,noodes(1,1));
nodess(1,noodes(1,1))=0;
nodess(2,noodes(1,1))=nodess(1,length(nodess));
nodess(1,length(nodess))=0;
g=2;
for m=2:length(noodes);
for n=1:g
if nodess(n,noodes(m,1))>0
g=g+1;
nodess(g,noodes(m,2))=nodess(n,noodes(m,1));
nodess(n,noodes(m,1))=0;
end
end
for n=1:g
if nodess(n,length(xdef)-m+1)>0
g=g+1;
nodess(g,noodes(m,1))=nodess(n,length(xdef)-
m+1);
nodess(n,length(xdef)-m+1)=0;
end
end
end
l=size(nodess);
for j=1:l(2)
n=0;
for k=1:l(1)
if nodess(k,j)>0
n=n+1;
hubs(j,n)=nodess(k,j);
end
end
end
a=size(hubs);
b=size(coordhubsx);
for o=1:a(2)
if b(1)>0 & hubs(1,o)>0 & a(1)>0
xdef1(o)=xdef(hubs(1,o));
ydef1(o)=ydef(hubs(1,o));
end
if b(2)>1 & hubs(2,o)>0 & a(1)>1
xdef2(o)=xdef(hubs(2,o));
ydef2(o)=ydef(hubs(2,o));
end
if b(2)>2 & hubs(3,o)>0 & a(1)>2

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```

xdef3(o)=xdef(hubs(3,o));
ydef3(o)=ydef(hubs(3,o));
end
if b(2)>3 & hubs(4,o)>0 & a(1)>3
xdef4(o)=xdef(hubs(4,o));
ydef4(o)=ydef(hubs(4,o));
end
if b(2)>4 & hubs(5,o)>0 & a(1)>4
xdef5(o)=xdef(hubs(5,o));
ydef5(o)=ydef(hubs(5,o));
end
if b(2)>5 & hubs(6,o)>0 & a(1)>5
xdef6(o)=xdef(hubs(6,o));
ydef6(o)=ydef(hubs(6,o));
end
if b(2)>6 & hubs(7,o)>0 & a(1)>6
xdef7(o)=xdef(hubs(7,o));
ydef7(o)=ydef(hubs(7,o));
end
end
%dibuixos
for o=1:a(2)
subplot(2,1,1);plot(coste)
if b(2)>0 & hubs(1,o)>0 & a(1)>0
subplot(2,1,2);plot(hubsx(1),hubsy(1),'kd')
hold on
subplot(2,1,2);plot(xdef1,ydef1,'kx')
end
hold on
if b(2)>1 & hubs(2,o)>0 & a(1)>1
subplot(2,1,2);plot(hubsx(2),hubsy(2),'bd')
hold on
subplot(2,1,2);plot(xdef2,ydef2,'bx')
end
hold on
if b(2)>2 & hubs(3,o)>0 & a(1)>2
subplot(2,1,2);plot(hubsx(3),hubsy(3),'rd')
hold on
subplot(2,1,2);plot(xdef3,ydef3,'rx')
end
hold on
if b(2)>3 & hubs(4,o)>0 & a(1)>3
subplot(2,1,2);plot(hubsx(4),hubsy(4),'gd')
hold on
subplot(2,1,2);plot(xdef4,ydef4,'gx')
end
hold on
if b(2)>4 & hubs(5,o)>0 & a(1)>4
subplot(2,1,2);plot(hubsx(5),hubsy(5),'yd')
hold on
subplot(2,1,2);plot(xdef5,ydef5,'yx')
end
hold on
if b(2)>5 & hubs(6,o)>0 & a(1)>5
subplot(2,1,2);plot(hubsx(6),hubsy(6),'md')
hold on
subplot(2,1,2);plot(xdef6,ydef6,'mx')
end
hold on
if b(2)>6 & hubs(7,o)>0 & a(1)>6
subplot(2,1,2);plot(hubsx(7),hubsy(7),'cd')
hold on
subplot(2,1,2);plot(xdef7,ydef7,'cx')
end
end
hold off

costhub
function [cosst,cosstt]=cost_hub(pesos_hubs,g,s);
for k=1:length(pesos_hubs)
if pesos_hubs(k)>0 & pesos_hubs(k)<150001
cosst(k)=500;
end
if pesos_hubs(k)>150000 & pesos_hubs(k)<250001
cosst(k)=550;
end
end

```

```

end
if pesos_hubs(k)>250000
cosst(k)=750;
end
end
suma=pesos_hubs(g)+pesos_hubs(s);
if suma<150001
cosstt=500;
end
if suma>150000 & suma<250001
cosstt=550;
end
if suma>250000
cosstt=750;
end
end

costhubs
function [costhubs]=cost_hubs(pesos_hubs);
for k=1:length(pesos_hubs)
if pesos_hubs(k)>0 & pesos_hubs(k)<150001
costhubs(k)=500;
end
if pesos_hubs(k)>150000 & pesos_hubs(k)<250001
costhubs(k)=550;
end
if pesos_hubs(k)>250000
costhubs(k)=750;
end
end

```

```

vehicles2
function [tra,veh,costd]=vehicles2(cant,i);
capv1=1500;
capv2=3000;
capv3=9000;
capv4=16000;
capv5=25000;
costv1=0.15;
costv2=0.188;
costv3=0.26;
costv4=0.393;
costv5=0.388;
costd(1)=142;
costd(2)=149;
costd(3)=180;
costd(4)=210;
costd(5)=232;
costt1=costv1*(1+fix((cant-1)/capv1));
costt2=costv2*(1+fix((cant-1)/capv2));
costt3=costv3*(1+fix((cant-1)/capv3));
costt4=costv4*(1+fix((cant-1)/capv4));
costt5=costv5*(1+fix((cant-1)/capv5));
costos=[costt1 costt2 costt3 costt4 costt5];
[tra veh]=min(costos);

```

rutes

dades

```

clear all
%entrada de dades
pesos=2*[300 200 400 100 200
200 300 300 200 100
200 300 100 200 300
200 200 100];
xdef=2*0.5*[88.067 20.545 117.08 24.547
91.981 74.595 20.077 6.5545
32.001 82.583 4.7436 72.981
48.178 24.866 106.35 43.305
117.21 38.608];
ydef=2*0.5*[2.7629 20.355 7.4733 48.62
58.397 7.6143 34.558 9.4936
22.197 15.464 54.161 24.466

```

```

31.676 4.4379 60.478 43.722
29.778 4.6565];
hub=2*0.5*[51.496 51.176];
capv=[1500 3000 9000 16000 25000];
costv=[0.15 0.188 0.26 0.393 0.388];
costd=[17.75 18.72 21.51 26.3 29.04];
%kmdiaris=[125 125 180 285 410];
kmdiaris=[640 640 640 640 640];
costparada=[15 20 35 40 40];
%costparada=[0 0 0 0];
%kmdiaris=[410 285 180 125 125];

CW_capacitat_furgos

for i=1:length(xdef)
    costdirecte(i)=sqrt((hub(1)-xdef(i))^2+(hub(2)-
ydef(i))^2);
end
for i=1:length(xdef)
    for j=1:length(xdef)
        dist(i,j)=sqrt((xdef(j)-xdef(i))^2+(ydef(j)-ydef(i))^2);
        dist(i,i)=10000;
        estalvi(i,j)=2*costdirecte(i)+2*costdirecte(j)-
costdirecte(i)-costdirecte(j)-dist(i,j);
        estalvi(i,i)=0;
    end
end
k=0;
while max(max(estalvi))>0
    k=k+1;
    [val,pos]=max(estalvi);
    [vall,poss]=max(val);
    par(k,1)=pos(poss);
    par(k,2)=poss;
    n1=par(k,1);
    n2=par(k,2);
    estalvi(n1,n2)=0;
    estalvi(n2,n1)=0;
end
costos_totals=10000*[1,1,1,1];
for h=1:4
    [cap,costfurgu,costfurgokm]=vehicles2(h,capv,costv,c
std);
    clear asignacions
    clear extremos
    asignacions(1,length(xdef))=0;
    extremos(1,length(xdef))=0;
    vol=0;
    unions=0;
    %creamos rutas
    p=1;
    for j=1:length(par)
        o=0;
        if max(abs(asignacions(:,par(j,1))))==0 &
max(abs(asignacions(:,par(j,2))))==0
            vol(p)=pesos(par(j,1))+pesos(par(j,2));
            asignacions(p,par(j,1))=p*100;
            asignacions(p,par(j,2))=p*100+1;
            extremos(1,par(j,1))=-1;
            extremos(1,par(j,2))=1;
            kmruta(p)=sqrt((xdef(par(j,2))-
hub(1,1))^2+(ydef(par(j,2))-
hub(1,2))^2)+sqrt((xdef(par(j,1))-
hub(1,1))^2+(ydef(par(j,1))-
hub(1,2))^2)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+2*costparada(h);
            p=p+1;
            o=1;
        end
        if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))==0 & o==0
            o=1;
            a=1;
            while asignacions(a,par(j,1))==0
                a=a+1;

```

```

end
            kmrutaa=sqrt((xdef(par(j,2))-
hub(1,1))^2+(ydef(par(j,2))-hub(1,2))^2)-
sqrt((xdef(par(j,1))-hub(1,1))^2+(ydef(par(j,1))-
hub(1,2))^2)+kmruta(a)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+costparada(h);
            voll=vol(a)+pesos(par(j,2));
            if (extremos(1,par(j,1)))>0 & voll<=cap &
kmrutaa<kmdiaris(h)
                %añado el arco a la ruta
                vol(a)=voll;
            end
            asignacions(a,par(j,2))=asignacions(a,par(j,1))+1;
            extremos(1,par(j,1))=0;
            extremos(1,par(j,2))=1;
            kmruta(a)=kmrutaa;
            end
            if (extremos(1,par(j,1)))<0 & voll<=cap &
kmrutaa<kmdiaris(h)
                %añado el arco a la ruta
                vol(a)=voll;
            asignacions(a,par(j,2))=asignacions(a,par(j,1))-
1;
            extremos(1,par(j,1))=0;
            extremos(1,par(j,2))=-1;
            kmruta(a)=kmrutaa;
            end
            if (extremos(1,par(j,1)))==0 | voll>cap |
kmrutaa>kmdiaris(h)
                %res
            end
            if max(abs(asignacions(:,par(j,2))))>0 &
max(abs(asignacions(:,par(j,1))))==0 & o==0
                o=1;
                a=1;
                while asignacions(a,par(j,2))==0
                    a=a+1;
                end
                kmrutaa=sqrt((xdef(par(j,1))-
hub(1,1))^2+(ydef(par(j,1))-hub(1,2))^2)-
sqrt((xdef(par(j,2))-hub(1,1))^2+(ydef(par(j,2))-
hub(1,2))^2)+kmruta(a)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+costparada(h);
                voll=vol(a)+pesos(par(j,1));
                if (extremos(1,par(j,2)))>0 & voll<=cap &
kmrutaa<kmdiaris(h)
                    %añado el arco a la ruta
                    vol(a)=voll;
                end
                asignacions(a,par(j,1))=asignacions(a,par(j,2))+1;
                extremos(1,par(j,2))=0;
                extremos(1,par(j,1))=1;
                kmruta(a)=kmrutaa;
                end
                if (extremos(1,par(j,2)))<0 & voll<=cap &
kmrutaa<kmdiaris(h)
                    %añado el arco a la ruta
                    vol(a)=voll;
                asignacions(a,par(j,1))=asignacions(a,par(j,2))-
1;
                extremos(1,par(j,2))=0;
                extremos(1,par(j,1))=-1;
                kmruta(a)=kmrutaa;
                end
                if (extremos(1,par(j,2)))==0 | voll>cap |
kmrutaa>kmdiaris(h)
                    %res
                end
                if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))>0 & o==0
                    o=1;
                    a=1;
                    while asignacions(a,par(j,1))==0
                        a=a+1;

```



