```
//FMOLP Model for a Lead/Acid Battery Closed-Loop Supply Chain Network Design;

//Sets;
int nbdealers=...;
range dealers=1..nbdealers;
int nbdepots=...;
range depots=1..nbdepots;
int nbcompo=...;
range compo=1..nbcompo;
int nbmanuf=...;
range manuf=1..nbmanuf;
int nbrecyc=...;
range recyc=1..nbrecyc;
int nbbattery=...;
range battery=1..nbbattery;
int nbvendors=...;
range vendors=1..nbvendors;

//Parameters;
float f1[depots]=...;
float f2[depots]=...;
float f3[depots]=...;
float tc2[compo]=...;
float fr[recyc]=...;
float w[battery]=...;
float alf[battery]=...;
float s[battery]=...;
float dispr[battery]=...;
float tc[battery]=...;
float tc1[battery]=...;
float prco[battery]=...;
float cco[battery]=...;
float disco[battery]=...;
float de[battery][dealers]=...;
float cap[battery][depots]=...;
float hcap[battery][depots]=...;
float ccap[battery][depots]=...;
float hrcap[battery][depots]=...;
float capp[battery][manuf]=...;
float a[compo][battery]=...;
float a1[compo][battery]=...;
float puc[compo][vendors][manuf]=...;
float recap[battery][recyc]=...;
float reco[battery][recyc]=...;
float scap[compo][vendors]=...;
float puc1[battery][depots]=...;
float sp[battery][depots]=...;
```

```
float d1[manuf][depots]=...;
float d2[depots][dealers]=...;
float d3[depots][recyc]=...;
float d4[recyc][manuf]=...;
float binp[depots][dealers]=...;
float dmax=...;
float d1max=...;
float w1=...;
float w2=...;
float w3=...;
float w4=...;

//Decision Variables;
dvar boolean hyb[depots];
dvar boolean reg[depots];
dvar boolean col[depots];
dvar boolean yre[recyc];
dvar boolean y[depots][dealers];
dvar boolean yr[dealers][depots];
dvar int+ q[battery][manuf][depots][dealers];
dvar int+ qr[battery][dealers][depots][recyc];
dvar int+ x[battery][manuf];
dvar float+ x1[compo][recyc][manuf];
dvar float+ qc[compo][vendors][manuf];
dvar float+ re[battery][recyc];
dvar int+ qp1[battery][depots];
dvar boolean y2[battery][depots];
dvar boolean y3[battery][depots];
dvar int+ qp[battery][depots][recyc];
dvar float+ coverage;
dvar float+ flexibility;
dvar float+ cost;
dvar float+ m1;
dvar float+ m2;
dvar float+ m3;

//Objective Function;
maximize
m1+m2+m3;

//Constraints;
subject to
{
m1<=(16535000-cost)/4516656;
m2<=(coverage-65181)/35976;
m3<=(flexibility-81453)/222906;
sum(b in battery, k in dealers, j in depots) de[b][k]*s[b]*yr[k][j]==coverage;
```

```
sum(j in depots) hyb[j]*f1[j]+sum(j in depots) reg[j]*f2[j]+sum(j in depots) col[j]*f3[j]+sum(l in recyc)
yre[l]*fr[l]+sum(b in battery, j in depots, i in manuf, k in dealers) q[b][i][j][k]*tc[b]*(d1[i][j]+d2[j][k])+sum(b in
battery, k in dealers, j in depots, l in recyc) qr[b][k][j][l]*tc1[b]*(d2[j][k]+d3[j][l])+ sum(b in battery, j in
depots, l in recyc) qp[b][j][l]*tc1[b]*d3[j][l]+sum(c in compo, l in recyc, i in manuf)
x1[c][l][i]*tc2[c]*d4[l][i]+sum(c in compo, v in vendors, i in manuf) qc[c][v][i]*puc[c][v][i]+sum(b in battery, j in
depots, l in recyc) qp[b][j][l]*puc1[b][j]-sum(b in battery, j in depots) qp1[b][j]*sp[b][j]+sum(b in battery, l in
recyc) re[b][l]*reco[b][l]+sum(b in battery, i in manuf) x[b][i]*prco[b]+sum(b in battery, j in depots, k in dealers)
yr[k][j]*de[b][k]*s[b]*cco[b]+sum(b in battery, j in depots, k in dealers, l in recyc)
(qr[b][k][j][l]+qp[b][j][l]qp1[b][j])*dispr[b]*disco[b]==cost;
w1*(sum(i in manuf)(sum(b in battery) capp[b][i]-sum(b in battery) x[b][i]))+w3*(sum(j in depots)(sum(b in battery)
cap[b][j]*reg[j]+sum(b in battery) hcap[b][j]*hyb[j]-sum(b in battery, k in dealers) y[j][k]*de[b][k]))+w2*(sum(l in
recyc) (sum(b in battery) recap[b][l]*yre[l]/w[b]-sum(b in battery) re[b][l]/w[b]))+w4*(sum(j in depots) (sum(b in
