حل مسئله کوله پشتی با الگوریتم تکامل تفاضلی DE در متلب

فرض کنید یک کوله‌پشتی با حجمی ثابت و مجموعه‌ای از اشیاء دارید که هر کدام از آن ها حجمی و ارزشی دارند. می‌خواهید کوله‌پشتی خود را به نحوی پرکنید که حجم اشیا برداشته شده از حجم کوله‌پشتی بیشتر نباشد و مجموع ارزش اشیا بیشینه باشد.

صورت مسئله:

یک کوله پشتی به حجم ۱۰۰۰۰ داریم و ۵۰ تا شی داریم که ارزش اشیابه صورت زیر است:

```
v=[75    17    22    21    63    71    67    76    45    49
...
        83    32    88    44    12    70    12    66    40
46 ...
        20    54    87    84    78    41    32    35    72
62 ...
        83    87    49    74    85    63    13    86    74
67 ...
        61    88    74    87    64    23    17    12    25
71];
```

و وزن اشیا به صورت زیر است:

```
w=[486  798 1152    1443    1277    590 592 500 206 281 ...
        1052    1444    457 866 456 375 1263    1160    175
896 ...
        1017    576 808 294 1240    451 919 1155    843 757
...
        327 919 1079    309 441 963 870 633 1191    116 ...
        266 413 1348    460 1401    763 1384    895 1408
572];
```

می باشد می خواهیم این اشیا را به نحوی در کوله پشتی قرار دهیم که ارزش اشیا در کوله پشتی ماکزیمم شود و حجم اشیا درون کوله پشتی از حجم کل کوله پشتی بیشتر نشود

شرح کد:

این سورس کد شامل ۳ فایل می باشد که عبارتند از:

DE.m, CreateModel.m, KnapsackFitness.m که یکی یکی به شرح آن ها می پردازیم

ابتدا تابع CreateModel() را پیاده سازی می کنیم که اطلاعات مسیله داخل یک مدل پیاده سازی می شود برای اینکه به پارامترهای مسیله به صورت یکجا دسترسی داشته باشیم

```
function model=CreateModel()

                                                ارزش هر کدام از اشیا

    v=[75    17    22    21    63    71    67    76    45
49 ...
        83    32    88    44    12    70    12    66    40
46 ...
        20    54    87    84    78    41    32    35    72
62 ...
        83    87    49    74    85    63    13    86    74
67 ...
        61    88    74    87    64    23    17    12    25
71];

                                                وزن هر کدام از اشیا


    w=[486  798 1152    1443    1277    590 592 500 206 281
…
        1052    1444    457 866 456 375 1263    1160    175
896 …
        1017    576 808 294 1240    451 919 1155    843 757
…
        327 919 1079    309 441 963 870 633 1191    116 …
        266 413 1348    460 1401    763 1384    895 1408
572];
                                                تعداد کل اشیا

    n=numel(v);

                                حداکثر وزنی که کوله پشتی می تواند تحمل کند

    W=10000;
```

اینجا هم اطلاعات مسیله را ذخیره کردیم.

```
    model.n=n;
    model.v=v;
    model.w=w;
    model.W=W;

end
```

تابع KnapsackFitness(x,model) برای محاسبه فیتنس بکار می رود

```
function z=KnapsackFitness(x,model)

    global NFE;
    if isempty(NFE)
        NFE=0;
    End
    NFE=NFE+1;


      ارزش و حجم اشیایی که برداشتیم و ظرفیت حجم کوله پشتی را نیاز
داریم

    v=model.v;
    w=model.w;
    W=model.W;

            مجموع اشیایی که انتخاب شده اند ضرب در ارزش شان

    z=sum(x.*v);

                    باید حجم کتر از ظرفیت حجم کوله پشتی باشه

    c=max(sum(x.*w)-W,0);

  تابع هدف c ضریب تخطی و 100 میزان جریمه درهم ضرب کرده و از
مجوع مضروب ارزش اشیایی که تاحالا برداشتیم کم می کنیم ما دوست
داریم این حاصل زیاد شود یعنی فیتنس است.
    z=z-100*c;

end
```

فایل DE.m که مربوط به الگوریتم تکامل تفاضلی است و دو تابع قبل اینجا استفاده می شوند.