```

for p=1:n
    [val pos]=min(ruta4);
    ruta4(pos)=10000;
    sol4(p)=pos;
end
xsol4=0;
ysol4=0;
xsol4(1)=hub(1);
ysol4(1)=hub(2);
for d=1:n
    xsol4(d+1)=xdef(sol4(d));
    ysol4(d+1)=ydef(sol4(d));
end
xsol4(n+2)=hub(1);
ysol4(n+2)=hub(2);
end
if m(1)>4
    t=5;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta5(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta5(k)=10000;
        end
    end
    for p=1:n
        [val pos]=min(ruta5);
        ruta5(pos)=10000;
        sol5(p)=pos;
    end
    xsol5=0;
    ysol5=0;
    xsol5(1)=hub(1);
    ysol5(1)=hub(2);
    for d=1:n
        xsol5(d+1)=xdef(sol5(d));
        ysol5(d+1)=ydef(sol5(d));
    end
    xsol5(n+2)=hub(1);
    ysol5(n+2)=hub(2);
    end
    if m(1)>5
        t=6;
        n=0;
        for k=1:length(asignacions)
            if asignacions(t,k)>0
                n=n+1;
                ruta6(k)=asignacions(t,k);
            end
            if asignacions(t,k)==0
                ruta6(k)=10000;
            end
        end
        for p=1:n
            [val pos]=min(ruta6);
            ruta6(pos)=10000;
            sol6(p)=pos;
        end
        xsol6=0;
        ysol6=0;
        xsol6(1)=hub(1);
        ysol6(1)=hub(2);
        for d=1:n
            xsol6(d+1)=xdef(sol6(d));
            ysol6(d+1)=ydef(sol6(d));
        end
        xsol6(n+2)=hub(1);
        ysol6(n+2)=hub(2);
        end
        if m(1)>6
            t=7;
            n=0;
            for k=1:length(asignacions)
                if asignacions(t,k)>0
                    n=n+1;
                    ruta7(k)=asignacions(t,k);
                end
                if asignacions(t,k)==0
                    ruta7(k)=10000;
                end
            end
            for p=1:n
                [val pos]=min(ruta7);
                ruta7(pos)=10000;
                sol7(p)=pos;
            end
            xsol7=0;
            ysol7=0;
            xsol7(1)=hub(1);
            ysol7(1)=hub(2);
            for d=1:n
                xsol7(d+1)=xdef(sol7(d));
                ysol7(d+1)=ydef(sol7(d));
            end
            xsol7(n+2)=hub(1);
            ysol7(n+2)=hub(2);
            end
            s=size(asignacions);
            numrutes=s(1)-unions;
            costfurgo1=0;
            costfurgo2=0;
            costfurgo3=0;
            costfurgo4=0;
            costfurgo5=0;
            costfurgo6=0;
            costfurgo7=0;
            costtfurgo1=0;
            costtfurgo2=0;
            costtfurgo3=0;
            costtfurgo4=0;
            costtfurgo5=0;
            costtfurgo6=0;
            costtfurgo7=0;
            traj1=0;
            traj2=0;
            traj3=0;
            traj4=0;
            traj5=0;
            traj6=0;
            traj7=0;
            if m(1)>0
                for b=1:length(xsol1)-1
                    traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-ysol1(b+1))^2);
                end
                traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
                if sum(traj1)>0
                    costfurgo1=sum(traj1);
                end
            end
            costtfurgo1=sum(traj1)+costparada(h)*(length(xsol1)-1);
            end
            if m(1)>1
                for b=1:length(xsol2)-1
                    traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-ysol2(b+1))^2);
                end
                if sum(traj2)>0
                    traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
                    costfurgo2=sum(traj2);
                end
            end
            costtfurgo2=sum(traj2)+costparada(h)*(length(xsol2)-1);
            end
            end
            if m(1)>2

```

```

for b=1:length(xsol3)-1
    traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
end
if sum(traj3)>0
    traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
    costfurgo3=sum(traj3);

costtfurgo3=sum(traj3)+costparada(h)*(length(xsol3)-
1);
end
end
if m(1)>3
    for b=1:length(xsol4)-1
        traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
        end
        if sum(traj4)>0
            traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
            costfurgo4=sum(traj4);

costtfurgo4=sum(traj4)+costparada(h)*(length(xsol4)-
1);
        end
        end
        if m(1)>4
            for b=1:length(xsol5)-1
                traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
                end
                if sum(traj5)>0
                    traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
                    costfurgo5=sum(traj5);

costtfurgo5=sum(traj5)+costparada(h)*(length(xsol5)-
1);
                end
                end
                if m(1)>5
                    for b=1:length(xsol6)-1
                        traj6(b)=sqrt((xsol6(b)-xsol6(b+1))^2+(ysol6(b)-
ysol6(b+1))^2);
                        end
                        if sum(traj6)>0
                            traj6(length(xsol6))=sqrt((xsol6(length(xsol6))-
xsol6(1))^2+(xsol6(length(xsol6))-xsol6(1))^2);
                            costfurgo6=sum(traj6);

costtfurgo6=sum(traj6)+costparada(h)*(length(xsol6)-
1);
                        end
                        end
                        if m(1)>6
                            for b=1:length(xsol7)-1
                                traj7(b)=sqrt((xsol7(b)-xsol7(b+1))^2+(ysol7(b)-
ysol7(b+1))^2);
                                end
                                if sum(traj7)>0
                                    traj7(length(xsol7))=sqrt((xsol7(length(xsol7))-
xsol7(1))^2+(xsol7(length(xsol7))-xsol7(1))^2);
                                    costfurgo7=sum(traj7);

costtfurgo7=sum(traj7)+costparada(h)*(length(xsol7)-
1);
                                end
                                end
                                trajectories=[costtfurgo1 costtfurgo2 costtfurgo3
costtfurgo4 costtfurgo5 costtfurgo6 costtfurgo7];
                                for o=1:7
                                    [distrec(o) pos]=max(trajectories);
                                    trajectories(pos)=0;
                                end
                                b=1;

p=0;
while b<8 & max(distrec)>0
    m(b)=distrec(b);
    repartos(b,b)=distrec(b);
    while m(b)<kmdiaris(h) & p>-1
        p=p+1;
        m(b)=m(b)+distrec(8-p);
        if p>7-b
            m(b)=kmdiaris(h);
            p=p-1;
        end
        repartos(b,8-p)=distrec(8-p);
    end
    repartos(b,8-p)=0;
    distrec(b)=0;
    p=p-1;
    for l=1:p
        distrec(8-l)=0;
    end
    b=b+1;
end
b=b-1;
costos_fixes(h)=costfurgo*b;
costos_variables(h)=costfurgokm*(costfurgo1+costfurgo
o2+costfurgo3+costfurgo4+costfurgo5+costfurgo6+cos
tfurgo7);
costos_totals(h)=costos_fixes(h)+costos_variables(h);
clear repartos
end
[val pos]=min(costos_totals);
h=pos;
[cap,costfurgo,costfurgokm]=vehicles2(h,capv,costv,co
std);
clear asignacions
clear extremos
asignacions(1,length(xdef))=0;
extremos(1,length(xdef))=0;
vol=0;
unions=0;
%creamos rutas
p=1;
for j=2:length(par)
    o=0;
    if max(abs(asignacions(:,par(j,1))))==0 &
max(abs(asignacions(:,par(j,2))))==0
        vol(p)=pesos(par(j,1))+pesos(par(j,2));
        asignacions(p,par(j,1))=p*100;
        asignacions(p,par(j,2))=p*100+1;
        extremos(1,par(j,1))=-1;
        extremos(1,par(j,2))=1;
        kmruta(p)=sqrt((xdef(par(j,2))-
hub(1,1))^2+(ydef(par(j,2))-
hub(1,2))^2)+sqrt((xdef(par(j,1))-
hub(1,1))^2+(ydef(par(j,1))-
hub(1,2))^2)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+2*costparada(h);
        p=p+1;
        o=1;
    end
    if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))==0 & o==0
        o=1;
        a=1;
        while asignacions(a,par(j,1))==0
            a=a+1;
        end
        kmrutaa=sqrt((xdef(par(j,2))-
hub(1,1))^2+(ydef(par(j,2))-hub(1,2))^2)-
sqrt((xdef(par(j,1))-hub(1,1))^2+(ydef(par(j,1))-
hub(1,2))^2)+kmruta(a)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+costparada(h);
        voll=vol(a)+pesos(par(j,2));
        if (extremos(1,par(j,1)))>0 & voll<=cap &
kmrutaa<kmdiaris(h)

```

```

%añado el arco a la ruta
vol(a)=voll;

asignacions(a,par(j,2))=asignacions(a,par(j,1))+1;
extremos(1,par(j,1))=0;
extremos(1,par(j,2))=1;
kmruta(a)=kmrutaa;
end
if (extremos(1,par(j,1)))<0 & voll<=cap &
kmrutaa<kmdiaris(h)
%añado el arco a la ruta
vol(a)=voll;
asignacions(a,par(j,2))=asignacions(a,par(j,1))-
1;
extremos(1,par(j,1))=0;
extremos(1,par(j,2))=-1;
kmruta(a)=kmrutaa;
end
if (extremos(1,par(j,1)))==0 | voll>cap |
kmrutaa>kmdiaris(h)
%res
end
end
if max(abs(asignacions(:,par(j,2))))>0 &
max(abs(asignacions(:,par(j,1))))==0 & o==0
o=1;
a=1;
while asignacions(a,par(j,2))==0
a=a+1;
end
kmrutaa=sqrt((xdef(par(j,1))-
hub(1,1))^2+(ydef(par(j,1))-hub(1,2))^2)-
sqrt((xdef(par(j,2))-hub(1,1))^2+(ydef(par(j,2))-
hub(1,2))^2)+kmruta(a)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-
ydef(par(j,2)))^2)+costparada(h);
voll=vol(a)+pesos(par(j,1));
if (extremos(1,par(j,2)))>0 & voll<=cap &
kmrutaa<kmdiaris(h)
%añado el arco a la ruta
vol(a)=voll;

asignacions(a,par(j,1))=asignacions(a,par(j,2))+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=1;
kmruta(a)=kmrutaa;
end
if (extremos(1,par(j,2)))<0 & voll<=cap &
kmrutaa<kmdiaris(h)
%añado el arco a la ruta
vol(a)=voll;
asignacions(a,par(j,1))=asignacions(a,par(j,2))-
1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=-1;
kmruta(a)=kmrutaa;
end
if (extremos(1,par(j,2)))==0 | voll>cap |
kmrutaa>kmdiaris(h)
%res
end
end
if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))>0 & o==0
o=1;
a=1;
while asignacions(a,par(j,1))==0
a=a+1;
end
b=1;
while asignacions(b,par(j,2))==0
b=b+1;
end
if a==b
%res
end

```

```

if abs(a-b)>0
kmrutaa=kmruta(a)+kmruta(b)-
costparada(h)-sqrt((xdef(par(j,2))-
hub(1,1))^2+(ydef(par(j,2))-hub(1,2))^2)-
sqrt((xdef(par(j,1))-hub(1,1))^2+(ydef(par(j,1))-
hub(1,2))^2)+sqrt((xdef(par(j,1))-
xdef(par(j,2)))^2+(ydef(par(j,1))-ydef(par(j,2)))^2);
voll=vol(a)+vol(b);
%unimos rutas
if b>a & voll<=cap & kmrutaa<kmdiaris(h)
kmruta(a)=kmrutaa;
kmruta(b)=0;
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=asignacions(b,g);
asignacions(b,g)=0;
g=g+1;
end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(a,g)>0
asignacions(a,g)=asignacions(a,g)+(b-a)*100;
end
if asignacions(b,g)>0
asignacions(a,g)=asignacions(b,g)-
(b-a)*100;
asignacions(b,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)==0
asignacions(b,g)=10000;
end
if asignacions(b,g)>0
asignacions(b,g)=asignacions(b,g);
end
g=g+1;
end
end
[val pos]=min(asignacions(b,:));
extremos(1,pos)=1;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=2*b*100-
asignacions(b,g);
asignacions(b,g)=0;
end
g=g+1;

```



```

t=2;
n=0;
for k=1:length(asignacions)
    if asignacions(t,k)>0
        n=n+1;
        ruta2(k)=asignacions(t,k);
    end
    if asignacions(t,k)==0
        ruta2(k)=10000;
    end
end
for p=1:n
    [val pos]=min(ruta2);
    ruta2(pos)=10000;
    sol2(p)=pos;
end
xsol2=0;
ysol2=0;
xsol2(1)=hub(1);
ysol2(1)=hub(2);
for d=1:n
    xsol2(d+1)=xdef(sol2(d));
    ysol2(d+1)=ydef(sol2(d));
end
xsol2(n+2)=hub(1);
ysol2(n+2)=hub(2);
end
if m(1)>2
    t=3;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta3(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta3(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta3);
    ruta3(pos)=10000;
    sol3(p)=pos;
end
xsol3=0;
ysol3=0;
xsol3(1)=hub(1);
ysol3(1)=hub(2);
for d=1:n
    xsol3(d+1)=xdef(sol3(d));
    ysol3(d+1)=ydef(sol3(d));
end
xsol3(n+2)=hub(1);
ysol3(n+2)=hub(2);
end
if m(1)>3
    t=4;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta4(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta4(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta4);
    ruta4(pos)=10000;
    sol4(p)=pos;
end
xsol4=0;
ysol4=0;
xsol4(1)=hub(1);
ysol4(1)=hub(2);
for d=1:n
    xsol4(d+1)=xdef(sol4(d));
    ysol4(d+1)=ydef(sol4(d));
end
xsol4(n+2)=hub(1);
ysol4(n+2)=hub(2);
end
if m(1)>4
    t=5;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta5(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta5(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta5);
    ruta5(pos)=10000;
    sol5(p)=pos;
end
xsol5=0;
ysol5=0;
xsol5(1)=hub(1);
ysol5(1)=hub(2);
for d=1:n
    xsol5(d+1)=xdef(sol5(d));
    ysol5(d+1)=ydef(sol5(d));
end
xsol5(n+2)=hub(1);
ysol5(n+2)=hub(2);
end
if m(1)>5
    t=6;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta6(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta6(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta6);
    ruta6(pos)=10000;
    sol6(p)=pos;
end
xsol6=0;
ysol6=0;
xsol6(1)=hub(1);
ysol6(1)=hub(2);
for d=1:n
    xsol6(d+1)=xdef(sol6(d));
    ysol6(d+1)=ydef(sol6(d));
end
xsol6(n+2)=hub(1);
ysol6(n+2)=hub(2);
end
if m(1)>6
    t=7;
    n=0;
    for k=1:length(asignacions)
        if asignacions(t,k)>0
            n=n+1;
            ruta7(k)=asignacions(t,k);
        end
        if asignacions(t,k)==0
            ruta7(k)=10000;
        end
    end
end
for p=1:n

```

