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Golden Section Search

Introduction

For Golden section search, it needs to exist in only one local maximizer or minimizer. Figure 1presents the function interval is from a to b, if we have to find the minimum point. According to properties, if f(x1) > f(x2), then local minimizer is between a and x2. In other words, if f(x1) < f(x2), then local minimizer is between x1 and b. In Figure 2, we can select our section points by Golden ratio. We have

$\frac{c}{a} = \frac{a}{b}$, $\frac{b}{a} = \varphi$ and $\varphi = \frac{1+\sqrt{5}}{2}$.

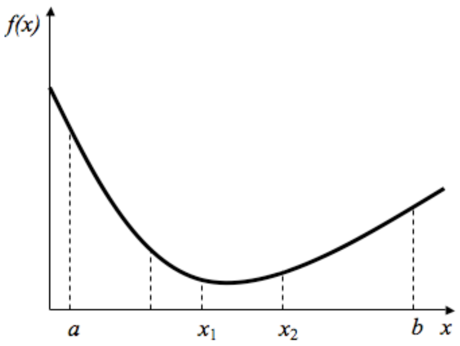


Figure 1Diagram of a golden section search

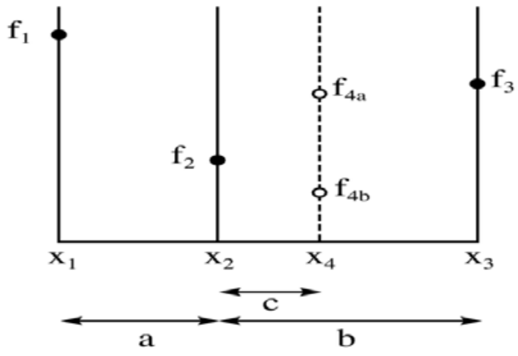


Figure 2Golden section

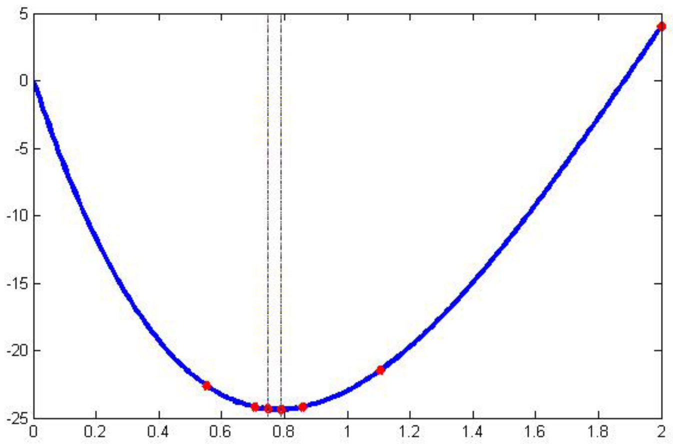
Question

Use the Golden section search to find a local minimizer for below function,

(a) f(x)=x^4-14x^3+60x^2-70x over [0,2]

```
B = 2;    A = 0;    times = 0;    range = 0.1;    %set the interval is from A to B
x = 0:0.01:2;                                     %range set 0.1
y = x.^4 - 14*x.^3 + 60*x.^2 -70*x;
plot(x,y)                                         %use x and y to plot the function
while B - A > range                               %set the condition to stop the loop
    a = (B-A)*2/(5+5^(1/2));                      %value a
    b = (B-A) - a;                                %value b
    x1 = A + a;                                   %value for section point 1
    x2 = A + a + a^2/b;                           %value for section point 2
    x = x1;
    y1 = x^4 - 14*x^3 + 60*x^2 -70*x;             %To get y1
    x = x2;
```

```
    y2 = x^4 - 14*x^3 + 60*x^2 -70*x;        %To get y2
    if y1<y2                                  %Based on the value magnitude to
        B = x2;                               % adjust interval
    elseif y1>y2
        A = x1;
    end
    times    = times + 1                      %calculate how many times of loop
    hold on;  plot(A,A^4 - 14*A^3 + 60*A^2 -70*A,'rx');
    hold on;  plot(B,B^4 - 14*B^3 + 60*B^2 -70*B,'rx');
end
A; B; times                                   %print value A and B
hold on; plot(A,t)
hold on; plot(B,t)
```



We can see the output of A and B in Figure 3.