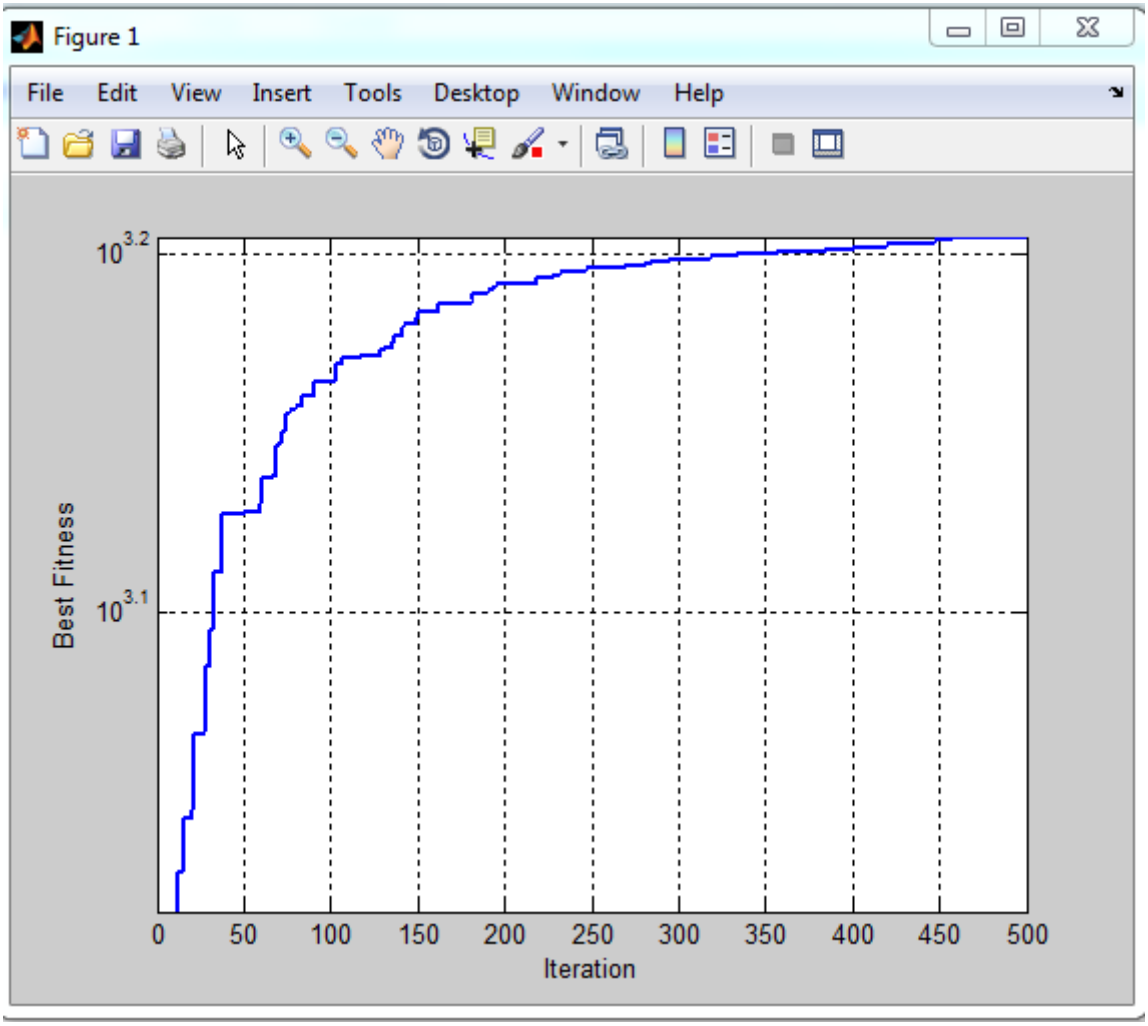
```
clc;
clear;
close all;
                                                    تعریف مسیله

global NFE;
NFE=0;

model=CreateModel();    ایجاد مدل کوله پشتی

FitnessFunction=@(x) KnapsackFitness(x,model);   تابع فیتنس
nVar=model.n;             تعداد متغیرهای تصمیم
VarSize=[1 nVar];   ماکزیمم اندازه متغیرهای تصمیم

VarMin=0;          حدپایین متغیرهای تصمیم
VarMax=1;          حدبالا متغیرهای تصمیم
                                        پارامترهای تکامل تفاضلی
MaxIt=500;       ماکزیمم تعداد تکرار الگوریتم
nPop=50;         اندازه جمعیت
beta_min=0.2;   حد پایین فاکتور اسکیلینگ
beta_max=0.8;   حد بالا فاکتور اسکیلینگ
pCR=0.2;         احتمال کراس اور
مقدار دهی اولیه
empty_individual.Position=[];
empty_individual.Fitness=[];
BestSol.Fitness=0;
pop=repmat(empty_individual,nPop,1);
for i=1:nPop
    pop(i).Position=randi([0 1],VarSize);

    pop(i).Fitness=FitnessFunction(pop(i).Position);

    if pop(i).Fitness>BestSol.Fitness
        BestSol=pop(i);
    end

end
BestFitness=zeros(MaxIt,1);
حلقه اصلی تکامل تفاضلی
for it=1:MaxIt

    for i=1:nPop
```

```
            x=pop(i).Position;

            A=randperm(nPop);

            A(A==i)=[];

            a=A(1);
            b=A(2);
            c=A(3);

            جهش
            %beta=unifrnd(beta_min,beta_max);
            beta=unifrnd(beta_min,beta_max,VarSize);
            y=pop(a).Position+beta.*(pop(b).Position-
pop(c).Position);
            y = max(y, VarMin);
            y = min(y, VarMax);

            % Crossover
            z=zeros(size(x));
            j0=randi([1 numel(x)]);
            for j=1:numel(x)
                if j==j0 || rand>=pCR
                    z(j)=y(j);
                else
                    z(j)=x(j);
                end
            end

            NewSol.Position=z;
            NewSol.Fitness=FitnessFunction(NewSol.Position);

            if NewSol.Fitness>pop(i).Fitness
                pop(i)=NewSol;

                if pop(i).Fitness>BestSol.Fitness
                   BestSol=pop(i);
                end
            end

        end

        آپدیت بهترین فیتنس
        BestFitness(it)=BestSol.Fitness;
```

```
    اطلاعات تکرار را نشان بده
    disp(['Iteration ' num2str(it) ': Best Fitness = '
num2str(BestFitness(it))]);

end
نشان دادن نتایج فیتنس در هر تکرار
figure;
%plot(BestFitness);
semilogy(BestFitness, 'LineWidth', 2);
xlabel('Iteration');
ylabel('Best Fitness');
grid on;
```

