```matlab
%LICNACHAN, LANCE OLIVER C.
%2014-64880

format long;
rng('shuffle');

ProbDim = 4;
ConsNum = 4;
Ans = zeros(30, ProbDim+ConsNum+1);
for trials = 1:30
Y = sprintf('Trial: %d',trials);
disp(Y);

ctr=0;

% Variables specific to the problem

DimMinMax = zeros(ProbDim, 2);
DimMinMax(1, :) = [1 99]*0.0625;
DimMinMax(2, :) = [1 99]*0.0625;
DimMinMax(3, :) = [10 200];
DimMinMax(4, :) = [10 200];

% Variables specific to the algorithm
AcceptThreshold = 1e-6;
PopNum = 20*ProbDim;
PSO_Curr = 1;
PSO_Max = 500;
c1 = 1.5;
c2 = 1.5;
wmax = 0.9;
wmin = 0.4;

GA_cross = 0.85;
GA_mut = 0.02;
GA_y = 10;
GA_B = 15;
GA_NumMax = 20;
GA_NumMin = 1;
GA_MinPS = 10;
GA_MaxPS = 5;
GA_MinItr = 10;
GA_MaxItr = 15;
GA_MaxItr = floor(GA_MinItr + ((PSO_Curr/PSO_Max)^GA_B)*(GA_MaxItr-GA_MinItr));
GA_Num = floor(GA_NumMax - ((PSO_Curr/PSO_Max)^GA_y)*(GA_NumMax-GA_NumMin));
GA_PS = floor(GA_MinPS + ((PSO_Curr/PSO_Max)^GA_y)*(GA_MaxPS-GA_MinPS));
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TransPos = zeros(PopNum, ProbDim);
TransVel = zeros(PopNum, ProbDim);

% Initialization Step
[PosPop, VelPop] = PSO_InitPop(PopNum, ProbDim, DimMinMax);
FitVal = PSO_GetFitValues(PopNum, PosPop, ProbDim, DimMinMax);
[Pbest, Gbest]= PSO_GetInitPGBest(PopNum, PosPop, ProbDim, FitVal);

PrevDiff = 0;
while PSO_Curr <= PSO_Max
%      disp(Gbest(ProbDim+1));

    % Evaluate
    FitVal = PSO_GetFitValues(PopNum, PosPop, ProbDim, DimMinMax);
%
%      clf;     %clear frame
%      figure(1);
%      hold on;
%      posit = 1:PopNum;
%      plot(posit,FitVal,'.r','MarkerSize', 10);
%      M(PSO_Curr)=getframe(gca);

    % Get best values
    [Pbest, Gbest] = PSO_GetPGBest(PopNum, PosPop, ProbDim, FitVal, Pbest, Gbest);

    if(PSO_Curr == PSO_Max)
        break;
    end
    % Change value according to how current iteration
    w = wmax-(wmax-wmin)*(PSO_Curr/PSO_Max);

    % Calculate new velocities and move
    [TransPos, TransVel] = PSO_ChangeVel(PopNum, PosPop, VelPop, ProbDim, Pbest, Gbest, w, c

    % Evaluate
    TransFitVal = PSO_GetFitValues(PopNum, TransPos, ProbDim, DimMinMax);

    % GA Portion
    PSO_Arranged = sort(TransFitVal);
    GA_Num_Curr = 1;
    while GA_Num_Curr <= GA_Num
        % Get one from best individuals
        for RowNum = 1:PopNum
            if TransFitVal(RowNum) == PSO_Arranged(GA_Num_Curr);
                Sel_Indiv = TransPos(RowNum, :);
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            break;
        end
    end

    % Generate a population with the first indiv being the selected
    % chromosome
    GA_Chroms = GA_InitPop(GA_PS, ProbDim, DimMinMax);
    GA_Chroms(1, :) = Sel_Indiv;

    GA_Fit_Elite = PSO_Arranged(GA_Num_Curr);
    GA_Fit_Chrom = Sel_Indiv;
    GA_Curr = 1;
    while GA_Curr <= GA_MaxItr
        % Get Fitness
        GA_FitVal = PSO_GetFitValues(GA_PS, GA_Chroms, ProbDim, DimMinMax);
        TransPop = zeros(GA_PS, ProbDim);

        % Keep Elite
        Arranged = sort(GA_FitVal);
        if Arranged(1) < GA_Fit_Elite
            GA_Fit_Elite = Arranged(1);
            for i = 1:GA_PS
                if Arranged(1) == GA_FitVal(i)
                    GA_Fit_Chrom = GA_Chroms(i,:);
                end
            end
        end

