

The Bisection Method

Theory

This method is based on the theorem stating that if a function $f(a)$ is continuous between a and b , and $f(a)$ and $f(b)$ are of opposite signs then there exists at least one root between a and b and its approximate value is $x = (a+b)/2$. If $f(x)=0$ then it is concluded that $x=0$ is the root of the equation $f(x)=0$. Otherwise the root lies between either x and b or x and a depending on whether $f(x)$ is positive or negative. This process continues until the desired value of root x is acquired. Thus this is the procedure of the bisection method.

Code

```
#include<iostream>
#include<stdio.h>
#include<cmath>
using namespace std;
#define Eps 0.00001

double f(double x)
{
    return (x*x*x)-2*x-5;
}

int main()
{
    double a,b,x,xn;
    int i=0;
    cout<<"Enter the Value of a: ";
    cin>>a;
    cout<<"Enter the value of b: ";
    cin>>b;
    x=(a+b)/2;
    if(f(a)*f(b)>0)
        cout<<"WRONG INPUT. \nPlease Try Again !!!"<<endl;
    else
    {
        cout<<"n"<<"      "<<"a"<<"      "      "<<"b"<<"      "      "<<"x"<<"      "      "<<"f(x)"<<"
        "<<"Error Rate"<<endl;
        do
        {
            cout<<"-----"<<endl;
            printf("%d      %0.5lf      %0.5lf      %0.5lf      %0.5lf
            %0.5lf\n",i,a,b,x,f(x),fabs(x-xn));
            xn=x;
```

```

    if(f(a)*f(x)<0)
        b=x;
    else if(f(a)*f(x)>0)
        a=x;
    else if(f(a)*f(b)==0)
    {
        x=0;
        break;
    }
    x=(a+b)/2;
    i++;
}while(fabs(x-xn)>=Eps);
cout<<"\nThe Value of x is: "<<x<<endl;
cout<<"Error rate: "<<error(x)<<" %"<<endl;
}
return 0;
}

```

Output

"E:\Study\My C\Lab\2-1\CSE 2104\Lab 1\BISECTIONRESULT.exe"

Enter the Value of a: 2
Enter the value of b: 3

n	a	b	x	f(x)	Error Rate
0	2.00000	3.00000	2.50000	5.62500	2.50000
1	2.00000	2.50000	2.25000	1.89063	0.25000
2	2.00000	2.25000	2.12500	0.34570	0.12500
3	2.00000	2.12500	2.06250	-0.35132	0.06250
4	2.06250	2.12500	2.09375	-0.00894	0.03125
5	2.09375	2.12500	2.10938	0.16684	0.01563
6	2.09375	2.10938	2.10156	0.07856	0.00781
7	2.09375	2.10156	2.09766	0.03471	0.00391
8	2.09375	2.09766	2.09570	0.01286	0.00195
9	2.09375	2.09570	2.09473	0.00195	0.00098
10	2.09375	2.09473	2.09424	-0.00350	0.00049
11	2.09424	2.09473	2.09448	-0.00077	0.00024
12	2.09448	2.09473	2.09460	0.00059	0.00012
13	2.09448	2.09460	2.09454	-0.00009	0.00006
14	2.09454	2.09460	2.09457	0.00025	0.00003
15	2.09454	2.09457	2.09456	0.00008	0.00002

The Value of x is: 2.09455
Error rate: 5.18692e-005 %

Discussion

In the above code, firstly a function $f()$ was declared as it hold the main equation $f(x) = x^3 - 2x - 5 = 0$. Then in the main function a do while loop was executing until the difference of the two consecutive roots of the equation became less than 0.00001. Firstly the value of a and b were taken from the user. In the loop it was checked whether $f(a)$ and $f(x)$ are of opposite signs or not. If so then the value of x was assigned to b, otherwise the value of x is assigned to a. If $f(x)$ becomes 0 then the root $x=0$. And then this equation $x = (a+b)/2$ was used. Thus this is the process of Bisection method and the result and all the values were shown as a tabular form.