در ادامه نتایج را مشاهده می کنیم.

نـتـايـج:



Iteration 1: Best Fitness = 0

Iteration 2: Best Fitness = 0

Iteration 3: Best Fitness = 0

Iteration 4: Best Fitness = 0

Iteration 5: Best Fitness = 852.2004

Iteration 6: Best Fitness = 852.2004

Iteration 7: Best Fitness = 852.2004

Iteration 8: Best Fitness = 852.2004

Iteration 9: Best Fitness = 852.2004

Iteration 10: Best Fitness = 871.7368

Iteration 11: Best Fitness = 871.7368

Iteration 12: Best Fitness = 871.7368

Iteration 13: Best Fitness = 944.6421

Iteration 14: Best Fitness = 944.6421

Iteration 15: Best Fitness = 944.6421

Iteration 16: Best Fitness = 944.6421

Iteration 17: Best Fitness = 1032.2514

Iteration 18: Best Fitness = 1108.0726

Iteration 19: Best Fitness = 1108.0726

Iteration 20: Best Fitness = 1108.0726

Iteration 21: Best Fitness = 1108.0726

Iteration 22: Best Fitness = 1108.0726

Iteration 23: Best Fitness = 1108.0726

Iteration 24: Best Fitness = 1108.0726

Iteration 25: Best Fitness = 1108.0726

Iteration 26: Best Fitness = 1108.0726

Iteration 27: Best Fitness = 1108.0726

Iteration 28: Best Fitness = 1108.0726

Iteration 29: Best Fitness = 1108.0726

Iteration 30: Best Fitness = 1108.0726

Iteration 31: Best Fitness = 1108.0726

Iteration 32: Best Fitness = 1108.0726

Iteration 33: Best Fitness = 1108.0726

Iteration 34: Best Fitness = 1129.6568

Iteration 35: Best Fitness = 1129.6568

Iteration 36: Best Fitness = 1152.7794

Iteration 37: Best Fitness = 1152.7794

Iteration 38: Best Fitness = 1210.133

Iteration 39: Best Fitness = 1210.133

Iteration 40: Best Fitness = 1210.133

Iteration 41: Best Fitness = 1216.5541

Iteration 42: Best Fitness = 1237.1917

Iteration 43: Best Fitness = 1266.4003

Iteration 44: Best Fitness = 1266.4003

Iteration 45: Best Fitness = 1266.4003

Iteration 46: Best Fitness = 1266.4003

Iteration 47: Best Fitness = 1266.4003

Iteration 48: Best Fitness = 1266.4003

Iteration 49: Best Fitness = 1266.4003

Iteration 50: Best Fitness = 1266.4003

Iteration 51: Best Fitness = 1268.764

Iteration 52: Best Fitness = 1280.6856

Iteration 53: Best Fitness = 1322.7532

Iteration 54: Best Fitness = 1338.7196

Iteration 55: Best Fitness = 1338.7196

Iteration 56: Best Fitness = 1338.7196

Iteration 57: Best Fitness = 1345.9816

Iteration 58: Best Fitness = 1365.551

Iteration 59: Best Fitness = 1365.551

Iteration 60: Best Fitness = 1365.551

Iteration 61: Best Fitness = 1365.551

Iteration 62: Best Fitness = 1365.551

Iteration 63: Best Fitness = 1365.551

Iteration 64: Best Fitness = 1365.551

Iteration 65: Best Fitness = 1376.0123

Iteration 66: Best Fitness = 1383.4201

Iteration 67: Best Fitness = 1383.4201

Iteration 68: Best Fitness = 1383.4201