        % Create Wheel
        GA_RouWheel = GA_CreateWheel(GA_PS, GA_FitVal);

        % Create the population
        for i = 1:GA_PS
            % Select 2 Parents
            [Parent1, Parent2] = GA_Selection(GA_PS, GA_Chroms, ProbDim, GA_FitVal, GA_R
            % Cross-over
            SibRep = GA_CrossOver(Parent1, Parent2, GA_cross, ProbDim);
            % Mutate
            if rand() <= GA_mut
                SibRep = GA_Mutation(SibRep, DimMinMax, ProbDim);
            end
            % Place
            TransPop(i, :) = SibRep;
        end

        GA_Chroms = TransPop;
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                GA_Curr = GA_Curr + 1;
        end
        % Replace the individual
        for RowNum = 1:PopNum
            if TransFitVal(RowNum) == PSO_Arranged(GA_Num_Curr);
                TransPos(RowNum,:) = GA_Fit_Chrom(1,:);
                break;
            end
        end
        GA_Num_Curr = GA_Num_Curr + 1;
    end

    % Update GA_Vars
    GA_MaxItr = floor(GA_MinItr + ((PSO_Curr/PSO_Max)^GA_B)*(GA_MaxItr-GA_MinItr));
    GA_Num = floor(GA_NumMax - ((PSO_Curr/PSO_Max)^GA_y)*(GA_NumMax-GA_NumMin));
    GA_PS = floor(GA_MinPS + ((PSO_Curr/PSO_Max)^GA_y)*(GA_MaxPS-GA_MinPS));

    if(PSO_Curr == 1)
        PrevDiff = max(FitVal) - min(FitVal);
    else
        CurrDiff = max(FitVal) - min(FitVal);
        % disp(CurrDiff);
        % Check for population convergence
        if PrevDiff - CurrDiff < AcceptThreshold && CurrDiff < AcceptThreshold
            g1 = -Gbest(1) + 0.0193*Gbest(3);
            g2 = -Gbest(2) + 0.0095*Gbest(3);
            g3 = -(pi*(Gbest(3)^2)*Gbest(4)) - ((4/3)*pi*(Gbest(3)^3)) + 1296000;
            g4 = Gbest(4) - 240;
            X = sprintf('Population Converged!\nNumber of Iterations: %0.15f\nBest Value: %0(
            disp(X);
            break;
        end
        PrevDiff = CurrDiff;
    end
    PosPop = TransPos;
    VelPop = TransVel;
    PSO_Curr = PSO_Curr + 1;
end

if PSO_Curr >= PSO_Max
    g1 = -Gbest(1) + 0.0193*Gbest(3);
    g2 = -Gbest(2) + 0.0095*Gbest(3);
    g3 = -(pi*(Gbest(3)^2)*Gbest(4)) - ((4/3)*pi*(Gbest(3)^3)) + 1296000;
    g4 = Gbest(4) - 240;
    X = sprintf('Did Not Converge!\nNumber of Iterations: %0.15f\nBest Value: %0.15f\nBest I
    disp(X);
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end
% g1 = 85.334407 + 0.0056858*Gbest( 2)*Gbest( 5) + 0.0006262*Gbest( 1)*Gbest( 4) - 0.0022053
% g2 = 80.51249 + 0.0071317*Gbest( 2)*Gbest( 5) + 0.0029955*Gbest( 1)*Gbest( 2) - 0.0021813*
% g3 = 9.300961 + 0.0047026*Gbest( 3)*Gbest( 5) + 0.0012547*Gbest( 1)*Gbest( 3) + 0.0019085*
%
% X = sprintf('Best Value: %d\nBest Position: %d %d %d %d %d\nConstraints:\nG1: %d\n G2: %d\
% disp(X);
%movie(M,1,120);
Ans(trials,:) = [Gbest g1 g2 g3 g4];
end

% Get Best Fit
Vals = zeros(30,1);
for o = 1:30
    Vals(o) = Ans(o,ProbDim+1);
end

% Generate Stats
Mean = mean(Vals);
StdDev = std(Vals);
Median = median(Vals);
Worst = max(Vals);
Best = min(Vals);

% Get index of best run
BesInd = 0;
for o = 1:30
    if min(Vals) == Ans(o,ProbDim+1)
        BesInd = o;
    end
end

X = sprintf('\n\nBest OverAll Value: %0.15f\nPosition: %0.15f %0.15f %0.15f %0.15f\nConstra
disp(X);


Trial: 1
Population Converged!