battery) ccap[b][j]*col[j]+sum(b in battery) hrcap[b][j]*hyb[j]-sum(b in battery, k in dealers) yr[k][j]*de[b][k]*s[b]-
sum(b in battery, l in recyc) qp[b][j][l]))==flexibility;
sum(j in depots) col[j]+sum(j in depots) hyb[j]<=5;
forall(k in dealers, j in depots) {yr[k][j]<=binp[j][k]*(hyb[j]+col[j]);}
forall(k in dealers) {sum(j in depots) yr[k][j]<=1;}
forall(k in dealers) {sum(j in depots) y[j][k]==1;}
forall(b in battery, j in depots) {sum(k in dealers) y[j][k]*de[b][k]<=cap[b][j]*reg[j]+hcap[b][j]*hyb[j];}
forall(b in battery, k in dealers, j in depots) {sum(i in manuf) q[b][i][j][k]==y[j][k]*de[b][k];}
forall(b in battery, j in depots) {sum(k in dealers) yr[k][j]*de[b][k]*s[b]+sum(l in recyc) qp[b][j][l]-
qp1[b][j]<=ccap[b][j]*col[j]+hrcap[b][j]*hyb[j];}
forall(b in battery, k in dealers, j in depots) {sum(l in recyc) qr[b][k][j][l]==yr[k][j]*round(de[b][k]*s[b]);}
forall(j in depots) {hyb[j]+reg[j]+col[j]<=1;}
forall(j in depots) {sum(k in dealers) y[j][k]<=(hyb[j]+reg[j])*9999;}
forall(b in battery, i in manuf) {sum(j in depots, k in dealers) q[b][i][j][k]<=x[b][i];}
forall(b in battery, i in manuf) {x[b][i]<=capp[b][i];}
forall(b in battery, l in recyc) {((sum(k in dealers, j in depots) qr[b][k][j][l]+sum(j in depots) qp[b][j][l]-sum(j in
depots) qp1[b][j])*(1-dispr[b]))*w[b]==re[b][l];}
forall(c in compo, l in recyc) {sum(i in manuf) x1[c][l][i]==sum(b in battery) re[b][l]*alf[b]*a[c][b];}
forall(b in battery, j in depots) {sum(l in recyc) qp[b][j][l]<=999999999*y2[b][j];}
forall(b in battery, j in depots) {qp1[b][j]<=999999999*y3[b][j];}
forall(b in battery, j in depots) {y2[b][j]+y3[b][j]<=1;}
forall(j in depots, k in dealers) {d2[j][k]*y[j][k]<=dmax;}
forall(j in depots, k in dealers) {d2[j][k]*yr[k][j]<=d1max;}
forall(i in manuf, c in compo) {sum(v in vendors) qc[c][v][i]+sum(l in recyc) x1[c][l][i]==sum(b in battery)
x[b][i]*a1[c][b];}
forall(b in battery, l in recyc) {re[b][l]<=recap[b][l]*yre[l];}
forall(b in battery, k in dealers, j in depots, l in recyc) {qr[b][k][j][l]+qp[b][j][l]<=999999999*yre[l];}
forall(v in vendors, c in compo) {sum(i in manuf) qc[c][v][i]<=scap[c][v];}
m1>=0.847;
m2>=0.746;
m3>=0.416;
m1<=1;
m2<=1;
m3<=1;
}
```

```
//Data for Computational Case Study;
nbdealers=30;
nbdepots=13;
nbmanuf=2;
nbcompo=3;
nbrecyc=4;
nbbattery=3;
nbvendors=3;
w=[15 21 35];
alf=[0.8 0.7 0.75];
f1=[432000 486000 405000 513000 360000 495000 387000 459000 360000 432000 504000 360000 522000];
f2=[150000 180000 170000 160000 190000 200000 230000 190000 215000 220000 230000 190000 210000];
f3=[100000 120000 90000 130000 140000 125000 150000 110000 138000 100000 120000 115000 140000];
fr=[600000 500000 600000 400000];
s=[0.85 0.75 0.9];
tc1=[0.002 0.0035 0.004];
tc=[0.001 0.002 0.003];
tc2=[0.0008 0.001 0.0015];
dmax=500;
d1max=400;
prco=[25 40 65];
cco=[2 3 5];
disco=[1 2 3];
w1=0.25;
w2=0.25;
w3=0.25;
w4=0.25;
a=[[0.5 0.55 0.52],[0.2 0.25 0.3],[0.1 0.15 0.13]];
dispr=[0.1 0.05 0.08];
a1=[[7 11 17],[3 5 7],[2 2.5 3]];
puc=[[[2 2.5],[1 1.2],[0.7 0.8]],[[2 3],[2 1],[0.5 2]],[[3 2],[3 4],[2 4]]];
recap=[[1050000 1500000 1050000 750000],[2520000 1680000 2520000 1260000],[2625000 4550000 2625000 1575000]];
scap=[[50000 60000 70000],[50000 65000 70000],[85000 70000 90000]];
de=[[744 1130 1577 1334 2271 2007 846 1787 1990 1163 895 1190 829 642 960 1350 2399 1538 1176 2041 740 1705 1993 1174
670 680 1901 1731 2476 2177],[2055 898 2211 2342 772 892 1065 1824 841 1103 1456 894 844 1332 826 2078 1797 805 2120
1030 2494 2466 1112 1241 1424 1617 1614 2428 794 582],[1594 592 615 975 1688 719 669 1013 841 2008 1662 1915 1946 821
1874 551 813 2039 2190 800 834 906 2286 2291 2443 532 2332 1956 578 2337]];