Iteration 69: Best Fitness = 1412.6982

Iteration 70: Best Fitness = 1412.6982

Iteration 71: Best Fitness = 1418.8064

Iteration 72: Best Fitness = 1442.5427

Iteration 73: Best Fitness = 1442.5427

Iteration 74: Best Fitness = 1442.5427

Iteration 75: Best Fitness = 1442.5427

Iteration 76: Best Fitness = 1442.5427

Iteration 77: Best Fitness = 1442.5427

Iteration 78: Best Fitness = 1442.5427

Iteration 79: Best Fitness = 1442.5427

Iteration 80: Best Fitness = 1442.5427

Iteration 81: Best Fitness = 1442.5427

Iteration 82: Best Fitness = 1442.5427

Iteration 83: Best Fitness = 1442.5427

Iteration 84: Best Fitness = 1450.3176

Iteration 85: Best Fitness = 1450.3176

Iteration 86: Best Fitness = 1450.3176

Iteration 87: Best Fitness = 1450.3176

Iteration 88: Best Fitness = 1450.3176

Iteration 89: Best Fitness = 1450.3176

Iteration 90: Best Fitness = 1452.3347

Iteration 91: Best Fitness = 1462.5646

Iteration 92: Best Fitness = 1462.5646

Iteration 93: Best Fitness = 1462.5646

Iteration 94: Best Fitness = 1462.5646

Iteration 95: Best Fitness = 1462.5646

Iteration 96: Best Fitness = 1462.5646

Iteration 97: Best Fitness = 1462.5646

Iteration 98: Best Fitness = 1462.5646

Iteration 99: Best Fitness = 1463.8533

Iteration 100: Best Fitness = 1463.8533

Iteration 101: Best Fitness = 1472.1971

Iteration 102: Best Fitness = 1472.1971

Iteration 103: Best Fitness = 1472.1971

Iteration 104: Best Fitness = 1472.1971

Iteration 105: Best Fitness = 1472.4515

Iteration 106: Best Fitness = 1472.4515

Iteration 107: Best Fitness = 1494.3464

Iteration 108: Best Fitness = 1494.3464

Iteration 109: Best Fitness = 1494.3464

Iteration 110: Best Fitness = 1494.3464

Iteration 111: Best Fitness = 1494.3464

Iteration 112: Best Fitness = 1494.3464

Iteration 113: Best Fitness = 1494.3464

Iteration 114: Best Fitness = 1494.3464

Iteration 115: Best Fitness = 1494.3464

Iteration 116: Best Fitness = 1494.3464

Iteration 117: Best Fitness = 1495.7775

Iteration 118: Best Fitness = 1496.2656

Iteration 119: Best Fitness = 1497.457

Iteration 120: Best Fitness = 1517.9386

Iteration 121: Best Fitness = 1517.9386

Iteration 122: Best Fitness = 1517.9386

Iteration 123: Best Fitness = 1517.9386

Iteration 124: Best Fitness = 1517.9386

Iteration 125: Best Fitness = 1517.9386

Iteration 126: Best Fitness = 1517.9386

Iteration 127: Best Fitness = 1517.9386

Iteration 128: Best Fitness = 1530.3439

Iteration 129: Best Fitness = 1530.3439

Iteration 130: Best Fitness = 1530.3439

Iteration 131: Best Fitness = 1530.3439

Iteration 132: Best Fitness = 1530.3439

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Iteration 134: Best Fitness = 1530.3439