Number of Iterations: 466.000000000000000
Best Value: 6302.615671455404500
Best Position: 0.974142663601552 0.479500274832428 50.473713139973256 94.630710102925477
G1: -0.000000000000068
G2: -0.000000000002682
G3: -0.000000000465661
G4: -145.369289897074510
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Trial: 2
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5880.670847119796200
Best Position: 0.778168641383470 0.383036377883055 40.319618724532091 199.999999993967120
G1: -0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -40.000000006032877

Trial: 3
Population Converged!
Number of Iterations: 451.000000000000000
Best Value: 6385.154177201944500
Best Position: 1.004337437280571 0.494362987262457 52.038209185521787 82.954490722096239
G1: 0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -157.045509277903760

Trial: 4
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5917.481114984899200
Best Position: 0.799244013095071 0.393472246273199 41.411597865626973 185.337744016118990
G1: -0.000000174288470
G2: -0.000062066549743
G3: 0.000000000000000
G4: -54.662255983881010

Trial: 5
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6027.368239690192200
Best Position: 0.856284083110852 0.421503175674648 44.360203763879099 150.490123425416810
G1: -0.000132150467985
G2: -0.000081239917796
G3: 0.000000000000000
G4: -89.509876574583188

Trial: 6
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5917.929413008237100
Best Position: 0.799599890831761 0.393585297553328 41.430020811565775 185.099306958752550
G1: -0.000000489168541
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G2: -0.000000099843453
G3: -0.085722410352901
G4: -54.90069304124750


Trial: 7
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6082.260447861179300
Best Position: 0.876872718675961 0.430141383180968 45.278040334551783 140.853329133747560
G1: -0.003006540219111
G2: -0.000000000002726
G3: -0.000010106479749
G4: -99.146670866252435


Trial: 8
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6133.504603870849700
Best Position: 0.904753000325718 0.445088385168432 46.850925555199424 125.471907313615490
G1: -0.000530137110369
G2: -0.000004592394038
G3: -0.000000015832484
G4: -114.528092686384510


Trial: 9
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5891.827318437960500
Best Position: 0.779240251964442 0.384207833816176 40.319618724131423 199.999999999545280
G1: -0.001071610588706
G2: -0.001171455936928
G3: -0.000000002793968
G4: -40.000000000454719


Trial: 10
Population Converged!
Number of Iterations: 474.000000000000000
Best Value: 6115.403863184699700
Best Position: 0.897663687071498 0.441855182755401 46.511071868989525 128.681610336575350
G1: 0.000000000000000
G2: -0.000000000000000
G3: 0.000000000000000
G4: -111.318389663424650


Trial: 11
Did Not Converge!
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Number of Iterations: 500.000000000000000
Best Value: 5895.175979477736300
Best Position: 0.786651391743123 0.387212092758755 40.759139432587567 193.970717570438210
G1: -0.000000000694183
G2: -0.000000268149173
G3: -0.003162120003253
G4: -46.029282429561789

Trial: 12
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5979.154817978307600
Best Position: 0.830394797660820 0.409256595463213 43.006236693319764 165.703225356577800
G1: -0.000374429479749
G2: -0.000697346876676
G3: -0.000314390053973
G4: -74.296774643422197

Trial: 13
Population Converged!
Number of Iterations: 442.000000000000000
Best Value: 6029.828547788435600
Best Position: 0.857907027730247 0.422285842665148 44.451141333173432 149.512005143074820
G1: -0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -90.487994856925184

Trial: 14
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6051.206251322799300
Best Position: 0.861311425074148 0.426184729882802 44.572443775584368 148.215437974300900
G1: -0.001063260205370
G2: -0.002746514014750
G3: 0.000000000000000
G4: -91.784562025699103

Trial: 15
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6380.212382120396800
Best Position: 0.999897808251834 0.493751493799536 51.808176524602040 84.616998094233338
G1: -0.000000001327015
G2: -0.001573816815816
G3: -0.000000000931323
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G4: -155.383001905766660

Trial: 16
Population Converged!