cap=[[15000 15000 15000 15000 15000 15000 15000 15000 15000 15000 15000 15000 15000],[12000 12000 12000 12000 12000
12000 12000 12000 12000 12000 12000 12000 12000],[7500 7500 7500 7500 7500 7500 7500 7500 7500 7500 7500 7500 7500]];
hcap=[[10500 10500 10500 10500 10500 10500 10500 10500 10500 10500 10500 10500 10500],[9000 9000 9000 9000 9000 9000
9000 9000 9000 9000 9000 9000 9000],[5250 5250 5250 5250 5250 5250 5250 5250 5250 5250 5250 5250 5250]];
ccap=[[20000 20000 20000 20000 20000 20000 20000 20000 20000 20000 20000 20000 20000],[16000 16000 16000 16000 16000
16000 16000 16000 16000 16000 16000 16000 16000],[10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000
10000 10000]];
hrcap=[[14000 14000 14000 14000 14000 14000 14000 14000 14000 14000 14000 14000 14000],[12000 12000 12000 12000 12000
12000 12000 12000 12000 12000 12000 12000 12000],[7000 7000 7000 7000 7000 7000 7000 7000 7000 7000 7000 7000 7000]];
capp=[[35000 40000],[28000 38500],[46000 56000]];
```

```
puc1=[[5 5 5 5 5 5 5 5 7 7 7 7 7],[8 8 8 8 8 8 8 8 8 14 14 14 14],[14 14 14 14 14 14 14 14 14 14 14 14 14]];
sp=[[5 5 5 5 5 5 5 5 5 7 7 7 7 7],[8 8 8 8 8 8 8 8 8 8 14 14 14 14],[14 14 14 14 14 14 14 14 14 14 14 14 14]];
reco=[[0.6 1 0.6 0.47],[0.71 0.58 0.71 0.48],[0.58 0.86 0.58 0.67]];
d3=[[525 660 111 1365],[600 680 130 1385],[36 550 454 1424],[561 258 342 912],[394 338 219 1134],[532 0 557 879],[428
322 613 1081],[1087 561 1015 317],[1400 874 1254 0],[1308 922 972 626],[975 640 626 819],[1632 1134 1313 526],[0 532
418 1406]];
d1=[[525 600 36 561 394 532 428 1087 1400 1308 975 1632 0],[1124 1200 1105 671 893 561 763 0 313 841 725 840 1087]];
d2=[[5 15 561 453 322 660 716 1124 1363 1067 734 1425 525 390 243 320 452 780 111 230 331 1141 1406 1638 1044 1261 771
1225 893 491],
[30 10 580 465 330 680 725 1130    1380 1100 750 1435 570 400 248 330 470 795 120 220 338 1160      1420 1665 1068 1290
      800   1250 930 500],
[565 600 8 579 412 550 446 1105    1418 1326 993 1650 40 173 322 325 327 225 450 534 664 1400 1631  1762 1085 1242 848
1450 1019 211],
[453 465 579 4 233 100 544 971 910 747 414 1071561   530   382   653   256   622   342   683   268   821   1052 1232 591
808 318 871 440 368],
[322 335 412 233 3 338 424 893 1132 980  647   1304 394 297 149 420 144 502 211 552 357 1054 1285 1454    813   1030
540 1104 673 217],
[660 680 550 258 338 6 322 561 874 922 640 1134532   544   487   744   223   556   549   890   522   996   1115 1218 541
698 304 934 499 339],
[716 736 446 544 424 322 4 763 1076 1236 954 1448 428 510 537 710 292 313 605 919 751 1310 1429      1453 743 900 618
1248 813 294],
[1124 1144 1105   971   893   561   763   8 313 841 725 840 1080 1099  1042 1299 778 1076 1013 1354 939 915 756 690 80
      137   353   637   425   894],
[1363 1383 1418   910   1132 874 1076 313 9     627   818   527   1400 1412 1281 1552     1091 1389 1252 1593     1178
701 443 377 369 176 592 324 480 1207],
[1067 1100 1326   747   980   922   1236 841 627 6 333 435 1308   1229 1078 1349 1003     1369 956 1297 882 74 484 716
768 803 618 303 423 1115],
[734 750 993 414 647 640 954 725 818 333 5 761 975   896   745   1016 670 1036 623 964 549 407 742 974 645 836 449 561
338 782],
[1425 1435 1650   1071 1304 1134 1448     840   527   435   761   7 1632 1587 1436 1707 1327 1690     1314 1655 1240 361
217 365 842 703 830 203 635 1439],
[530 608 45 580   410   550   435   1080 1420 1320 965 1640 6 137 286 335 309 255 414 544 628 1382 1613    1144 1067
1373 830 1432     1001 193]];
d4=[[0 1087],[525 561],[418 1015],[1406 317]];
binp=[[1 1 0 0 1 0 0 0 0 0 0 0 0 1 1 1 0 0 1 1 1 0 0 0 0 0 0 0 0 0],
[1 1 0 0 1 0 0 0 0 0 0 0 0 1 1 1 0 0 1 1 1 0 0 0 0 0 0 0 0 0],