```

[val pos]=min(ruta7);
ruta7(pos)=10000;
sol7(p)=pos;
end
xsol7=0;
ysol7=0;
xsol7(1)=hub(1);
ysol7(1)=hub(2);
for d=1:n
    xsol7(d+1)=xdef(sol7(d));
    ysol7(d+1)=ydef(sol7(d));
end
xsol7(n+2)=hub(1);
ysol7(n+2)=hub(2);
end
s=size(asignacions);
numrutes=s(1)-unions;
costfurgo1=0;
costfurgo2=0;
costfurgo3=0;
costfurgo4=0;
costfurgo5=0;
costfurgo6=0;
costfurgo7=0;
costtfurgo1=0;
costtfurgo2=0;
costtfurgo3=0;
costtfurgo4=0;
costtfurgo5=0;
costtfurgo6=0;
costtfurgo7=0;
traj1=0;
traj2=0;
traj3=0;
traj4=0;
traj5=0;
traj6=0;
traj7=0;
if m(1)>0
    for b=1:length(xsol1)-1
        traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
ysol1(b+1))^2);
    end
    traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
    if sum(traj1)>0
        costfurgo1=sum(traj1);
    end
costtfurgo1=sum(traj1)+costparada(h)*(length(xsol1)-
1);
end
end
if m(1)>1
    for b=1:length(xsol2)-1
        traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
ysol2(b+1))^2);
    end
    if sum(traj2)>0
        traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
        costfurgo2=sum(traj2);
    end
costtfurgo2=sum(traj2)+costparada(h)*(length(xsol2)-
1);
end
end
if m(1)>2
    for b=1:length(xsol3)-1
        traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
    end
    if sum(traj3)>0
        traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
        costfurgo3=sum(traj3);
    end
costtfurgo3=sum(traj3)+costparada(h)*(length(xsol3)-
1);
end
end
if m(1)>3
    for b=1:length(xsol4)-1
        traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
    end
    if sum(traj4)>0
        traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
        costfurgo4=sum(traj4);
    end
costtfurgo4=sum(traj4)+costparada(h)*(length(xsol4)-
1);
end
end
if m(1)>4
    for b=1:length(xsol5)-1
        traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
    end
    if sum(traj5)>0
        traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
        costfurgo5=sum(traj5);
    end
costtfurgo5=sum(traj5)+costparada(h)*(length(xsol5)-
1);
end
end
if m(1)>5
    for b=1:length(xsol6)-1
        traj6(b)=sqrt((xsol6(b)-xsol6(b+1))^2+(ysol6(b)-
ysol6(b+1))^2);
    end
    if sum(traj6)>0
        traj6(length(xsol6))=sqrt((xsol6(length(xsol6))-
xsol6(1))^2+(xsol6(length(xsol6))-xsol6(1))^2);
        costfurgo6=sum(traj6);
    end
costtfurgo6=sum(traj6)+costparada(h)*(length(xsol6)-
1);
end
end
if m(1)>6
    for b=1:length(xsol7)-1
        traj7(b)=sqrt((xsol7(b)-xsol7(b+1))^2+(ysol7(b)-
ysol7(b+1))^2);
    end
    if sum(traj7)>0
        traj7(length(xsol7))=sqrt((xsol7(length(xsol7))-
xsol7(1))^2+(xsol7(length(xsol7))-xsol7(1))^2);
        costfurgo7=sum(traj7);
    end
costtfurgo7=sum(traj7)+costparada(h)*(length(xsol7)-
1);
end
end
trajectories=[costfurgo1 costfurgo2 costfurgo3
costfurgo4 costfurgo5 costfurgo6 costfurgo7];
for o=1:7
    [distrec(o) pos]=max(trajectories);
    trajectories(pos)=0;
end
b=1;
p=0;
while b<8 & max(distrec)>0
    m(b)=distrec(b);
    repartos(b,b)=distrec(b);
    while m(b)<kmdiaris(h) & p>-1
        p=p+1;
        m(b)=m(b)+distrec(8-p);
        if p>7-b

```

```

        m(b)=kmdiaris(h);          4 21 45
        p=p-1;                    5 45 35
        end                        6 55 20
        repartos(b,8-p)=distrec(8-p); 7 33 34
        end                        8 50 50
    repartos(b,8-p)=0;            9 55 45
    distrec(b)=0;                10 26 59
    p=p-1;                       11 40 66
    for l=1:p                      12 55 65
        distrec(8-l)=0;          13 35 51
    end                            14 62 35
    b=b+1;                        15 62 57
    end                            16 62 24
    b=b-1;                        17 21 36
    costos_fixess=costfurgo*b;    18 33 44
    costos_variablss=costfurgokm*(costfurgo1+costfurgo
2+costfurgo3+costfurgo4+costfurgo5+costfurgo6+costf
urgo7);                          19 9 56
    costos_totalss=costos_fixes(h)+costos_variablss(h); 20 62 48
    m=size(asignacions);         21 66 14
    %m(1)=m(1)-unions;          22 44 13
    subplot(2,1,1),plot(costos_totals) 23 26 13
    hold on                       24 11 28
    subplot(2,1,1),plot(costos_fixes,'r') 25 7 43
    hold on                       26 17 64
    subplot(2,1,1),plot(costos_variablss,'g') 27 41 46
    hold on                       28 55 34
    subplot(2,1,1),plot(costos_unions,'b') 29 35 16
    hold off                      30 52 26
    h=pos;                        31 43 26
    if m(1)>0                      32 31 76
    subplot(2,1,2),plot(xsol1,ysol1,'--bs') 33 22 53
    hold on                       34 26 29
    end                            35 50 40
    if m(1)>1                      36 55 50
    subplot(2,1,2),plot(xsol2,ysol2,'--gs') 37 54 10
    hold on                       38 60 15
    end                            39 47 66
    if m(1)>2                      40 30 60
    subplot(2,1,2),plot(xsol3,ysol3,'--rs') 41 30 50
    hold on                       42 12 17
    end                            43 15 14
    if m(1)>3                      44 16 19
    subplot(2,1,2),plot(xsol4,ysol4,'--cs') 45 21 48
    hold on                       46 50 30
    end                            47 51 42
    if m(1)>4                      48 50 15
    subplot(2,1,2),plot(xsol5,ysol5,'--ms') 49 48 21
    hold on                       50 12 38
    end                            51 15 56
    if m(1)>5                      52 29 39
    subplot(2,1,2),plot(xsol6,ysol6,'--ys') 53 54 38
    hold on                       54 55 57
    end                            55 67 41
    if m(1)>6                      56 10 70
    subplot(2,1,2),plot(xsol7,ysol7,'--ks') 57 6 25
    hold on                       58 65 27
    end                            59 40 60
    subplot(2,1,2),plot(hub(1),hub(2),'db') 60 70 64
    hold off                      61 64 4
    %nvehicles=costos_fixes./costd; 62 36 6
    %nvehicles                    63 30 20
    vehicles2                    64 20 30
    %nvehicles                    65 15 5
    function                      66 50 70
    [cap,costfurgo,costfurgokm]=vehicles2(h,capv,costv,costd); 67 57 72
    cap=capv(h);                  68 45 42
    costfurgo=costd(h);           69 38 33
    costfurgokm=costv(h);        70 50 4
    %nvehicles                    71 66 8
    %nvehicles                    72 59 5
    solomontests                73 35 60
    %nvehicles                    74 27 24
    clear all                     75 40 20
    %entrada de dades            76 40 37];
    A=[1 40 40                   B=[1 0
    2 22 22                      2 18
    3 36 26                      3 26

```

```

4 11         xdef(i)=A(i+1,2);
5 30         ydef(i)=A(i+1,3);
6 21     end
7 19     hub=[A(1,2) A(1,3)];
8 15     cap=280;
9 16     for i=1:length(xdef)
10 29         costdirecte(i)=sqrt((hub(1)-xdef(i))^2+(hub(2)-
11 26         ydef(i))^2);
12 37     end
13 16     for i=1:length(xdef)
14 12         for j=1:length(xdef)
15 31             dist(i,j)=sqrt((xdef(j)-xdef(i))^2+(ydef(j)-ydef(i))^2);
16 8             dist(i,i)=10000;
17 19             estalvi(i,j)=2*costdirecte(i)+2*costdirecte(j)-
18 20             costdirecte(i)-costdirecte(j)-dist(i,j);
19 13             estalvi(i,i)=0;
20 15         end
21 22     end
22 28     k=0;
23 12     while max(max(estalvi))>0
24 6         k=k+1;
25 27         [val,pos]=max(estalvi);
26 14         [vall,poss]=max(val);
27 18         par(k,1)=pos(poss);
28 17         par(k,2)=poss;
29 29         n1=par(k,1);
30 13         n2=par(k,2);
31 22         estalvi(n1,n2)=0;
32 25         estalvi(n2,n1)=0;
33 28     end
34 27     clear asignacions
35 19     clear extremos
36 10     asignacions(1,length(xdef))=0;
37 12     extremos(1,length(xdef))=0;
38 14     vol=0;
39 24     unions=0;
40 16     %creamos rutas
41 33     vol(1)=pesos(par(1,1))+pesos(par(1,2));
42 15     asignacions(1,par(1,1))=100;
43 11     asignacions(1,par(1,2))=101;
44 18     extremos(1,par(1,1))=-1;
45 17     extremos(1,par(1,2))=1;
46 21     p=2;
47 27     for j=2:length(par)
48 19         o=0;
49 20         if      max(abs(asignacions(:,par(j,1))))==0      &
50 5         max(abs(asignacions(:,par(j,2))))==0
51 22             vol(p)=pesos(par(j,1))+pesos(par(j,2));
52 12             asignacions(p,par(j,1))=p*100;
53 19             asignacions(p,par(j,2))=p*100+1;
54 22             extremos(1,par(j,1))=-1;
55 16             extremos(1,par(j,2))=1;
56 7             p=p+1;
57 26             o=1;
58 14         end
59 21         if      max(abs(asignacions(:,par(j,1))))>0      &
60 24         max(abs(asignacions(:,par(j,2))))==0 & o==0
61 13             o=1;
62 15             a=1;
63 18             while asignacions(a,par(j,1))==0
64 11                 a=a+1;
65 28             end
66 9             voll=vol(a)+pesos(par(j,2));
67 37             if (extremos(1,par(j,1)))>0 & voll<=cap
68 30                 %añado el arco a la ruta
69 10                 vol(a)=voll;
70 8
71 11         asignacions(a,par(j,2))=asignacions(a,par(j,1))+1;
72 3         extremos(1,par(j,1))=0;
73 1         extremos(1,par(j,2))=1;
74 6         end
75 10         if (extremos(1,par(j,1)))<0 & voll<=cap
76 20];         %añado el arco a la ruta
                    vol(a)=voll;
                    asignacions(a,par(j,2))=asignacions(a,par(j,1))-
1;

```