Iteration 135: Best Fitness = 1530.3439

Iteration 136: Best Fitness = 1530.3439

Iteration 137: Best Fitness = 1530.3439

Iteration 138: Best Fitness = 1538.4231

Iteration 139: Best Fitness = 1538.4231

Iteration 140: Best Fitness = 1538.4231

Iteration 141: Best Fitness = 1538.4231

Iteration 142: Best Fitness = 1538.4231

Iteration 143: Best Fitness = 1540.7808

Iteration 144: Best Fitness = 1540.7808

Iteration 145: Best Fitness = 1544.4861

Iteration 146: Best Fitness = 1556.1531

Iteration 147: Best Fitness = 1556.1531

Iteration 148: Best Fitness = 1556.1531

Iteration 149: Best Fitness = 1556.1531

Iteration 150: Best Fitness = 1556.1531

Iteration 151: Best Fitness = 1556.1531

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Iteration 155: Best Fitness = 1556.1531

Iteration 156: Best Fitness = 1556.1531

Iteration 157: Best Fitness = 1556.1531

Iteration 158: Best Fitness = 1559.7076

Iteration 159: Best Fitness = 1559.7076

Iteration 160: Best Fitness = 1559.7076

Iteration 161: Best Fitness = 1559.7076

Iteration 162: Best Fitness = 1559.7076

Iteration 163: Best Fitness = 1559.7076

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Iteration 168: Best Fitness = 1559.7076

Iteration 169: Best Fitness = 1559.7076

Iteration 170: Best Fitness = 1559.7076

Iteration 171: Best Fitness = 1560.4448

Iteration 172: Best Fitness = 1560.4448

Iteration 173: Best Fitness = 1560.4448

Iteration 174: Best Fitness = 1560.4448

Iteration 175: Best Fitness = 1563.7297

Iteration 176: Best Fitness = 1565.4031

Iteration 177: Best Fitness = 1567.1086

Iteration 178: Best Fitness = 1567.1086

Iteration 179: Best Fitness = 1567.1086

Iteration 180: Best Fitness = 1567.1086

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Iteration 182: Best Fitness = 1567.1086

Iteration 183: Best Fitness = 1569.6432

Iteration 184: Best Fitness = 1569.6432

Iteration 185: Best Fitness = 1569.6432

Iteration 186: Best Fitness = 1569.6432

Iteration 187: Best Fitness = 1573.5607

Iteration 188: Best Fitness = 1573.5607

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Iteration 195: Best Fitness = 1573.5607

Iteration 196: Best Fitness = 1573.5607

Iteration 197: Best Fitness = 1576.6787

Iteration 198: Best Fitness = 1576.6787

Iteration 199: Best Fitness = 1576.6787

Iteration 200: Best Fitness = 1576.6787

Iteration 201: Best Fitness = 1576.6787

Iteration 202: Best Fitness = 1576.6787

Iteration 203: Best Fitness = 1576.6787

Iteration 204: Best Fitness = 1576.6787

Iteration 205: Best Fitness = 1576.6787

Iteration 206: Best Fitness = 1577.494

Iteration 207: Best Fitness = 1577.494

Iteration 208: Best Fitness = 1577.494

Iteration 209: Best Fitness = 1577.494

Iteration 210: Best Fitness = 1577.494

Iteration 211: Best Fitness = 1577.494

Iteration 212: Best Fitness = 1577.494

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Iteration 219: Best Fitness = 1577.494