[0 0 1 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 1],
[0 0 0 1 1 1 0 0 0 0 0 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 1 0 0 1],
[1 1 0 1 1 1 0 0 0 0 0 0 1 1 1 0 1 0 1 0 1 0 0 0 0 0 0 0 0 1],
[0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 1],
[0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1],
[0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0],
[0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 1 0 0],
[0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0],
[0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0],
[0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 0 0],
[0 0 1 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 1]];
```

```
//Solution of the Proposed Model;
// solution (integer optimal, tolerance)
m1 = 0.85088;
m2 = 0.86534;
m3 = 0.57767;
cost = 1.2692e+7;
coverage = 96313;
flexibility = 2.1022e+5;
yr = [[1 0 0 0 0 0 0 0 0 0 0 0 0][1 0 0 0 0 0 0 0 0 0 0 0 0][0 0 1 0 0 0 0 0 0 0 0 0 0][0 0 0 0 0 1 0 0 0 0 0 0 0]
[1 0 0 0 0 0 0 0 0 0 0 0 0][0 0 0 0 0 1 0 0 0 0 0 0 0][0 0 0 0 0 1 0 0 0 0 0 0 0][0 0 0 0 0 0 0 1 0 0 0 0 0]
[0 0 0 0 0 0 0 1 0 0 0 0 0][0 0 0 0 0 0 0 0 0 0 0 0 0][0 0 0 0 0 0 0 0 0 0 0 0 0][0 0 0 0 0 0 0 0 0 0 0 1 0]
[0 0 1 0 0 0 0 0 0 0 0 0 0][0 0 1 0 0 0 0 0 0 0 0 0 0][1 0 0 0 0 0 0 0 0 0 0 0 0][1 0 0 0 0 0 0 0 0 0 0 0 0]
[0 0 0 0 0 1 0 0 0 0 0 0 0][0 0 1 0 0 0 0 0 0 0 0 0 0][1 0 0 0 0 0 0 0 0 0 0 0 0][1 0 0 0 0 0 0 0 0 0 0 0 0]
[1 0 0 0 0 0 0 0 0 0 0 0 0][0 0 0 0 0 0 0 0 0 0 0 1 0][0 0 0 0 0 0 0 0 0 0 0 1 0][0 0 0 0 0 0 0 0 0 0 0 1 0]
[0 0 0 0 0 0 0 1 0 0 0 0 0][0 0 0 0 0 0 0 1 0 0 0 0 0][0 0 0 0 0 1 0 0 0 0 0 0 0][0 0 0 0 0 0 0 0 0 0 0 1 0]
[0 0 0 0 0 0 0 0 0 0 0 0 0][0 0 1 0 0 0 0 0 0 0 0 0 0]];
hyb = [0 0 0 0 0 0 0 0 0 0 0 0 0];
reg = [0 1 0 0 1 0 0 0 1 1 1 0 1];
col = [1 0 1 0 0 1 0 1 0 0 0 1 0];
yre = [1 1 0 1];
q = [[[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [744 1130 0 0 0 0 0 0 0 0 0 0 0 0 960 0 0 0 1176 2041 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 1334 2271 2007 0 0 0 0 0 0 0 0 0 0 0 0 0 0 740 0 0 0 0 0 0 0 0 2177]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 1163 895 0 0 0 0 0 0 0 0 0 0 1705 0 0 0 0 1901 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 1577 0 0 0 846 0 0 0 0 0 829 642 0 1350 2399 1538 0 0 0 0 0 0 0 0 0 0 0 0]]
                     [[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
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                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 1787 1990 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1174 670 680 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 1190 0 0 0 0 0 0 0 0 0 0 1993 0 0 0 0 1731 2476 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
                     [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]]]
```

```
[[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [2055 898 0 0 0 0 0 0 0 0 0 0 0 0 826 0 0 0 2120 1030 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 2342 772 892 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1018 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 163 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 2211 0 0 0 1065 0 0 0 0 0 844 1332 0 2078 1797 805 0 0 0 0 0 0 0 0 0 0 0 0]]
 [[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1476 0 0 0 0 0 0 0 0 582]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 1824 841 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1241 1424 1617 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 731 0 0 0 0 0 0 0 0 0 0 1112 0 0 0 0 2428 794 0]
  [0 0 0 0 0 0 0 0 0 1103 1456 0 0 0 0 0 0 0 0 0 0 2466 0 0 0 0 1614 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]]]