```

%transformació de dades
for i=1:length(A)-1
    pesos(i)=B(i+1,2);

```

```

extremos(1,par(j,1))=0;
extremos(1,par(j,2))=-1;
end
if (extremos(1,par(j,1)))==0 | voll>cap
%res
end
end
if max(abs(asignacions(:,par(j,2))))>0 &
max(abs(asignacions(:,par(j,1))))==0 & o==0
o=1;
a=1;
while asignacions(a,par(j,2))==0
a=a+1;
end
voll=vol(a)+pesos(par(j,1));
if (extremos(1,par(j,2)))>0 & voll<=cap
%añado el arco a la ruta
vol(a)=voll;
asignacions(a,par(j,1))=asignacions(a,par(j,2))+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=1;
end
if (extremos(1,par(j,2)))<0 & voll<=cap
%añado el arco a la ruta
vol(a)=voll;
asignacions(a,par(j,1))=asignacions(a,par(j,2))-
1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=-1;
end
if (extremos(1,par(j,2)))==0 | voll>cap
%res
end
end
if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))>0 & o==0
o=1;
a=1;
while asignacions(a,par(j,1))==0
a=a+1;
end
b=1;
while asignacions(b,par(j,2))==0
b=b+1;
end
if a==b
%res
end
if abs(a-b)>0
voll=vol(a)+vol(b);
%unimos rutas
if b>a & voll<=cap
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=asignacions(b,g);
asignacions(b,g)=0;
g=g+1;
end
end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=asignacions(b,g);
asignacions(b,g)=0;
g=g+1;
end
end
end
if a>b & voll<=cap
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(b)=voll;
vol(a)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(a,g)>0
asignacions(b,g)=asignacions(a,g);
asignacions(a,g)=0;
g=g+1;
end
end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(b)=0;
vol(a)=voll;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=2*b*100-
asignacions(b,g);
asignacions(b,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
[ val pos]=max(asignacions(b,:));
extremos(1,pos)=-1;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(a,g)>0
asignacions(b,g)=2*b*100-
asignacions(a,g);
asignacions(a,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
[ val pos]=min(asignacions(b,:));
extremos(1,pos)=1;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=2*b*100-
asignacions(b,g);
asignacions(b,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
[ val pos]=max(asignacions(b,:));
extremos(1,pos)=-1;
vol(a)=voll;
vol(b)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(a,g)>0
asignacions(b,g)=2*b*100-
asignacions(a,g);
asignacions(a,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(b)=voll;
vol(a)=0;
f=size(asignacions);
for g=1:f(2)
if asignacions(b,g)>0
asignacions(a,g)=2*b*100-
asignacions(b,g);
asignacions(b,g)=0;
end
g=g+1;
end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
unions=unions+1;
extremos(1,par(j,2))=0;
extremos(1,par(j,1))=0;
vol(a)=0;
vol(b)=voll;
f=size(asignacions);
for g=1:f(2)
if asignacions(a,g)>0
asignacions(b,g)=2*b*100-
asignacions(a,g);
asignacions(a,g)=0;
end
g=g+1;
end
end

```



```

    ysol2(d+1)=ydef(sol2(d));
end
xsol2(n+2)=hub(1);
ysol2(n+2)=hub(2);
end
if m(1)>2
    t=3;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta3(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta3(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta3);
    ruta3(pos)=10000;
    sol3(p)=pos;
end
xsol3=0;
ysol3=0;
xsol3(1)=hub(1);
ysol3(1)=hub(2);
for d=1:n
    xsol3(d+1)=xdef(sol3(d));
    ysol3(d+1)=ydef(sol3(d));
end
xsol3(n+2)=hub(1);
ysol3(n+2)=hub(2);
end
if m(1)>3
    t=4;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta4(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta4(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta4);
    ruta4(pos)=10000;
    sol4(p)=pos;
end
xsol4=0;
ysol4=0;
xsol4(1)=hub(1);
ysol4(1)=hub(2);
for d=1:n
    xsol4(d+1)=xdef(sol4(d));
    ysol4(d+1)=ydef(sol4(d));
end
xsol4(n+2)=hub(1);
ysol4(n+2)=hub(2);
end
if m(1)>4
    t=5;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta5(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta5(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta5);
    ruta5(pos)=10000;
end
sol5(p)=pos;
end
xsol5=0;
ysol5=0;
xsol5(1)=hub(1);
ysol5(1)=hub(2);
for d=1:n
    xsol5(d+1)=xdef(sol5(d));
    ysol5(d+1)=ydef(sol5(d));
end
xsol5(n+2)=hub(1);
ysol5(n+2)=hub(2);
end
if m(1)>5
    t=6;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta6(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta6(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta6);
    ruta6(pos)=10000;
    sol6(p)=pos;
end
xsol6=0;
ysol6=0;
xsol6(1)=hub(1);
ysol6(1)=hub(2);
for d=1:n
    xsol6(d+1)=xdef(sol6(d));
    ysol6(d+1)=ydef(sol6(d));
end
xsol6(n+2)=hub(1);
ysol6(n+2)=hub(2);
end
if m(1)>6
    t=7;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta7(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta7(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta7);
    ruta7(pos)=10000;
    sol7(p)=pos;
end
xsol7=0;
ysol7=0;
xsol7(1)=hub(1);
ysol7(1)=hub(2);
for d=1:n
    xsol7(d+1)=xdef(sol7(d));
    ysol7(d+1)=ydef(sol7(d));
end
xsol7(n+2)=hub(1);
ysol7(n+2)=hub(2);
end
if m(1)>7
    t=8;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta8(k)=aassignacions(t,k);
        end
    end
end

```

```

end
if aassignacions(t,k)==0
ruta8(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta8);
ruta8(pos)=10000;
sol8(p)=pos;
end
xsol8=0;
ysol8=0;
xsol8(1)=hub(1);
ysol8(1)=hub(2);
for d=1:n
xsol8(d+1)=xdef(sol8(d));
ysol8(d+1)=ydef(sol8(d));
end
xsol8(n+2)=hub(1);
ysol8(n+2)=hub(2);
end
if m(1)>8
t=9;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta9(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta9(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta9);
ruta9(pos)=10000;
sol9(p)=pos;
end
xsol9=0;
ysol9=0;
xsol9(1)=hub(1);
ysol9(1)=hub(2);
for d=1:n
xsol9(d+1)=xdef(sol9(d));
ysol9(d+1)=ydef(sol9(d));
end
xsol9(n+2)=hub(1);
ysol9(n+2)=hub(2);
end
if m(1)>9
t=10;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta10(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta10(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta10);
ruta10(pos)=10000;
sol10(p)=pos;
end
xsol10=0;
ysol10=0;
xsol10(1)=hub(1);
ysol10(1)=hub(2);
for d=1:n
xsol10(d+1)=xdef(sol10(d));
ysol10(d+1)=ydef(sol10(d));
end
xsol10(n+2)=hub(1);
ysol10(n+2)=hub(2);

```

```

end
if m(1)>10
t=11;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta11(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta11(k)=11000;
end
end
for p=1:n
[val pos]=min(ruta11);
ruta11(pos)=11000;
sol11(p)=pos;
end
xsol11=0;
ysol11=0;
xsol11(1)=hub(1);
ysol11(1)=hub(2);
for d=1:n
xsol11(d+1)=xdef(sol11(d));
ysol11(d+1)=ydef(sol11(d));
end
xsol11(n+2)=hub(1);
ysol11(n+2)=hub(2);
end
if m(1)>11
t=12;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta12(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta12(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta12);
ruta12(pos)=10000;
sol12(p)=pos;
end
xsol12=0;
ysol12=0;
xsol12(1)=hub(1);
ysol12(1)=hub(2);
for d=1:n
xsol12(d+1)=xdef(sol12(d));
ysol12(d+1)=ydef(sol12(d));
end
xsol12(n+2)=hub(1);
ysol12(n+2)=hub(2);
end
if m(1)>12
t=13;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta13(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta13(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta13);
ruta13(pos)=10000;
sol13(p)=pos;
end
xsol13=0;
ysol13=0;

```

```

xsol13(1)=hub(1);
ysol13(1)=hub(2);
for d=1:n
    xsol13(d+1)=xdef(sol13(d));
    ysol13(d+1)=ydef(sol13(d));
end
xsol13(n+2)=hub(1);
ysol13(n+2)=hub(2);
end
s=size(aassignacions);
numrutes=s(1)-unions;
traj1=0;
traj2=0;
traj3=0;
traj4=0;
traj5=0;
traj6=0;
traj7=0;
traj8=0;
traj9=0;
traj10=0;
traj11=0;
traj12=0;
traj13=0;
if m(1)>0
    for b=1:length(xsol1)-1
        traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
ysol1(b+1))^2);
    end
    traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
end
if m(1)>1
    for b=1:length(xsol2)-1
        traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
ysol2(b+1))^2);
    end
    if sum(traj2)>0
        traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
    end
end
if m(1)>2
    for b=1:length(xsol3)-1
        traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
    end
    if sum(traj3)>0
        traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
    end
end
if m(1)>3
    for b=1:length(xsol4)-1
        traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
    end
    if sum(traj4)>0
        traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
    end
end
if m(1)>4
    for b=1:length(xsol5)-1
        traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
    end
    if sum(traj5)>0
        traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
    end
end
if m(1)>5
    for b=1:length(xsol6)-1
        traj6(b)=sqrt((xsol6(b)-xsol6(b+1))^2+(ysol6(b)-
ysol6(b+1))^2);
    end
    if sum(traj6)>0
        traj6(length(xsol6))=sqrt((xsol6(length(xsol6))-
xsol6(1))^2+(xsol6(length(xsol6))-xsol6(1))^2);
    end
end
if m(1)>6
    for b=1:length(xsol7)-1
        traj7(b)=sqrt((xsol7(b)-xsol7(b+1))^2+(ysol7(b)-
ysol7(b+1))^2);
    end
    if sum(traj7)>0
        traj7(length(xsol7))=sqrt((xsol7(length(xsol7))-
xsol7(1))^2+(xsol7(length(xsol7))-xsol7(1))^2);
    end
end
if m(1)>7
    for b=1:length(xsol8)-1
        traj8(b)=sqrt((xsol8(b)-xsol8(b+1))^2+(ysol8(b)-
ysol8(b+1))^2);
    end
    if sum(traj8)>0
        traj8(length(xsol8))=sqrt((xsol8(length(xsol8))-
xsol8(1))^2+(xsol8(length(xsol8))-xsol8(1))^2);
    end
end
if m(1)>8
    for b=1:length(xsol9)-1
        traj9(b)=sqrt((xsol9(b)-xsol9(b+1))^2+(ysol9(b)-
ysol9(b+1))^2);
    end
    traj9(length(xsol9))=sqrt((xsol9(length(xsol9))-
xsol9(1))^2+(xsol9(length(xsol9))-xsol9(1))^2);
end
if m(1)>9
    for b=1:length(xsol10)-1
        traj10(b)=sqrt((xsol10(b)-
xsol10(b+1))^2+(ysol10(b)-ysol10(b+1))^2);
    end
    traj10(length(xsol10))=sqrt((xsol10(length(xsol10))-
xsol10(1))^2+(xsol10(length(xsol10))-xsol10(1))^2);
end
if m(1)>10
    for b=1:length(xsol11)-1
        traj11(b)=sqrt((xsol11(b)-
xsol11(b+1))^2+(ysol11(b)-ysol11(b+1))^2);
    end
    traj11(length(xsol11))=sqrt((xsol11(length(xsol11))-
xsol11(1))^2+(xsol11(length(xsol11))-xsol11(1))^2);
end
if m(1)>11
    for b=1:length(xsol12)-1
        traj12(b)=sqrt((xsol12(b)-
xsol12(b+1))^2+(ysol12(b)-ysol12(b+1))^2);
    end
    traj12(length(xsol12))=sqrt((xsol12(length(xsol12))-
xsol12(1))^2+(xsol12(length(xsol12))-xsol12(1))^2);
end
if m(1)>12
    for b=1:length(xsol13)-1
        traj13(b)=sqrt((xsol13(b)-
xsol13(b+1))^2+(ysol13(b)-ysol13(b+1))^2);
    end
    traj13(length(xsol13))=sqrt((xsol13(length(xsol13))-
xsol13(1))^2+(xsol13(length(xsol13))-xsol13(1))^2);
end
clear repartos
m=size(aassignacions);
% m(1)=m(1)-unions;
longitud_total=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5)+sum(traj6)+sum(traj7)+sum(traj8)+sum(traj9)+sum(t
raj10)+sum(traj11)+sum(traj12)+sum(traj13)
if m(1)>0
    plot(xsol1,ysol1,'--bs')
hold on

```

```

end
if m(1)>1
plot(xsol2,ysol2,'--gs')
hold on
end
if m(1)>2
plot(xsol3,ysol3,'--rs')
hold on
end
if m(1)>3
plot(xsol4,ysol4,'--cs')
hold on
end
if m(1)>4
plot(xsol5,ysol5,'--ms')
hold on
end
if m(1)>5
plot(xsol6,ysol6,'--ys')
hold on
end
if m(1)>6
plot(xsol7,ysol7,'--ks')
hold on
end
if m(1)>7
plot(xsol8,ysol8,'--bs')
hold on
end
plot(hub(1),hub(2),'db')
hold off

```

tabusearch

dades

```

clear all
%entrada de dades
A=[ 1 9 35
2 43 19
3 79 35
4 93 7
5 13 35
6 67 13
7 31 77
8 81 7
9 27 49
10 27 35
11 69 23
12 31 51
13 27 27
14 15 83
15 7 35
16 53 25
17 75 13
18 47 49
19 25 33
20 1 23
21 45 11
22 1 47
23 93 15
24 41 9
25 75 55
26 3 1
27 51 67
28 57 91
29 21 97
30 55 13
31 3 71
32 37 19
33 73 21
34 19 19
35 75 73
36 93 49
37 41 87
38 97 73

```