Iteration 220: Best Fitness = 1577.494

Iteration 221: Best Fitness = 1577.9617

Iteration 222: Best Fitness = 1577.9617

Iteration 223: Best Fitness = 1577.9617

Iteration 224: Best Fitness = 1577.9617

Iteration 225: Best Fitness = 1578.9406

Iteration 226: Best Fitness = 1578.9406

Iteration 227: Best Fitness = 1581.1197

Iteration 228: Best Fitness = 1581.1197

Iteration 229: Best Fitness = 1581.1197

Iteration 230: Best Fitness = 1581.9728

Iteration 231: Best Fitness = 1581.9728

Iteration 232: Best Fitness = 1581.9728

Iteration 233: Best Fitness = 1583.8351

Iteration 234: Best Fitness = 1583.8351

Iteration 235: Best Fitness = 1583.8351

Iteration 236: Best Fitness = 1583.8351

Iteration 237: Best Fitness = 1587.1081

Iteration 238: Best Fitness = 1587.8427

Iteration 239: Best Fitness = 1587.8427

Iteration 240: Best Fitness = 1587.8427

Iteration 241: Best Fitness = 1587.8427

Iteration 242: Best Fitness = 1587.8427

Iteration 243: Best Fitness = 1587.8427

Iteration 244: Best Fitness = 1587.9929

Iteration 245: Best Fitness = 1587.9929

Iteration 246: Best Fitness = 1587.9929

Iteration 247: Best Fitness = 1587.9929

Iteration 248: Best Fitness = 1589.032

Iteration 249: Best Fitness = 1589.032

Iteration 250: Best Fitness = 1589.032

Iteration 251: Best Fitness = 1589.032

Iteration 252: Best Fitness = 1590.5533

Iteration 253: Best Fitness = 1592.0581

Iteration 254: Best Fitness = 1592.0581

Iteration 255: Best Fitness = 1592.0581

Iteration 256: Best Fitness = 1592.0581

Iteration 257: Best Fitness = 1592.0581

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Iteration 260: Best Fitness = 1592.0581

Iteration 261: Best Fitness = 1592.0581

Iteration 262: Best Fitness = 1592.0581

Iteration 263: Best Fitness = 1593.2716

Iteration 264: Best Fitness = 1593.2716

Iteration 265: Best Fitness = 1593.2716

Iteration 266: Best Fitness = 1593.2716

Iteration 267: Best Fitness = 1593.2716

Iteration 268: Best Fitness = 1593.4448

Iteration 269: Best Fitness = 1593.4448

Iteration 270: Best Fitness = 1593.4448

Iteration 271: Best Fitness = 1593.4448

Iteration 272: Best Fitness = 1593.4448

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Iteration 278: Best Fitness = 1593.4448

Iteration 279: Best Fitness = 1593.5455

Iteration 280: Best Fitness = 1594.6634

Iteration 281: Best Fitness = 1594.6634

Iteration 282: Best Fitness = 1594.6634

Iteration 283: Best Fitness = 1594.6634

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Iteration 286: Best Fitness = 1594.6634

Iteration 287: Best Fitness = 1594.6634

Iteration 288: Best Fitness = 1594.6634

Iteration 289: Best Fitness = 1595.2668

Iteration 290: Best Fitness = 1595.2668

Iteration 291: Best Fitness = 1595.2668

Iteration 292: Best Fitness = 1595.2668

Iteration 293: Best Fitness = 1595.2668

Iteration 294: Best Fitness = 1595.2668

Iteration 295: Best Fitness = 1595.2668

Iteration 296: Best Fitness = 1595.2668

Iteration 297: Best Fitness = 1596.3692

Iteration 298: Best Fitness = 1596.3692

Iteration 299: Best Fitness = 1596.3692

Iteration 300: Best Fitness = 1596.3692

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Iteration 302: Best Fitness = 1596.3692

Iteration 303: Best Fitness = 1596.3692

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Iteration 306: Best Fitness = 1596.3692

Iteration 307: Best Fitness = 1596.3692

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Iteration 309: Best Fitness = 1596.3692

Iteration 310: Best Fitness = 1596.3692

Iteration 311: Best Fitness = 1596.3692

Iteration 312: Best Fitness = 1596.3692

Iteration 313: Best Fitness = 1597.114

Iteration 314: Best Fitness = 1597.114

Iteration 315: Best Fitness = 1597.114

Iteration 316: Best Fitness = 1597.5179

Iteration 317: Best Fitness = 1597.5179

Iteration 318: Best Fitness = 1597.5179

Iteration 319: Best Fitness = 1597.5179

Iteration 320: Best Fitness = 1597.5179

Iteration 321: Best Fitness = 1597.5179

Iteration 322: Best Fitness = 1597.5179

Iteration 323: Best Fitness = 1597.5179

Iteration 324: Best Fitness = 1597.5179

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Iteration 326: Best Fitness = 1597.5179