[[[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [1594 592 0 0 0 0 0 0 0 0 0 0 0 0 1874 0 0 0 2190 800 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 975 1688 719 0 0 0 0 0 0 0 0 0 0 0 0 0 0 834 0 0 0 0 0 0 0 0 2337]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 1915 0 0 0 0 0 0 0 0 0 0 2286 0 0 0 0 1956 578 0]
  [0 0 0 0 0 0 0 0 0 2008 1662 0 0 0 0 0 0 0 0 0 0 906 0 0 0 0 2332 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 615 0 0 0 669 0 0 0 0 0 1946 821 0 551 813 2039 0 0 0 0 0 0 0 0 0 0 0 0]]
 [[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
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  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
  [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
```

```
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           [0 0 0 0 0 0 0 1012 841 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2291 2443 532 0 0 0 0]
           [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
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```

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```

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```

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```

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```

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```

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```

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[[1519 0 0 0]
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    [0 0 0 0]
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    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
```

```
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     [0 0 0 0]
     [0 0 0 0]]
[[0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]
     [647 0 0 0]
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     [0 0 0 0]
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[[0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]
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[[0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [912 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]]
[[0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
```

```
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  [0 0 0 0]
  [0 0 0 0]
  [757 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]]
[[0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
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  [0 0 0 0]
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  [0 0 0 0]
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  [0 0 0 0]
  [0 0 0 0]
  [0 0 0 0]
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  [0 0 0 0]
```

```
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    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [1751 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [739 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
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    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
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    [0 0 0 0]
    [0 0 0 0]
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    [0 0 0 0]
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    [0 0 0 0]]
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    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
```

```
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    [0 0 0 0]
    [0 0 0 0]
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[[0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
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    [0 0 0 0]
    [0 0 0 0]