```

39 45 29];
B=[1 0
2 5
3 24
4 3
5 20
6 26
7 23
8 15
9 3
10 20
11 16
12 9
13 21
14 3
15 24
16 14
17 6
18 6
19 13
20 5
21 3
22 3
23 20
24 16
25 22
26 10
27 12
28 20
29 24
30 6
31 1
32 2
33 13
34 7
35 6
36 24
37 19
38 4
39 7 ];
%transformació de dades
for i=1:length(A)-1
pesos(i)=B(i+1,2);
xdef(i)=A(i+1,2);
ydef(i)=A(i+1,3);
end
hub=[A(1,2) A(1,3)];
cap=100;

```

CW_capacitat_furgos

```

for i=1:length(xdef)
costdirecte(i)=sqrt((hub(1)-xdef(i))^2+(hub(2)-
ydef(i))^2);
end
for i=1:length(xdef)
for j=1:length(xdef)
dist(i,j)=sqrt((xdef(j)-xdef(i))^2+(ydef(j)-ydef(i))^2);
dist(i,i)=10000;
estalvi(i,j)=2*costdirecte(i)+2*costdirecte(j)-
costdirecte(i)-costdirecte(j)-dist(i,j);
estalvi(i,i)=0;
end
end
k=0;
while max(max(estalvi))>0
k=k+1;
[val,pos]=max(estalvi);
[vall,poss]=max(val);
par(k,1)=pos(poss);
par(k,2)=poss;
n1=par(k,1);
n2=par(k,2);
estalvi(n1,n2)=0;
estalvi(n2,n1)=0;
end

```

```

clear asignacions
clear extremos
asignacions(1,length(xdef))=0;
extremos(1,length(xdef))=0;
vol=0;
unions=0;
%creamos rutas
vol(1)=pesos(par(1,1))+pesos(par(1,2));
asignacions(1,par(1,1))=100;
asignacions(1,par(1,2))=101;
extremos(1,par(1,1))=-1;
extremos(1,par(1,2))=1;
p=2;
for j=2:length(par)
    o=0;
    if max(abs(asignacions(:,par(j,1))))==0 &
max(abs(asignacions(:,par(j,2))))==0
        vol(p)=pesos(par(j,1))+pesos(par(j,2));
        asignacions(p,par(j,1))=p*100;
        asignacions(p,par(j,2))=p*100+1;
        extremos(1,par(j,1))=-1;
        extremos(1,par(j,2))=1;
        p=p+1;
        o=1;
    end
    if max(abs(asignacions(:,par(j,1))))>0 &
max(abs(asignacions(:,par(j,2))))==0 & o==0
        o=1;
        a=1;
        while asignacions(a,par(j,1))==0
            a=a+1;
        end
        voll=vol(a)+pesos(par(j,2));
        if (extremos(1,par(j,1)))>0 & voll<=cap
            %añado el arco a la ruta
            vol(a)=voll;
            asignacions(a,par(j,2))=asignacions(a,par(j,1))+1;
            extremos(1,par(j,1))=0;
            extremos(1,par(j,2))=1;
        end
        if (extremos(1,par(j,1)))<0 & voll<=cap
            %añado el arco a la ruta
            vol(a)=voll;
            asignacions(a,par(j,2))=asignacions(a,par(j,1))-
1;
            extremos(1,par(j,1))=0;
            extremos(1,par(j,2))=-1;
        end
        if (extremos(1,par(j,1)))==0 | voll>cap
            %res
        end
    end
    if max(abs(asignacions(:,par(j,2))))>0 &
max(abs(asignacions(:,par(j,1))))==0 & o==0
        o=1;
        a=1;
        while asignacions(a,par(j,2))==0
            a=a+1;
        end
        voll=vol(a)+pesos(par(j,1));
        if (extremos(1,par(j,2)))>0 & voll<=cap
            %añado el arco a la ruta
            vol(a)=voll;
            asignacions(a,par(j,1))=asignacions(a,par(j,2))+1;
            extremos(1,par(j,2))=0;
            extremos(1,par(j,1))=1;
        end
        if (extremos(1,par(j,2)))<0 & voll<=cap
            %añado el arco a la ruta
            vol(a)=voll;
            asignacions(a,par(j,1))=asignacions(a,par(j,2))-
1;
            extremos(1,par(j,2))=0;
            extremos(1,par(j,1))=-1;
        end
    end
end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))<0
    unions=unions+1;
    extremos(1,par(j,2))=0;
    extremos(1,par(j,1))=0;
    vol(a)=voll;
    vol(b)=0;
    f=size(asignacions);
    for g=1:f(2)
        if asignacions(b,g)>0
            asignacions(a,g)=asignacions(b,g);
            asignacions(b,g)=0;
            g=g+1;
        end
    end
end
if (extremos(1,par(j,1)))<0 &
(extremos(1,par(j,2)))>0
    unions=unions+1;
    extremos(1,par(j,2))=0;
    extremos(1,par(j,1))=0;
    vol(a)=voll;
    vol(b)=0;
    f=size(asignacions);
    for g=1:f(2)
        if asignacions(a,g)>0
            asignacions(a,g)=asignacions(a,g)+(b-a)*100;
        end
        if asignacions(b,g)>0
            asignacions(a,g)=asignacions(b,g)-
(b-a)*100;
            asignacions(b,g)=0;
        end
        g=g+1;
    end
end
if (extremos(1,par(j,1)))>0 &
(extremos(1,par(j,2)))>0
    unions=unions+1;
    extremos(1,par(j,2))=0;
    extremos(1,par(j,1))=0;
    f=size(asignacions);
    for g=1:f(2)
        if asignacions(b,g)==0
            assignacions(b,g)=10000;
        end
        if asignacions(b,g)>0
            assignacions(b,g)=asignacions(b,g);
        end
        g=g+1;
    end
end
[ val pos]=min(assignacions(b,:));

```



```

n=n+1;
ruta1(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta1(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta1);
ruta1(pos)=10000;
sol1(p)=pos;
end
xsol1=0;
ysol1=0;
xsol1(1)=hub(1);
ysol1(1)=hub(2);
for d=1:n
xsol1(d+1)=xdef(sol1(d));
ysol1(d+1)=ydef(sol1(d));
end
xsol1(n+2)=hub(1);
ysol1(n+2)=hub(2);
end
if m(1)>1
t=2;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta2(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta2(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta2);
ruta2(pos)=10000;
sol2(p)=pos;
end
xsol2=0;
ysol2=0;
xsol2(1)=hub(1);
ysol2(1)=hub(2);
for d=1:n
xsol2(d+1)=xdef(sol2(d));
ysol2(d+1)=ydef(sol2(d));
end
xsol2(n+2)=hub(1);
ysol2(n+2)=hub(2);
end
if m(1)>2
t=3;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta3(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta3(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta3);
ruta3(pos)=10000;
sol3(p)=pos;
end
xsol3=0;
ysol3=0;
xsol3(1)=hub(1);
ysol3(1)=hub(2);
for d=1:n
xsol3(d+1)=xdef(sol3(d));
ysol3(d+1)=ydef(sol3(d));
end
xsol3(n+2)=hub(1);
ysol3(n+2)=hub(2);
end
if m(1)>3
t=4;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta4(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta4(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta4);
ruta4(pos)=10000;
sol4(p)=pos;
end
xsol4=0;
ysol4=0;
xsol4(1)=hub(1);
ysol4(1)=hub(2);
for d=1:n
xsol4(d+1)=xdef(sol4(d));
ysol4(d+1)=ydef(sol4(d));
end
xsol4(n+2)=hub(1);
ysol4(n+2)=hub(2);
end
if m(1)>4
t=5;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta5(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta5(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta5);
ruta5(pos)=10000;
sol5(p)=pos;
end
xsol5=0;
ysol5=0;
xsol5(1)=hub(1);
ysol5(1)=hub(2);
for d=1:n
xsol5(d+1)=xdef(sol5(d));
ysol5(d+1)=ydef(sol5(d));
end
xsol5(n+2)=hub(1);
ysol5(n+2)=hub(2);
end
if m(1)>5
t=6;
n=0;
for k=1:length(aassignacions)
if aassignacions(t,k)>0
n=n+1;
ruta6(k)=aassignacions(t,k);
end
if aassignacions(t,k)==0
ruta6(k)=10000;
end
end
for p=1:n
[val pos]=min(ruta6);
ruta6(pos)=10000;
sol6(p)=pos;
end
end

```

```

xsol6=0;
ysol6=0;
xsol6(1)=hub(1);
ysol6(1)=hub(2);
for d=1:n
    xsol6(d+1)=xdef(sol6(d));
    ysol6(d+1)=ydef(sol6(d));
end
xsol6(n+2)=hub(1);
ysol6(n+2)=hub(2);
end
if m(1)>6
    t=7;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta7(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta7(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta7);
    ruta7(pos)=10000;
    sol7(p)=pos;
end
xsol7=0;
ysol7=0;
xsol7(1)=hub(1);
ysol7(1)=hub(2);
for d=1:n
    xsol7(d+1)=xdef(sol7(d));
    ysol7(d+1)=ydef(sol7(d));
end
xsol7(n+2)=hub(1);
ysol7(n+2)=hub(2);
end
if m(1)>7
    t=8;
    n=0;
    for k=1:length(aassignacions)
        if aassignacions(t,k)>0
            n=n+1;
            ruta8(k)=aassignacions(t,k);
        end
        if aassignacions(t,k)==0
            ruta8(k)=10000;
        end
    end
end
for p=1:n
    [val pos]=min(ruta8);
    ruta8(pos)=10000;
    sol8(p)=pos;
end
xsol8=0;
ysol8=0;
xsol8(1)=hub(1);
ysol8(1)=hub(2);
for d=1:n
    xsol8(d+1)=xdef(sol8(d));
    ysol8(d+1)=ydef(sol8(d));
end
xsol8(n+2)=hub(1);
ysol8(n+2)=hub(2);
end
s=size(aassignacions);
numrutes=s(1)-unions;
traj1=0;
traj2=0;
traj3=0;
traj4=0;
traj5=0;
traj6=0;
traj7=0;

traj8=0;
if m(1)>0
    for b=1:length(xsol1)-1
        traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-ysol1(b+1))^2);
    end
    traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
end
if m(1)>1
    for b=1:length(xsol2)-1
        traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-ysol2(b+1))^2);
    end
    if sum(traj2)>0
        traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
    end
end
if m(1)>2
    for b=1:length(xsol3)-1
        traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-ysol3(b+1))^2);
    end
    if sum(traj3)>0
        traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
    end
end
if m(1)>3
    for b=1:length(xsol4)-1
        traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-ysol4(b+1))^2);
    end
    if sum(traj4)>0
        traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
    end
end
if m(1)>4
    for b=1:length(xsol5)-1
        traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-ysol5(b+1))^2);
    end
    if sum(traj5)>0
        traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
    end
end
if m(1)>5
    for b=1:length(xsol6)-1
        traj6(b)=sqrt((xsol6(b)-xsol6(b+1))^2+(ysol6(b)-ysol6(b+1))^2);
    end
    if sum(traj6)>0
        traj6(length(xsol6))=sqrt((xsol6(length(xsol6))-xsol6(1))^2+(xsol6(length(xsol6))-xsol6(1))^2);
    end
end
if m(1)>6
    for b=1:length(xsol7)-1
        traj7(b)=sqrt((xsol7(b)-xsol7(b+1))^2+(ysol7(b)-ysol7(b+1))^2);
    end
    if sum(traj7)>0
        traj7(length(xsol7))=sqrt((xsol7(length(xsol7))-xsol7(1))^2+(xsol7(length(xsol7))-xsol7(1))^2);
    end
end
if m(1)>7
    for b=1:length(xsol8)-1
        traj8(b)=sqrt((xsol8(b)-xsol8(b+1))^2+(ysol8(b)-ysol8(b+1))^2);
    end
    if sum(traj8)>0

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    traj8(length(xsol2))=sqrt((xsol8(length(xsol8))-
xsol8(1))^2+(xsol8(length(xsol8))-xsol8(1))^2);
    end
end
clear repartos
m=size(aasignacions);
%m(1)=m(1)-unions;
if m(1)>0
plot(xsol1,ysol1,'--bs')
hold on
end
if m(1)>1
plot(xsol2,ysol2,'--gs')
hold on
end
if m(1)>2
plot(xsol3,ysol3,'--rs')
hold on
end
if m(1)>3
plot(xsol4,ysol4,'--cs')
hold on
end
if m(1)>4
plot(xsol5,ysol5,'--ms')
hold on
end
if m(1)>5
plot(xsol6,ysol6,'--ys')
hold on
end
if m(1)>6
plot(xsol7,ysol7,'--ks')
hold on
end
if m(1)>7
plot(xsol8,ysol8,'--bs')
hold on
end
plot(hub(1),hub(2),'db')
hold off
longitud_total_aproximacio_inicial=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5)+sum(traj6)+sum(traj7)+sum(traj8)
%% Tabu search(guardem les 3 millors
soluciones)
sol_fact=[longitud_total_aproximacio_inicial
longitud_total_aproximacio_inicial+1
longitud_total_aproximacio_inicial+2];
sol_no_fact=[longitud_total_aproximacio_inicial
longitud_total_aproximacio_inicial+1
longitud_total_aproximacio_inicial+2];
iter_total=1;
iter_sup=0;
matriu_tabu=zeros(length(xdef));
sol(1)=longitud_total_aproximacio_inicial;
    sol_fact1_1=sol1;
    sol_fact2_1=sol2;
    sol_fact3_1=sol3;
    sol_fact4_1=sol4;
    sol_fact5_1=sol5;

tope=10;

while iter_total<5000

    iter_total=iter_total+1;
    sol(iter_total)=sol(iter_total-1);
    if iter_sup<tope
        matriu_tabu=matriu_tabu.^2;
    decisio=3*rand;
    decisio(iter_total+1)=decisio;
    if decisio<1
        o=0;

```