Iteration 327: Best Fitness = 1597.5179

Iteration 328: Best Fitness = 1597.5179

Iteration 329: Best Fitness = 1597.5179

Iteration 330: Best Fitness = 1597.8707

Iteration 331: Best Fitness = 1597.8707

Iteration 332: Best Fitness = 1597.8707

Iteration 333: Best Fitness = 1598.0007

Iteration 334: Best Fitness = 1598.0007

Iteration 335: Best Fitness = 1598.1862

Iteration 336: Best Fitness = 1598.1862

Iteration 337: Best Fitness = 1598.1862

Iteration 338: Best Fitness = 1599.3757

Iteration 339: Best Fitness = 1599.3757

Iteration 340: Best Fitness = 1599.3757

Iteration 341: Best Fitness = 1599.3757

Iteration 342: Best Fitness = 1599.3757

Iteration 343: Best Fitness = 1599.3757

Iteration 344: Best Fitness = 1599.3757

Iteration 345: Best Fitness = 1599.3757

Iteration 346: Best Fitness = 1599.3757

Iteration 347: Best Fitness = 1599.3757

Iteration 348: Best Fitness = 1599.3757

Iteration 349: Best Fitness = 1599.3757

Iteration 350: Best Fitness = 1599.3757

Iteration 351: Best Fitness = 1599.3757

Iteration 352: Best Fitness = 1599.3757

Iteration 353: Best Fitness = 1599.3757

Iteration 354: Best Fitness = 1599.3757

Iteration 355: Best Fitness = 1599.3757

Iteration 356: Best Fitness = 1599.3757

Iteration 357: Best Fitness = 1599.3757

Iteration 358: Best Fitness = 1599.3757

Iteration 359: Best Fitness = 1599.3757

Iteration 360: Best Fitness = 1599.6755

Iteration 361: Best Fitness = 1599.6755

Iteration 362: Best Fitness = 1599.6755

Iteration 363: Best Fitness = 1599.7663

Iteration 364: Best Fitness = 1599.7663

Iteration 365: Best Fitness = 1599.9245

Iteration 366: Best Fitness = 1599.9561

Iteration 367: Best Fitness = 1599.9561

Iteration 368: Best Fitness = 1599.9561

Iteration 369: Best Fitness = 1599.9561

Iteration 370: Best Fitness = 1599.9561

Iteration 371: Best Fitness = 1599.9561

Iteration 372: Best Fitness = 1599.9561

Iteration 373: Best Fitness = 1599.9561

Iteration 374: Best Fitness = 1601.1443

Iteration 375: Best Fitness = 1601.1443

Iteration 376: Best Fitness = 1601.1443

Iteration 377: Best Fitness = 1601.1443

Iteration 378: Best Fitness = 1601.1443

Iteration 379: Best Fitness = 1601.1443

Iteration 380: Best Fitness = 1601.1443

Iteration 381: Best Fitness = 1601.1443

Iteration 382: Best Fitness = 1601.1443

Iteration 383: Best Fitness = 1601.1443

Iteration 384: Best Fitness = 1601.1443

Iteration 385: Best Fitness = 1601.1443

Iteration 386: Best Fitness = 1601.1443

Iteration 387: Best Fitness = 1601.1443

Iteration 388: Best Fitness = 1601.1443

Iteration 389: Best Fitness = 1601.1443

Iteration 390: Best Fitness = 1601.1443

Iteration 391: Best Fitness = 1601.3215

Iteration 392: Best Fitness = 1601.3215

Iteration 393: Best Fitness = 1601.3215

Iteration 394: Best Fitness = 1601.3215

Iteration 395: Best Fitness = 1601.3215

Iteration 396: Best Fitness = 1601.3215

Iteration 397: Best Fitness = 1601.3215

Iteration 398: Best Fitness = 1601.3215

Iteration 399: Best Fitness = 1601.3215

Iteration 400: Best Fitness = 1601.3215

Iteration 401: Best Fitness = 1601.3215

Iteration 402: Best Fitness = 1602.3195

Iteration 403: Best Fitness = 1602.3195

Iteration 404: Best Fitness = 1602.3195

Iteration 405: Best Fitness = 1602.3195

Iteration 406: Best Fitness = 1602.3195

Iteration 407: Best Fitness = 1602.3195

Iteration 408: Best Fitness = 1602.3195

Iteration 409: Best Fitness = 1602.6344

Iteration 410: Best Fitness = 1602.6344

Iteration 411: Best Fitness = 1602.6344

Iteration 412: Best Fitness = 1602.6344

Iteration 413: Best Fitness = 1602.6344

Iteration 414: Best Fitness = 1602.6344

Iteration 415: Best Fitness = 1602.6344

Iteration 416: Best Fitness = 1602.6344

Iteration 417: Best Fitness = 1602.6344