Number of Iterations: 449.000000000000000
Best Value: 6355.232444088143900
Best Position: 0.993602738256051 0.489079068053497 51.482007163525964 87.005554182370943
G1: 0.000000000000000
G2: -0.000000000000000
G3: 0.000000000000000
G4: -152.994445817629070

Trial: 17
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6346.644492522939800
Best Position: 0.990470734553036 0.487533446553123 51.319310163486570 88.210947369335358
G1: -0.000008048397745
G2: -0.000000000000000
G3: 0.000000000000000
G4: -151.789052630664630

Trial: 18
Population Converged!
Number of Iterations: 479.000000000000000
Best Value: 5901.554627225623300
Best Position: 0.779390025544754 0.387197184650815 40.319618724098731 199.999999999999770
G1: -0.001221384169649
G2: -0.004160806771877
G3: 0.000000000000000
G4: -40.000000000000227

Trial: 19
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6085.144256601004600
Best Position: 0.884012526205397 0.435135698555104 45.803757742642560 135.559740874396450
G1: -0.000000001772396
G2: -0.000000000000000
G3: 0.000000000000000
G4: -104.440259125603550

Trial: 20
Population Converged!
Number of Iterations: 444.000000000000000
Best Value: 6176.244848165532900
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Best Position: 0.923920377824140 0.454779460590032 47.871522167030321 116.182971304097680
G1: -0.000000000000455
G2: -0.000000000003244
G3: -0.000000942265615
G4: -123.817028695902320

Trial: 21
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6005.704168301591400
Best Position: 0.841867348663343 0.413519527887044 43.528369621284263 159.688190620910320
G1: -0.001769814972556
G2: -0.000000016484843
G3: -0.000000002328306
G4: -80.311809379089681

Trial: 22
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5964.995034663432300
Best Position: 0.825133139469621 0.406153617873647 42.753012407752358 168.690853142444920
G1: 0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -71.309146857555078

Trial: 23
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5911.300810260071600
Best Position: 0.784417112859033 0.384329372409025 40.455722503901242 198.113971955401840
G1: -0.003621668533739
G2: -0.000000008621963
G3: 0.000000000000000
G4: -41.886028044598163

Trial: 24
Population Converged!
Number of Iterations: 441.000000000000000
Best Value: 6190.080657604294200
Best Position: 0.929687243354160 0.457618073153602 48.170323489852834 113.558265151175630
G1: 0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -126.441734848824370
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Trial: 25
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5990.334635443438900
Best Position: 0.837748796273313 0.412262599265015 43.395904777162023 161.196044836386560
G1: -0.000207834074086
G2: -0.000001503881976
G3: -0.000000769970939
G4: -78.803955163613438

Trial: 26
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6320.366378861182100
Best Position: 0.980794181930193 0.482774338255795 50.818351395346788 91.982310273175415
G1: 0.000000000000000
G2: -0.000000000000000
G3: 0.000000000000000
G4: -148.017689726824590

Trial: 27
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5880.670849918420600
Best Position: 0.778168642325347 0.383036378357710 40.319618773334021 199.999999369337250
G1: 0.000000000000000
G2: -0.000000000011037
G3: -0.000279509462416
G4: -40.000000630662754

Trial: 28
Population Converged!
Number of Iterations: 442.000000000000000
Best Value: 6243.249310838272300
Best Position: 0.951209076472837 0.468211721579951 49.285444376828941 104.117390390976180
G1: -0.000000000000038
G2: -0.000000000000076
G3: -0.000000000931323
G4: -135.882609609023800

Trial: 29
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 5895.056378855687400
Best Position: 0.780150759032813 0.383036903623740 40.319674065656827 199.999999999999770
G1: -0.001981049565636
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G2: -0.000000000000000
G3: -3.934562445851043
G4: -40.000000000000227


Trial: 30
Did Not Converge!
Number of Iterations: 500.000000000000000
Best Value: 6256.586645639259600
Best Position: 0.948060097465768 0.471575701160376 49.120459894838469 105.480135364846520
G1: -0.000035221495385
G2: -0.004931332159411
G3: -0.000042728846893
G4: -134.519864635153480



Best OverAll Value: 5880.670847119796200
Position: 0.778168641383470 0.383036377883055 40.319618724532091 199.999999993967120
Constraints:
G1: -0.000000000000000
G2: 0.000000000000000
G3: 0.000000000000000
G4: -40.000000006032877
Mean: 6083.765307149724300
Median: 6040.517399555617900
Standard Deviation:172.172683824856050
Worst Overall Value: 6385.154177201944500
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