```

ruta_a_invertir=rand;
if ruta_a_invertir<0.2 & o==0
o=1;
l1=length(sol1);
num2=fix(1+l1*(rand));
num1=fix(1+l1*(rand));
    if num1>num2
        n1=num1;
        n2=num2;
    end
    if num2>num1
        n2=num1;
        n1=num2;
    end
    if num1==num2
        n2=1;
        n1=1;
    end
    if (matriu_tabu(sol1(n1),sol1(n1-1))==0 &
matriu_tabu(sol1(n2),sol1(n2+1))==0)
|(matriu_tabu(sol1(n1),sol1(n1-1))>1000 &
matriu_tabu(sol1(n2),sol1(n2+1))>1000);
        matriu_tabu(sol1(n1),sol1(n1-1))=2;
        matriu_tabu(sol1(n1-1),sol1(n1))=2;
        matriu_tabu(sol1(n2),sol1(n2+1))=2;
        matriu_tabu(sol1(n2+1),sol1(n2))=2;
        for l=n2:n1
            soll1(l)=sol1(l);
        end
        for l=n2:n1
            sol1(l)=soll1(n1+n2-l);
        end
    end
end
if ruta_a_invertir<0.40 & o==0
o=1;
l2=length(sol2);
num2=fix(1+l2*(rand));
num1=fix(1+l2*(rand));
    if num1>num2
        n1=num1;
        n2=num2;
    end
    if num2>num1
        n2=num1;
        n1=num2;
    end
    if num1==num2
        n2=1;
        n1=2;
    end
    if (matriu_tabu(sol2(n1),sol2(n1-1))==0 &
matriu_tabu(sol2(n2),sol2(n2+1))==0)
|(matriu_tabu(sol2(n1),sol2(n1-1))>1000 &
matriu_tabu(sol2(n2),sol2(n2+1))>1000);
        matriu_tabu(sol2(n1),sol2(n1-1))=2;
        matriu_tabu(sol2(n1-1),sol2(n1))=2;
        matriu_tabu(sol2(n2),sol2(n2+1))=2;
        matriu_tabu(sol2(n2+1),sol2(n2))=2;
        for l=n2:n1
            soll2(l)=sol2(l);
        end
        for l=n2:n1
            sol2(l)=soll2(n1+n2-l);
        end
    end
end
if ruta_a_invertir<0.6 & o==0
o=1;
l3=length(sol3);
num2=fix(1+l3*(rand));
num1=fix(1+l3*(rand));
    if num1>num2
        n1=num1;
        n2=num2;
    end

```

```

        if num2>num1
            n2=num1;
            n1=num2;
        end
        if num1==num2
            n2=1;
            n1=l3;
        end
        if (matriu_tabu(sol3(n1),sol3(n1-1))==0 &
matriu_tabu(sol3(n2),sol3(n2+1))==0) &
|(matriu_tabu(sol3(n1),sol3(n1-1))>1000 &
matriu_tabu(sol3(n2),sol3(n2+1))>1000);
        matriu_tabu(sol3(n1),sol3(n1-1))=2;
        matriu_tabu(sol3(n1-1),sol3(n1))=2;
        matriu_tabu(sol3(n2),sol3(n2+1))=2;
        matriu_tabu(sol3(n2+1),sol3(n2))=2;
        for l=n2:n1
            soll3(l)=sol3(l);
        end
        for l=n2:n1
            sol3(l)=soll3(n1+n2-l);
        end
        end
    end
    if ruta_a_invertir<0.8 & o==0
        o=1;
        l4=length(sol4);
        num2=fix(1+l4*(rand));
        num1=fix(1+l4*(rand));
        if num1>num2
            n1=num1;
            n2=num2;
        end
        if num2>num1
            n2=num1;
            n1=num2;
        end
        if num1==num2
            n2=1;
            n1=l4;
        end
        if (matriu_tabu(sol4(n1),sol4(n1-1))==0 &
matriu_tabu(sol4(n2),sol4(n2+1))==0) &
|(matriu_tabu(sol4(n1),sol4(n1-1))>1000 &
matriu_tabu(sol4(n2),sol4(n2+1))>1000);
        matriu_tabu(sol4(n1),sol4(n1-1))=2;
        matriu_tabu(sol4(n1-1),sol4(n1))=2;
        matriu_tabu(sol4(n2),sol4(n2+1))=2;
        matriu_tabu(sol4(n2+1),sol4(n2))=2;
        for l=n2:n1
            soll4(l)=sol4(l);
        end
        for l=n2:n1
            sol4(l)=soll4(n1+n2-l);
        end
        end
    end
    if ruta_a_invertir<1 & o==0
        o=1;
        l5=length(sol5);
        num2=fix(1+l5*(rand));
        num1=fix(1+l5*(rand));
        if num1>num2
            n1=num1;
            n2=num2;
        end
        if num2>num1
            n2=num1;
            n1=num2;
        end
        if num1==num2
            n2=1;
            n1=l5;
        end
        if (matriu_tabu(sol5(n1),sol5(n1-1))==0 &
matriu_tabu(sol5(n2),sol5(n2+1))==0) &
|(matriu_tabu(sol5(n1),sol5(n1-1))>1000 &
matriu_tabu(sol5(n2),sol5(n2+1))>1000);
        matriu_tabu(sol5(n1),sol5(n1-1))=2;
        matriu_tabu(sol5(n1-1),sol5(n1))=2;
        matriu_tabu(sol5(n2),sol5(n2+1))=2;
        matriu_tabu(sol5(n2+1),sol5(n2))=2;
        for l=n2:n1
            soll5(l)=sol5(l);
        end
        for l=n2:n1
            sol5(l)=soll5(n1+n2-l);
        end
        end
    end
    xsol1=0;
    ysol1=0;
    xsol1(1)=hub(1);
    ysol1(1)=hub(2);
    n=length(sol1);
    for d=1:n
        xsol1(d+1)=xdef(sol1(d));
        ysol1(d+1)=ydef(sol1(d));
    end
    xsol1(n+2)=hub(1);
    ysol1(n+2)=hub(2);
    xsol2=0;
    ysol2=0;
    xsol2(1)=hub(1);
    ysol2(1)=hub(2);
    n=length(sol2);
    for d=1:n
        xsol2(d+1)=xdef(sol2(d));
        ysol2(d+1)=ydef(sol2(d));
    end
    xsol2(n+2)=hub(1);
    ysol2(n+2)=hub(2);
    xsol3=0;
    ysol3=0;
    xsol3(1)=hub(1);
    ysol3(1)=hub(2);
    n=length(sol3);
    for d=1:n
        xsol3(d+1)=xdef(sol3(d));
        ysol3(d+1)=ydef(sol3(d));
    end
    xsol3(n+2)=hub(1);
    ysol3(n+2)=hub(2);
    xsol4=0;
    ysol4=0;
    xsol4(1)=hub(1);
    ysol4(1)=hub(2);
    n=length(sol4);
    for d=1:n
        xsol4(d+1)=xdef(sol4(d));
        ysol4(d+1)=ydef(sol4(d));
    end
    xsol4(n+2)=hub(1);
    ysol4(n+2)=hub(2);
    xsol5=0;
    ysol5=0;
    xsol5(1)=hub(1);
    ysol5(1)=hub(2);
    n=length(sol5);
    for d=1:n
        xsol5(d+1)=xdef(sol5(d));
        ysol5(d+1)=ydef(sol5(d));
    end
    xsol5(n+2)=hub(1);
    ysol5(n+2)=hub(2);
    traj1=0;
    traj2=0;
    traj3=0;
    traj4=0;
    traj5=0;
    traj6=0;
    for b=1:length(xsol1)-1

```

```

    traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
ysol1(b+1))^2);
    end
    traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
    for b=1:length(xsol2)-1
        traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
ysol2(b+1))^2);
    end
    if sum(traj2)>0
        traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
    end
    for b=1:length(xsol3)-1
        traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
    end
    if sum(traj3)>0
        traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
    end
    for b=1:length(xsol4)-1
        traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
    end
    if sum(traj4)>0
        traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
    end
    for b=1:length(xsol5)-1
        traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
    end
    if sum(traj5)>0
        traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
    end
    longitud_total=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5);
    sol(iter_total)=longitud_total;
    [comp_pos]=max(sol_fact);
    if longitud_total<comp
        sol_fact(pos)=longitud_total;
        if pos==1
            sol_fact1_1=sol1;
            sol_fact2_1=sol2;
            sol_fact3_1=sol3;
            sol_fact4_1=sol4;
            sol_fact5_1=sol5;
        end
        if pos==2
            sol_fact1_2=sol1;
            sol_fact2_2=sol2;
            sol_fact3_2=sol3;
            sol_fact4_2=sol4;
            sol_fact5_2=sol5;
        end
        if pos==3
            sol_fact1_3=sol1;
            sol_fact2_3=sol2;
            sol_fact3_3=sol3;
            sol_fact4_3=sol4;
            sol_fact5_3=sol5;
        end
    end
    if longitud_total>comp
    end
end
if decisio<2 & decisio>1
    sortida=0;
    entrada=0;
    ruta1_a_conectar=fix(1+5*rand);
    if ruta1_a_conectar==1
        node_1=fix(2+(length(sol1)-2)*rand);
        for j=1:node_1

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```

            part1(j)=sol1(j);
        end
        for h=node_1+1:length(sol1)
            part2(h-node_1)=sol1(h);
        end
        n1=node_1;
        if (matriu_tabu(sol1(n1),sol1(n1+1))==0)
            |(matriu_tabu(sol1(n1),sol1(n1+1))>1000);
                matriu_tabu(sol1(n1),sol1(n1+1))=2;
                matriu_tabu(sol1(n1+1),sol1(n1))=2;
                sort=1;
            end
        end
        if ruta1_a_conectar==2
            node_1=fix(2+(length(sol2)-2)*rand);
            for j=1:node_1
                part1(j)=sol2(j);
            end
            for h=node_1+1:length(sol2)
                part2(h-node_1)=sol2(h);
            end
            n1=node_1;
            if (matriu_tabu(sol2(n1),sol2(n1+1))==0)
                |(matriu_tabu(sol2(n1),sol2(n1+1))>1000);
                    matriu_tabu(sol2(n1),sol2(n1+1))=2;
                    matriu_tabu(sol2(n1+1),sol2(n1))=2;
                    sortida=1;
                end
            end
            if ruta1_a_conectar==3
                node_1=fix(2+(length(sol3)-2)*rand);
                for j=1:node_1
                    part1(j)=sol3(j);
                end
                for h=node_1+1:length(sol3)
                    part2(h-node_1)=sol3(h);
                end
                n1=node_1;
                if (matriu_tabu(sol3(n1),sol3(n1+1))==0)
                    |(matriu_tabu(sol3(n1),sol3(n1+1))>1000);
                        matriu_tabu(sol3(n1),sol3(n1+1))=2;
                        matriu_tabu(sol3(n1+1),sol3(n1))=2;
                        sortida=1;
                    end
                end
            end
            if ruta1_a_conectar==4
                node_1=fix(2+(length(sol4)-2)*rand);
                for j=1:node_1
                    part1(j)=sol4(j);
                end
                for h=node_1+1:length(sol4)
                    part2(h-node_1)=sol4(h);
                end
                n1=node_1;
                if (matriu_tabu(sol4(n1),sol4(n1+1))==0)
                    |(matriu_tabu(sol4(n1),sol4(n1+1))>1000);
                        matriu_tabu(sol4(n1),sol4(n1+1))=2;
                        matriu_tabu(sol4(n1+1),sol4(n1))=2;
                        sortida=1;
                    end
                end
            end
            if ruta1_a_conectar==5
                node_1=fix(2+(length(sol5)-2)*rand);
                for j=1:node_1
                    part1(j)=sol5(j);
                end
                for h=node_1+1:length(sol5)
                    part2(h-node_1)=sol5(h);
                end
                n1=node_1;
                if (matriu_tabu(sol5(n1),sol5(n1+1))==0)
                    |(matriu_tabu(sol5(n1),sol5(n1+1))>1000);
                        matriu_tabu(sol5(n1),sol5(n1+1))=2;
                        matriu_tabu(sol5(n1+1),sol5(n1))=2;
                        sortida=1;
                    end
                end
            end
        end
    end
end

```