Iteration 418: Best Fitness = 1602.6344

Iteration 419: Best Fitness = 1602.6344

Iteration 420: Best Fitness = 1602.6344

Iteration 421: Best Fitness = 1602.6344

Iteration 422: Best Fitness = 1602.6344

Iteration 423: Best Fitness = 1602.6344

Iteration 424: Best Fitness = 1602.6344

Iteration 425: Best Fitness = 1602.6344

Iteration 426: Best Fitness = 1602.6344

Iteration 427: Best Fitness = 1602.8275

Iteration 428: Best Fitness = 1602.8275

Iteration 429: Best Fitness = 1602.8275

Iteration 430: Best Fitness = 1602.8275

Iteration 431: Best Fitness = 1602.8275

Iteration 432: Best Fitness = 1602.8275

Iteration 433: Best Fitness = 1602.8275

Iteration 434: Best Fitness = 1602.8275

Iteration 435: Best Fitness = 1602.8275

Iteration 436: Best Fitness = 1602.8275

Iteration 437: Best Fitness = 1602.8275

Iteration 438: Best Fitness = 1602.8275

Iteration 439: Best Fitness = 1602.8275

Iteration 440: Best Fitness = 1602.8275

Iteration 441: Best Fitness = 1602.8275

Iteration 442: Best Fitness = 1602.8275

Iteration 443: Best Fitness = 1602.8275

Iteration 444: Best Fitness = 1602.8275

Iteration 445: Best Fitness = 1602.8275

Iteration 446: Best Fitness = 1602.8275

Iteration 447: Best Fitness = 1602.8275

Iteration 448: Best Fitness = 1602.8275

Iteration 449: Best Fitness = 1602.8275

Iteration 450: Best Fitness = 1602.8275

Iteration 451: Best Fitness = 1602.8275

Iteration 452: Best Fitness = 1603.0452

Iteration 453: Best Fitness = 1603.0452

Iteration 454: Best Fitness = 1603.0452

Iteration 455: Best Fitness = 1603.0452

Iteration 456: Best Fitness = 1603.0452

Iteration 457: Best Fitness = 1603.0452

Iteration 458: Best Fitness = 1603.0452

Iteration 459: Best Fitness = 1603.0452

Iteration 460: Best Fitness = 1603.1048

Iteration 461: Best Fitness = 1603.1048

Iteration 462: Best Fitness = 1603.1048

Iteration 463: Best Fitness = 1603.1048

Iteration 464: Best Fitness = 1603.1048

Iteration 465: Best Fitness = 1603.1424

Iteration 466: Best Fitness = 1603.1424

Iteration 467: Best Fitness = 1603.1424

Iteration 468: Best Fitness = 1603.1424

Iteration 469: Best Fitness = 1603.1424

Iteration 470: Best Fitness = 1603.1424

Iteration 471: Best Fitness = 1603.1424

Iteration 472: Best Fitness = 1603.4937

Iteration 473: Best Fitness = 1603.4937

Iteration 474: Best Fitness = 1603.4937

Iteration 475: Best Fitness = 1603.4937

Iteration 476: Best Fitness = 1603.4937

Iteration 477: Best Fitness = 1603.4937

Iteration 478: Best Fitness = 1603.4937

Iteration 479: Best Fitness = 1603.4937

Iteration 480: Best Fitness = 1603.4937

Iteration 481: Best Fitness = 1603.4937

Iteration 482: Best Fitness = 1603.4937

Iteration 483: Best Fitness = 1603.4937

Iteration 484: Best Fitness = 1603.4937

Iteration 485: Best Fitness = 1603.4937

Iteration 486: Best Fitness = 1603.4937

Iteration 487: Best Fitness = 1603.4937

Iteration 488: Best Fitness = 1603.4937

Iteration 489: Best Fitness = 1603.4937

Iteration 490: Best Fitness = 1603.4937

Iteration 491: Best Fitness = 1603.4937

Iteration 492: Best Fitness = 1603.4937

Iteration 493: Best Fitness = 1603.4937

Iteration 494: Best Fitness = 1603.5725

Iteration 495: Best Fitness = 1603.5725

Iteration 496: Best Fitness = 1603.5725

Iteration 497: Best Fitness = 1603.5725

Iteration 498: Best Fitness = 1603.5725

Iteration 499: Best Fitness = 1603.5725

Iteration 500: Best Fitness = 1603.5725

>>BestSol.Position

ans =

Columns 1 through 18

1 0 0 0 0 1 1 1 1 1 0 0 1 0 0 1 0 0

Columns 19 through 36

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

  Columns 37 through 50

    0     1     0     1     1     1     0     1     0     0     0     0     0     1

>>
```

همانطور که این جا می بینیم اشیایی که مقدار آن ها ۱ است انتخاب می شوند.