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```
clc;
clear;
close all;
```

Problem Definition

```
CostFunction=@(x) Sphere(x);    % Cost Function

nVar=20;            % Number of Decision Variables

VarSize=[1 nVar];   % Decision Variables Matrix Size

VarMin=-5;          % Lower Bound of Decision Variables
VarMax= 5;          % Upper Bound of Decision Variables
```

DE Parameters

```
MaxIt=1000;      % Maximum Number of Iterations

nPop=50;        % Population Size

beta_min=0.2;   % Lower Bound of Scaling Factor
beta_max=0.8;   % Upper Bound of Scaling Factor

pCR=0.2;        % Crossover Probability
```

Initialization

```
empty_individual.Position=[];
empty_individual.Cost=[];

BestSol.Cost=inf;

pop=repmat(empty_individual,nPop,1);

for i=1:nPop

    pop(i).Position=unifrnd(VarMin,VarMax,VarSize);
```

```
    pop(i).Cost=CostFunction(pop(i).Position);

    if pop(i).Cost<BestSol.Cost
        BestSol=pop(i);
    end

end

BestCost=zeros(MaxIt,1);
```

DE Main Loop

```
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);

        % Mutation
        %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.Cost=CostFunction(NewSol.Position);

        if NewSol.Cost<pop(i).Cost
            pop(i)=NewSol;

            if pop(i).Cost<BestSol.Cost
               BestSol=pop(i);
```

```
            end
        end

    end

    % Update Best Cost
    BestCost(it)=BestSol.Cost;

    % Show Iteration Information
    disp(['Iteration ' num2str(it) ': Best Cost = ' num2str(BestCost(it))]);

end
```

```
Iteration 1: Best Cost = 99.3511
Iteration 2: Best Cost = 95.7127
Iteration 3: Best Cost = 84.1225
Iteration 4: Best Cost = 84.1225
Iteration 5: Best Cost = 84.1225
Iteration 6: Best Cost = 79.7132
Iteration 7: Best Cost = 63.4119
Iteration 8: Best Cost = 58.8981
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Iteration 988: Best Cost = 5.7942e-22
Iteration 989: Best Cost = 5.4666e-22
Iteration 990: Best Cost = 4.5086e-22
Iteration 991: Best Cost = 4.0706e-22
Iteration 992: Best Cost = 2.4026e-22
Iteration 993: Best Cost = 2.4026e-22
Iteration 994: Best Cost = 2.2519e-22
Iteration 995: Best Cost = 2.2519e-22
Iteration 996: Best Cost = 1.6623e-22
Iteration 997: Best Cost = 1.6623e-22
Iteration 998: Best Cost = 1.6623e-22
Iteration 999: Best Cost = 1.6623e-22
Iteration 1000: Best Cost = 1.6623e-22
```
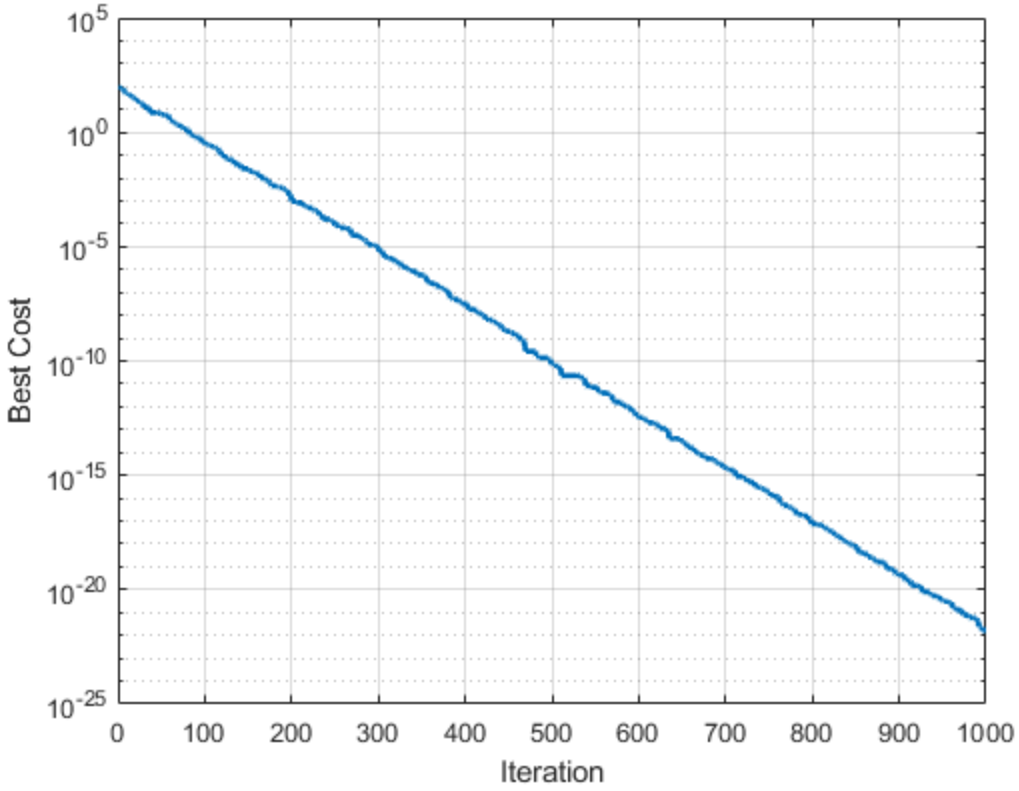

Show Results

```
figure;
%plot(BestCost);
semilogy(BestCost, 'LineWidth', 2);
xlabel('Iteration');
ylabel('Best Cost');
grid on;
```



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