```

end
ruta2_a_conectar=fix(1+5*rand);
if ruta2_a_conectar==1
node_2=fix(2+(length(sol1)-2)*rand);
for j=1:node_2
part3(j)=sol1(j);
end
for h=node_2+1:length(sol1)
part4(h-node_2)=sol1(h);
end
n2=node_2;
if (matriu_tabu(sol1(n2),sol1(n2+1))==0)
|(matriu_tabu(sol1(n2),sol1(n2+1))>1000);
matriu_tabu(sol1(n2),sol1(n2+1))=2;
matriu_tabu(sol1(n2+1),sol1(n2))=2;
entrada=1;
end
end
if ruta2_a_conectar==2
node_2=fix(2+(length(sol2)-2)*rand);
for j=1:node_2
part3(j)=sol2(j);
end
for h=node_2+1:length(sol2)
part4(h-node_2)=sol2(h);
end
n2=node_2;
if (matriu_tabu(sol2(n2),sol2(n2+1))==0)
|(matriu_tabu(sol2(n2),sol2(n2+1))>1000);
matriu_tabu(sol2(n2),sol2(n2+1))=2;
matriu_tabu(sol2(n2+1),sol2(n2))=2;
entrada=1;
end
end
if ruta2_a_conectar==3
node_2=fix(2+(length(sol3)-2)*rand);
for j=1:node_2
part3(j)=sol3(j);
end
for h=node_2+1:length(sol3)
part4(h-node_2)=sol3(h);
end
n2=node_2;
if (matriu_tabu(sol3(n2),sol3(n2+1))==0)
|(matriu_tabu(sol3(n2),sol3(n2+1))>1000);
matriu_tabu(sol3(n2),sol3(n2+1))=2;
matriu_tabu(sol3(n2+1),sol3(n2))=2;
entrada=1;
end
end
if ruta2_a_conectar==4
node_2=fix(2+(length(sol4)-2)*rand);
for j=1:node_2
part3(j)=sol4(j);
end
for h=node_2+1:length(sol4)
part4(h-node_2)=sol4(h);
end
n2=node_2;
if (matriu_tabu(sol4(n2),sol4(n2+1))==0)
|(matriu_tabu(sol4(n2),sol4(n2+1))>1000);
matriu_tabu(sol4(n2),sol4(n2+1))=2;
matriu_tabu(sol4(n2+1),sol4(n2))=2;
entrada=1;
end
end
if ruta2_a_conectar==5
node_2=fix(2+(length(sol5)-2)*rand);
for j=1:node_2
part3(j)=sol5(j);
end
for h=node_2+1:length(sol5)
part4(h-node_2)=sol5(h);
end
n2=node_2;
if (matriu_tabu(sol5(n2),sol5(n2+1))==0)
|(matriu_tabu(sol5(n2),sol5(n2+1))>1000);
matriu_tabu(sol5(n2),sol5(n2+1))=2;
matriu_tabu(sol5(n2+1),sol5(n2))=2;
entrada=1;
end
end
if ruta1_a_conectar>ruta2_a_conectar
if ruta1_a_conectar==1
sol1=[part1 part4];
end
if ruta1_a_conectar==2
sol2=[part1 part4];
end
if ruta1_a_conectar==3
sol3=[part1 part4];
end
if ruta1_a_conectar==4
sol4=[part1 part4];
end
if ruta1_a_conectar==5
sol5=[part1 part4];
end
if ruta2_a_conectar==1
sol1=[part3 part2];
end
if ruta2_a_conectar==2
sol2=[part3 part2];
end
if ruta2_a_conectar==3
sol3=[part3 part2];
end
if ruta2_a_conectar==4
sol4=[part3 part2];
end
if ruta2_a_conectar==5
sol5=[part3 part2];
end
end
end
clear part1
clear part2
clear part3
clear part4
clear sort
clear ent
vol1=0;
vol2=0;
vol3=0;
vol4=0;
vol5=0;
xsol1=0;
ysol1=0;
xsol1(1)=hub(1);
ysol1(1)=hub(2);
n=length(sol1);
for d=1:n
xsol1(d+1)=xdef(sol1(d));
ysol1(d+1)=ydef(sol1(d));
vol1=vol1+pesos(sol1(d));
end
xsol1(n+2)=hub(1);
ysol1(n+2)=hub(2);
xsol2=0;
ysol2=0;
xsol2(1)=hub(1);
ysol2(1)=hub(2);
n=length(sol2);
for d=1:n
xsol2(d+1)=xdef(sol2(d));
ysol2(d+1)=ydef(sol2(d));
vol2=vol2+pesos(sol2(d));
end
xsol2(n+2)=hub(1);

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```

ysol2(n+2)=hub(2);
xsol3=0;
ysol3=0;
xsol3(1)=hub(1);
ysol3(1)=hub(2);
n=length(sol3);
for d=1:n
    xsol3(d+1)=xdef(sol3(d));
    ysol3(d+1)=ydef(sol3(d));
    vol3=vol3+pesos(sol3(d));
end
xsol3(n+2)=hub(1);
ysol3(n+2)=hub(2);
xsol4=0;
ysol4=0;
xsol4(1)=hub(1);
ysol4(1)=hub(2);
n=length(sol4);
for d=1:n
    xsol4(d+1)=xdef(sol4(d));
    ysol4(d+1)=ydef(sol4(d));
    vol4=vol4+pesos(sol4(d));
end
xsol4(n+2)=hub(1);
ysol4(n+2)=hub(2);
xsol5=0;
ysol5=0;
xsol5(1)=hub(1);
ysol5(1)=hub(2);
n=length(sol5);
for d=1:n
    xsol5(d+1)=xdef(sol5(d));
    ysol5(d+1)=ydef(sol5(d));
    vol5=vol5+pesos(sol5(d));
end
xsol5(n+2)=hub(1);
ysol5(n+2)=hub(2);
traj1=0;
traj2=0;
traj3=0;
traj4=0;
traj5=0;
for b=1:length(xsol1)-1
    traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
ysol1(b+1))^2);
end
traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
for b=1:length(xsol2)-1
    traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
ysol2(b+1))^2);
end
if sum(traj2)>0
    traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
end
for b=1:length(xsol3)-1
    traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
end
if sum(traj3)>0
    traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
end
for b=1:length(xsol4)-1
    traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
end
if sum(traj4)>0
    traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
end
for b=1:length(xsol5)-1
    traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
end
if sum(traj5)>0
    traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
end
longitud_total=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5)+sum(traj6)+sum(traj7)+sum(traj8);
sol(iter_total)=longitud_total;
[comp pos]=max(sol_fact);
if longitud_total<comp
    sol_fact(pos)=longitud_total;
    if pos==1
        sol_fact1_1=sol1;
        sol_fact2_1=sol2;
        sol_fact3_1=sol3;
        sol_fact4_1=sol4;
        sol_fact5_1=sol5;
    end
    if pos==2
        sol_fact1_2=sol1;
        sol_fact2_2=sol2;
        sol_fact3_2=sol3;
        sol_fact4_2=sol4;
        sol_fact5_2=sol5;
    end
    if pos==3
        sol_fact1_3=sol1;
        sol_fact2_3=sol2;
        sol_fact3_3=sol3;
        sol_fact4_3=sol4;
        sol_fact5_3=sol5;
    end
end
if longitud_total>comp
    iter_sup=iter_sup+1;
end
end
if vol1>cap | vol2>cap | vol3>cap | vol4>cap |
vol5>cap
    exces1=0;
    exces2=0;
    exces3=0;
    exces4=0;
    exces5=0;
    if vol1>cap
        exces1=vol1-cap;
    end
    if vol2>cap
        exces2=vol2-cap;
    end
    if vol3>cap
        exces3=vol3-cap;
    end
    if vol4>cap
        exces4=vol4-cap;
    end
    if vol5>cap
        exces5=vol5-cap;
    end
end
exces_total=exces1+exces2+exces3+exces4+exces5;
alfa=1;
longitud_total=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5)+alfa*exces_total;
sol(iter_total)=longitud_total;
[comp pos]=max(sol_no_fact);
if longitud_total<comp
    sol_fact(pos)=longitud_total;
    if pos==1
        sol_no_fact1_1=sol1;
        sol_no_fact2_1=sol2;
        sol_no_fact3_1=sol3;
        sol_no_fact4_1=sol4;
    end
end

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```

    sol_no_fact5_1=sol5;
end
if pos==2
sol_no_fact1_2=sol1;
sol_no_fact2_2=sol2;
sol_no_fact3_2=sol3;
sol_no_fact4_2=sol4;
sol_no_fact5_2=sol5;
end
if pos==3
sol_no_fact1_3=sol1;
sol_no_fact2_3=sol2;
sol_no_fact3_3=sol3;
sol_no_fact4_3=sol4;
sol_no_fact5_3=sol5;
end
end
if longitud_total>comp
iter_sup=iter_sup+1;
end
end
end
if decisio>2
extret=0;
q=0;
ruta_a_extreure_node=fix(1+5*rand);
if ruta_a_extreure_node==1 & length(sol1)>1
node_a_extreure=fix(1+(length(sol1))*rand);
if node_a_extreure>1
for h=1:node_a_extreure-1
solt(h)=sol1(h);
end
end
if node_a_extreure<length(sol1)
for l=node_a_extreure+1:length(sol1)
solt(l-1)=sol1(l);
end
end
q=sol1(node_a_extreure);
extret=1;
end
if ruta_a_extreure_node==2 & length(sol2)>1
node_a_extreure=fix(1+(length(sol2))*rand);
if node_a_extreure>1
for h=1:node_a_extreure-1
solt(h)=sol2(h);
end
end
if node_a_extreure<length(sol2)
for l=node_a_extreure+1:length(sol2)
solt(l-1)=sol2(l);
end
end
q=sol2(node_a_extreure);
extret=1;
end
if ruta_a_extreure_node==3 & length(sol3)>1
node_a_extreure=fix(1+(length(sol3))*rand);
if node_a_extreure>1
for h=1:node_a_extreure-1
solt(h)=sol3(h);
end
end
if node_a_extreure<length(sol3)
for l=node_a_extreure+1:length(sol3)
solt(l-1)=sol3(l);
end
end
q=sol3(node_a_extreure);
extret=1;
end
if ruta_a_extreure_node==4 & length(sol4)>1
node_a_extreure=fix(1+(length(sol4))*rand);
if node_a_extreure>1
for h=1:node_a_extreure-1
solt(h)=sol4(h);
end
end
end
end
if node_a_extreure<length(sol4)
for l=node_a_extreure+1:length(sol4)
solt(l-1)=sol4(l);
end
end
q=sol4(node_a_extreure);
extret=1;
end
if ruta_a_extreure_node==5 & length(sol5)>1
node_a_extreure=fix(1+(length(sol5))*rand);
if node_a_extreure>1
for h=1:node_a_extreure-1
solt(h)=sol5(h);
end
end
if node_a_extreure<length(sol5)
for l=node_a_extreure+1:length(sol5)
solt(l-1)=sol5(l);
end
end
q=sol5(node_a_extreure);
extret=1;
end
ruta_a_introduir_node=fix(1+5*rand);
if ruta_a_introduir_node==1 &
ruta_a_extreure_node>1 & extret==1
node_a_introduir=fix(1+(length(sol1))*rand);
if node_a_introduir>1
for h=1:node_a_introduir-1
sole(h)=sol1(h);
end
end
sole(node_a_introduir)=q;
if node_a_introduir<length(sol1)
for l=node_a_introduir+1:length(sol1)+1
sole(l)=sol1(l-1);
end
end
end
if
ruta_a_introduir_node==2 &
(ruta_a_extreure_node>2 | ruta_a_extreure_node<2)
& extret==1
node_a_introduir=fix(1+(length(sol2))*rand);
if node_a_introduir>1
for h=1:node_a_introduir-1
sole(h)=sol2(h);
end
end
sole(node_a_introduir)=q;
if node_a_introduir<length(sol2)
for l=node_a_introduir+1:length(sol2)+1
sole(l)=sol2(l-1);
end
end
end
if
ruta_a_introduir_node==3 &
(ruta_a_extreure_node>3 | ruta_a_extreure_node<3)
& extret==1
node_a_introduir=fix(1+(length(sol3))*rand);
if node_a_introduir>1
for h=1:node_a_introduir-1
sole(h)=sol3(h);
end
end
sole(node_a_introduir)=q;
if node_a_introduir<length(sol3)
for l=node_a_introduir+1:length(sol3)+1
sole(l)=sol3(l-1);
end
end
end
if
ruta_a_introduir_node==4 &
(ruta_a_extreure_node>4 | ruta_a_extreure_node<4)
& extret==1

```