A = 0.7478

B = 0.7900

Because I set the condition for stop is the interval less than 0.1.

times = 6.

Figure 3the output of (a)

Remark:

If I set the interval is 0.0000001,

A = 0.780883986706499 and B = 0.780884064933138. It's very close to minimizer.

times = 31.

(b) f(x)=8e^(1-x)+7ln(x) over [1,2]

```
B = 2;     A = 1;     times = 0;        %set the interval is from A to B
x = 1:0.01:2;   range = 0.1;            %range set 0.1
y = 8*exp(1-x) + 7*log(x);
plot(x,y)                               %use x and y to plot the function
while B - A > range,                    %set the condition to stop the loop
    a = (B-A)*2/(5+5^(1/2));            %value a
    b = (B-A) - a;                      %value b
    x1 = A + a;                         %value for section point 1
```

```
        x2 = A + a + a^2/b;                 %value for section point 2
        x = x1;
        y1 = 8*exp(1-x) + 7*log(x);         %To get y1
        x = x2;
        y2 = 8*exp(1-x) + 7*log(x);         %To get y2
        if y1<y2                            %Based on the value magnitude to
            B = x2;                         % adjust interval
        elseif y1>y2
            A = x1;
        end
        times   = times + 1                 %calculate how many times of loop
        hold on;  plot(A,A^4 - 14*A^3 + 60*A^2 -70*A,'rx');
        hold on;  plot(B,B^4 - 14*B^3 + 60*B^2 -70*B,'rx');
end
A; B;                                       %print value A and B
times                                       %print times
t = 7.65:0.001:8;
hold on; plot(A,t)
hold on; plot(B,t)
```

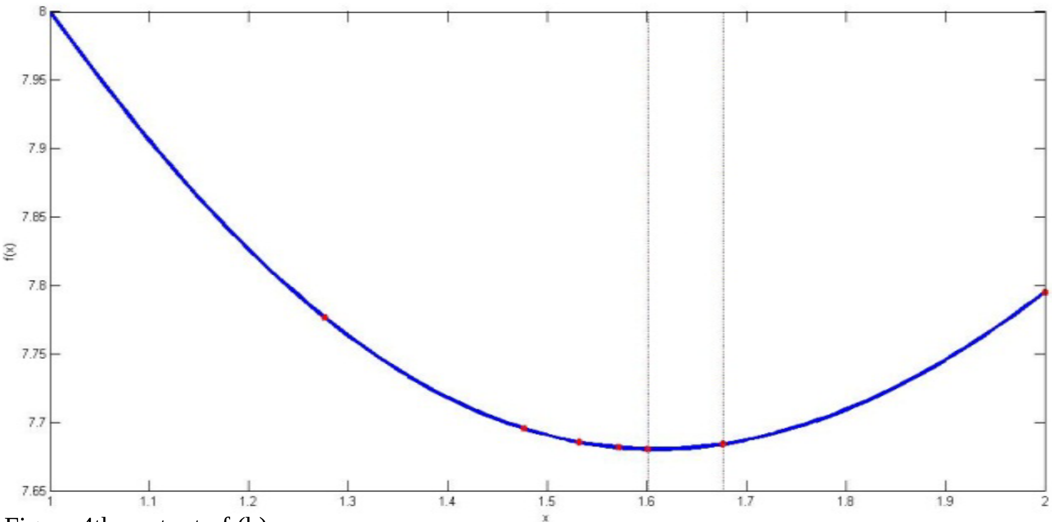


Figure 4the output of (b)

We can see the output of A and B in Figure 4.

A = 1.6006

B = 1.6764

Because I set the condition for stop is the interval less than 0.1, times = 6.

Remark:

If I set the interval is 0.000001,

A = 1.609380697125004and B = 1.609381659249061. It’s very close to minimizer.

times   = 29.