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    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [1835 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
[[1971 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
[[720 0 0 0]
```

```
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     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
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[[751 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]]
[[0 0 0 0]
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     [0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]]
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     [0 0 0 0]
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     [0 0 0 0]
     [0 0 0 0]
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     [0 0 0 0]
```

```
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    [0 0 0 2057]
    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [1883 0 0 179]
    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [2199 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [479 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]]
[[0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
    [0 0 0 0]
```

```
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     [2098 0 0 1]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]]
[[0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [1672 0 0 88]
     [0 0 0 0]]
[[0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]]
[[0 0 0 0]
     [0 0 0 0]
     [2103 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
     [0 0 0 0]
```

```
                    [0 0 0 0]]]];
qp = [[[1701 2 0 2]
                [0 0 0 0]
                [14249 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 15641]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [0 1 0 1]
                [0 0 0 0]]
            [[0 0 0 0]
                [0 0 0 0]
                [11669 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [5044 3 0 0]
                [0 0 0 0]
                [0 0 0 11717]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [3 0 0 0]
                [0 0 0 0]]
            [[888 0 0 0]
                [0 0 0 0]
                [2948 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [2965 0 0 0]
                [0 0 0 0]
                [0 0 0 1]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 0]
                [0 0 0 69]
                [0 0 0 0]]];
x1 = [[[8.7247e+5 0]
                [0 15931]
                [-1.0137e-16 0]
                [0 4.1688e+5]]
            [[4.4242e+5 0]
                [0.03 7240.3]
                [-3.0219e-17 0]
```

```
                [0 1.8721e+5]]
             [[2.1423e+5 0]
                [4343.6 0]
                [-3.1604e-17 0]
                [0.25475 1.0051e+5]]];
qc = [[[50000 0]
                [60000 0]
                [58152 11847]]
             [[0 0]
                [0 0.82875]
                [0 0]]
             [[0 0]
                [0 0]
                [0.84525 0]]];
qp1 = [[0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0]];
re = [[4.5872e+5 40.5 0 4.1055e+5][6.0409e+5 41336 0 5.1457e+5][1.1703e+6 0 0 1.3988e+5]];
x = [[29425 13691][22248 20709][34701 7119]];
y = [[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 1 0]
             [0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 1 0 0 0 1 0 0 0 0 0 0 1 1 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0]];
y2 = [[1 1 1 1 1 1 1 1 0 1 1 1 1]
             [1 1 1 1 1 1 1 1 1 1 1 1 1]
             [1 1 1 1 1 1 1 1 1 0 1 1 1 1]];
y3 = [[0 0 0 0 0 0 0 0 1 0 0 0 0]
             [0 0 0 0 0 0 0 0 0 0 0 0 0]
             [0 0 0 0 0 0 0 0 1 0 0 0 0]];
```