```

node_a_introduir=fix(1+(length(sol4))*rand);
if node_a_introduir>1
    for h=1:node_a_introduir-1
        sole(h)=sol4(h);
    end
end
sole(node_a_introduir)=q;
if node_a_introduir<length(sol4)
    for l=node_a_introduir+1:length(sol4)+1
        sole(l)=sol4(l-1);
    end
end
end
if ruta_a_introduir_node==5 &
ruta_a_extreure_node<5 & extret==1
node_a_introduir=fix(1+(length(sol5))*rand);
if node_a_introduir>1
    for h=1:node_a_introduir-1
        sole(h)=sol5(h);
    end
end
sole(node_a_introduir)=q;
if node_a_introduir<length(sol5)
    for l=node_a_introduir+1:length(sol5)+1
        sole(l)=sol5(l-1);
    end
end
end
if (ruta_a_introduir_node<ruta_a_extreure_node &
extret==1) |
(ruta_a_introduir_node>ruta_a_extreure_node &
extret==1)
    if ruta_a_introduir_node==1
        sol1=[solt];
    end
    if ruta_a_introduir_node==2
        sol2=[solt];
    end
    if ruta_a_introduir_node==3
        sol3=[solt];
    end
    if ruta_a_introduir_node==4
        sol4=[solt];
    end
    if ruta_a_introduir_node==5
        sol5=[solt];
    end
    if ruta_a_extreure_node==1
        sol1=[sole];
    end
    if ruta_a_extreure_node==2
        sol2=[sole];
    end
    if ruta_a_extreure_node==3
        sol3=[sole];
    end
    if ruta_a_extreure_node==4
        sol4=[sole];
    end
    if ruta_a_extreure_node==5
        sol5=[sole];
    end
    clear sole
    clear solt
end
end
end
if iter_sup==tope
    iter_sup=0;
    sol1=sol_fact1_1;
    sol2=sol_fact2_1;
    sol3=sol_fact3_1;
    sol4=sol_fact4_1;
    sol5=sol_fact5_1;
    vol1=0;
    vol2=0;
    vol3=0;
    vol4=0;
    vol5=0;
    xsol1=0;
    ysol1=0;
    xsol1(1)=hub(1);
    ysol1(1)=hub(2);
    n=length(sol1);
    for d=1:n
        xsol1(d+1)=xdef(sol1(d));
        ysol1(d+1)=ydef(sol1(d));
        vol1=vol1+pesos(sol1(d));
    end
    xsol1(n+2)=hub(1);
    ysol1(n+2)=hub(2);
    xsol2=0;
    ysol2=0;
    xsol2(1)=hub(1);
    ysol2(1)=hub(2);
    n=length(sol2);
    for d=1:n
        xsol2(d+1)=xdef(sol2(d));
        ysol2(d+1)=ydef(sol2(d));
        vol2=vol2+pesos(sol2(d));
    end
    xsol2(n+2)=hub(1);
    ysol2(n+2)=hub(2);
    xsol3=0;
    ysol3=0;
    xsol3(1)=hub(1);
    ysol3(1)=hub(2);
    n=length(sol3);
    for d=1:n
        xsol3(d+1)=xdef(sol3(d));
        ysol3(d+1)=ydef(sol3(d));
        vol3=vol3+pesos(sol3(d));
    end
    xsol3(n+2)=hub(1);
    ysol3(n+2)=hub(2);
    xsol4=0;
    ysol4=0;
    xsol4(1)=hub(1);
    ysol4(1)=hub(2);
    n=length(sol4);
    for d=1:n
        xsol4(d+1)=xdef(sol4(d));
        ysol4(d+1)=ydef(sol4(d));
        vol4=vol4+pesos(sol4(d));
    end
    xsol4(n+2)=hub(1);
    ysol4(n+2)=hub(2);
    xsol5=0;
    ysol5=0;
    xsol5(1)=hub(1);
    ysol5(1)=hub(2);
    n=length(sol5);
    for d=1:n
        xsol5(d+1)=xdef(sol5(d));
        ysol5(d+1)=ydef(sol5(d));
        vol5=vol5+pesos(sol5(d));
    end
    xsol5(n+2)=hub(1);
    ysol5(n+2)=hub(2);
    traj1=0;
    traj2=0;
    traj3=0;
    traj4=0;
    traj5=0;
    for b=1:length(xsol1)-1
        traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
        ysol1(b+1))^2);
    end
    traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
    xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
    for b=1:length(xsol2)-1

```

```

    traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
ysol2(b+1))^2);
    end
    if sum(traj2)>0
    traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
    end
    for b=1:length(xsol3)-1
    traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
ysol3(b+1))^2);
    end
    if sum(traj3)>0
    traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
    end
    for b=1:length(xsol4)-1
    traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
ysol4(b+1))^2);
    end
    if sum(traj4)>0
    traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
    end
    for b=1:length(xsol5)-1
    traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
ysol5(b+1))^2);
    end
    if sum(traj5)>0
    traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
    end
    if vol1<cap & vol2<cap & vol3<cap & vol4<cap &
vol5<cap
    longitud_total=
sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
5)+sum(traj6)+sum(traj7)+sum(traj8);
    sol(iter_total)=longitud_total;
    end
    end
end
plot(sol)
min(sol)

```

Dibuix nova solució

```

sol1=sol_fact1_1;
sol2=sol_fact2_1;
sol3=sol_fact3_1;
sol4=sol_fact4_1;
sol5=sol_fact5_1;
if m(1)>0
    t=1;
    n=length(sol1);
    xsol1=0;
    ysol1=0;
    xsol1(1)=hub(1);
    ysol1(1)=hub(2);
    for d=1:n
        xsol1(d+1)=xdef(sol1(d));
        ysol1(d+1)=ydef(sol1(d));
    end
    xsol1(n+2)=hub(1);
    ysol1(n+2)=hub(2);
end
if m(1)>1
    t=2;
    n=length(sol2);
    xsol2=0;
    ysol2=0;
    xsol2(1)=hub(1);
    ysol2(1)=hub(2);
    for d=1:n
        xsol2(d+1)=xdef(sol2(d));
        ysol2(d+1)=ydef(sol2(d));
    end
    xsol2(n+2)=hub(1);

```

```

    ysol2(n+2)=hub(2);
end
if m(1)>2
    t=3;
    n=length(sol3);
    xsol3=0;
    ysol3=0;
    xsol3(1)=hub(1);
    ysol3(1)=hub(2);
    for d=1:n
        xsol3(d+1)=xdef(sol3(d));
        ysol3(d+1)=ydef(sol3(d));
    end
    xsol3(n+2)=hub(1);
    ysol3(n+2)=hub(2);
end
if m(1)>3
    t=4;
    n=length(sol4);

    xsol4=0;
    ysol4=0;
    xsol4(1)=hub(1);
    ysol4(1)=hub(2);
    for d=1:n
        xsol4(d+1)=xdef(sol4(d));
        ysol4(d+1)=ydef(sol4(d));
    end
    xsol4(n+2)=hub(1);
    ysol4(n+2)=hub(2);
end
if m(1)>4
    t=5;
    n=length(sol5);

    xsol5=0;
    ysol5=0;
    xsol5(1)=hub(1);
    ysol5(1)=hub(2);
    for d=1:n
        xsol5(d+1)=xdef(sol5(d));
        ysol5(d+1)=ydef(sol5(d));
    end
    xsol5(n+2)=hub(1);
    ysol5(n+2)=hub(2);
end
if m(1)>5
    t=6;
    n=length(sol6);

    xsol6=0;
    ysol6=0;
    xsol6(1)=hub(1);
    ysol6(1)=hub(2);
    for d=1:n
        xsol6(d+1)=xdef(sol6(d));
        ysol6(d+1)=ydef(sol6(d));
    end
    xsol6(n+2)=hub(1);
    ysol6(n+2)=hub(2);
end
if m(1)>6
    t=7;
    n=length(sol7);

    xsol7=0;
    ysol7=0;
    xsol7(1)=hub(1);
    ysol7(1)=hub(2);
    for d=1:n
        xsol7(d+1)=xdef(sol7(d));
        ysol7(d+1)=ydef(sol7(d));
    end
    xsol7(n+2)=hub(1);
    ysol7(n+2)=hub(2);
end

```

```

if m(1)>7
    t=8;
    n=length(sol8);

    xsol8=0;
    ysol8=0;
    xsol8(1)=hub(1);
    ysol8(1)=hub(2);
    for d=1:n
        xsol8(d+1)=xdef(sol8(d));
        ysol8(d+1)=ydef(sol8(d));
    end
    xsol8(n+2)=hub(1);
    ysol8(n+2)=hub(2);
    end
    s=size(aassignacions);
    numrutes=s(1)-unions;
    traj1=0;
    traj2=0;
    traj3=0;
    traj4=0;
    traj5=0;
    traj6=0;
    traj7=0;
    traj8=0;
    if m(1)>0
        for b=1:length(xsol1)-1
            traj1(b)=sqrt((xsol1(b)-xsol1(b+1))^2+(ysol1(b)-
            ysol1(b+1))^2);
        end
        traj1(length(xsol1))=sqrt((xsol1(length(xsol1))-
        xsol1(1))^2+(xsol1(length(xsol1))-xsol1(1))^2);
    end
    if m(1)>1
        for b=1:length(xsol2)-1
            traj2(b)=sqrt((xsol2(b)-xsol2(b+1))^2+(ysol2(b)-
            ysol2(b+1))^2);
        end
        if sum(traj2)>0
            traj2(length(xsol2))=sqrt((xsol2(length(xsol2))-
            xsol2(1))^2+(xsol2(length(xsol2))-xsol2(1))^2);
        end
    end
    if m(1)>2
        for b=1:length(xsol3)-1
            traj3(b)=sqrt((xsol3(b)-xsol3(b+1))^2+(ysol3(b)-
            ysol3(b+1))^2);
        end
        if sum(traj3)>0
            traj3(length(xsol3))=sqrt((xsol3(length(xsol3))-
            xsol3(1))^2+(xsol3(length(xsol3))-xsol3(1))^2);
        end
    end
    if m(1)>3
        for b=1:length(xsol4)-1
            traj4(b)=sqrt((xsol4(b)-xsol4(b+1))^2+(ysol4(b)-
            ysol4(b+1))^2);
        end
        if sum(traj4)>0
            traj4(length(xsol4))=sqrt((xsol4(length(xsol4))-
            xsol4(1))^2+(xsol4(length(xsol4))-xsol4(1))^2);
        end
    end
    if m(1)>4
        for b=1:length(xsol5)-1
            traj5(b)=sqrt((xsol5(b)-xsol5(b+1))^2+(ysol5(b)-
            ysol5(b+1))^2);
        end
        if sum(traj5)>0
            traj5(length(xsol5))=sqrt((xsol5(length(xsol5))-
            xsol5(1))^2+(xsol5(length(xsol5))-xsol5(1))^2);
        end
    end
    if m(1)>5
        for b=1:length(xsol6)-1
            traj6(b)=sqrt((xsol6(b)-xsol6(b+1))^2+(ysol6(b)-
            ysol6(b+1))^2);
        end
        if sum(traj6)>0
            traj6(length(xsol6))=sqrt((xsol6(length(xsol6))-
            xsol6(1))^2+(xsol6(length(xsol6))-xsol6(1))^2);
        end
    end
    if m(1)>6
        for b=1:length(xsol7)-1
            traj7(b)=sqrt((xsol7(b)-xsol7(b+1))^2+(ysol7(b)-
            ysol7(b+1))^2);
        end
        if sum(traj7)>0
            traj7(length(xsol7))=sqrt((xsol7(length(xsol7))-
            xsol7(1))^2+(xsol7(length(xsol7))-xsol7(1))^2);
        end
    end
    if m(1)>7
        for b=1:length(xsol8)-1
            traj8(b)=sqrt((xsol8(b)-xsol8(b+1))^2+(ysol8(b)-
            ysol8(b+1))^2);
        end
        if sum(traj8)>0
            traj8(length(xsol8))=sqrt((xsol8(length(xsol8))-
            xsol8(1))^2+(xsol8(length(xsol8))-xsol8(1))^2);
        end
    end
    clear repartos
    m=size(aassignacions);
    %m(1)=m(1)-unions;
    if m(1)>0
        plot(xsol1,ysol1,'--bs')
        hold on
    end
    if m(1)>1
        plot(xsol2,ysol2,'--gs')
        hold on
    end
    if m(1)>2
        plot(xsol3,ysol3,'--rs')
        hold on
    end
    if m(1)>3
        plot(xsol4,ysol4,'--cs')
        hold on
    end
    if m(1)>4
        plot(xsol5,ysol5,'--ms')
        hold on
    end
    if m(1)>5
        plot(xsol6,ysol6,'--ys')
        hold on
    end
    if m(1)>6
        plot(xsol7,ysol7,'--ks')
        hold on
    end
    if m(1)>7
        plot(xsol8,ysol8,'--bs')
        hold on
    end
    plot(hub(1),hub(2),'db')
    hold off
    longitud_total_aproximacio_inicial=
    sum(traj1)+sum(traj2)+sum(traj3)+sum(traj4)+sum(traj
    5)+sum(traj6)+sum(traj7)+sum(traj8)

```