Program-1
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This program demonstrate the implementation of bisection and newton's method for the function

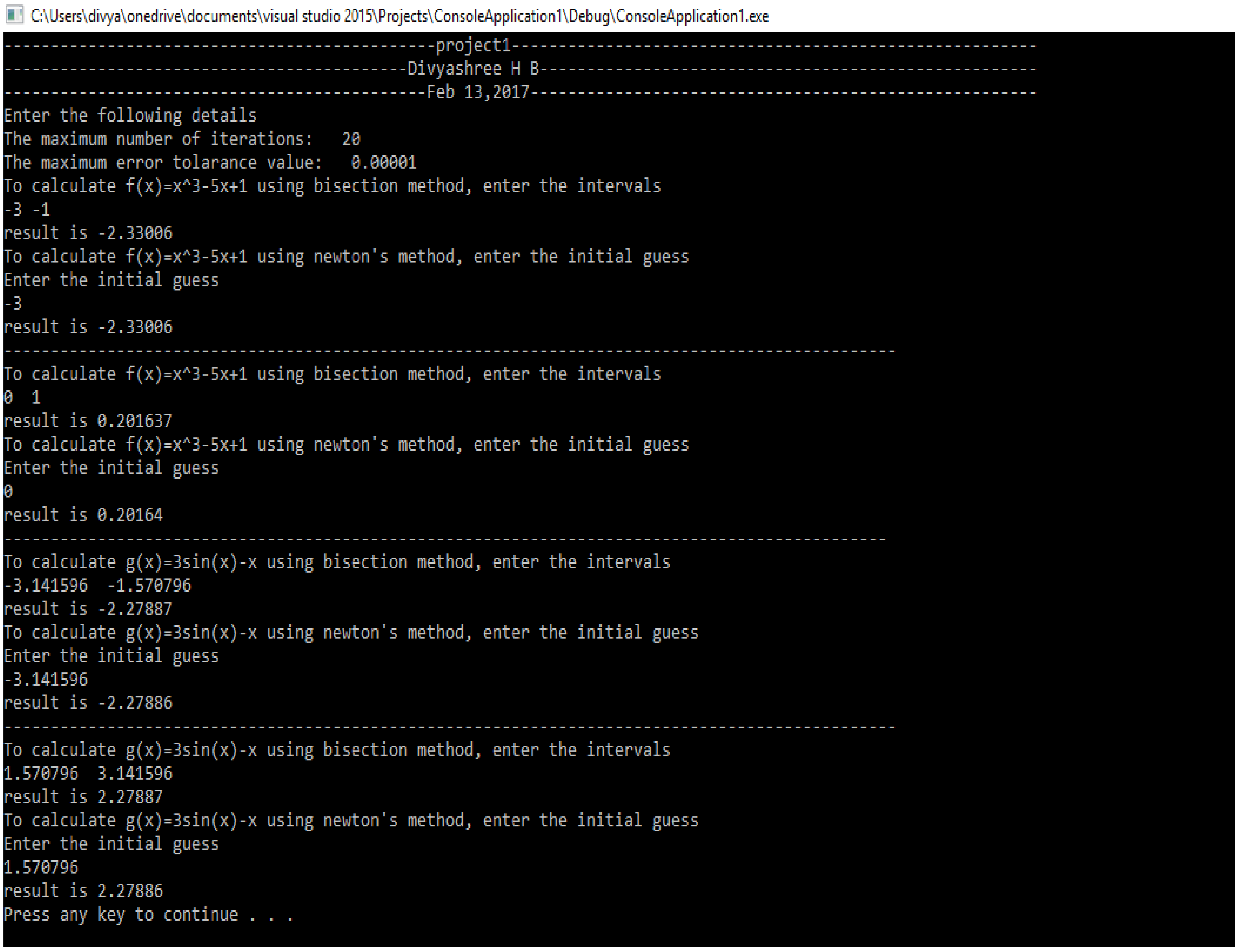
- User provides the max iteration, error bound and the intervals for bisection & initial value for newton's method.
- This report contains the source code, screenshot of the console and the output file.
- The following is the source code to calculate the given F(x) and G(x) using bisection and newton method.

```
#include<iostream>
#include<iomanip>//setpression
#include<vector>
#include<fstream>//write to file
#include <cmath>        // std::abs
#include <math.h>       /* sin */
using namespace std;

std::ofstream out;


vector<long double> bisec_arr;
vector<long double> newton_arr;


long double f_x(long double x) {
	return ((x*x*x) - (5 * x) + 1);
}

long double f1_x(long double x) {
	return ( (3*x*x) - 5);
}

long double g_x(long double x) {
	return ((3 * sin(x)) - x);
}

long double g1_x(long double x) {
	return ((3 * cos(x)) - 1);
}

long double bisection_f(long double err, int NMAX, long double a, long double b) {
	//INPUT: Function f, endpoint values a, b, tolerance TOL, maximum iterations NMAX
	//CONDITIONS: a < b, either f(a) < 0 and f(b) > 0 or f(a) > 0 and f(b) < 0
	//RETURN: value which differs from a root of f(x)=0 by less than TOL
	long double c;
	long double E = 0.0001;
	long double TOL = err, fc; //initialize error to large value
	int N = 1;
	bisec_arr.clear();
	while (N <= NMAX && abs(E)>TOL) {  // limit iterations to prevent infinite loop
		setprecision(8);
		c = (a + b) / 2;// new midpoint
		bisec_arr.push_back(c);
		if (f_x(c) * f_x(a) <= 0) { // compare function values to determine interval side
			E = c - b;    //compute new error
			b = c; // new interval
		}
		else
		{
			E = c - a;    //compute new error
			a = c; // new interval
		}
		N = N + 1; // increment step counter
	}//endWhile
	out << "The number of itrations take to run F(x) using bisection method is\t" << N-1 << endl;
	return c;
}

//Let f : R → R be a differentiable function. The following algorithm computes
// an approximate solution x ∗ to the equation f(x) = 0.

long double newton_f(long double err, int NMAX, long double xo) {
	long double TOL = err, x = xo;
	long double temp, E = 0.0001;
	int N = 1;
	newton_arr.clear();
	while (N <= NMAX && abs(E) > TOL) {	// limit iterations to prevent infinite loop
		temp = x - (f_x(x) / f1_x(x));//newton formula
								//Compute new error | xk + 1 − xk |
		newton_arr.push_back(temp);
		E = (temp - x);
		x = temp;
		N = N + 1;
	}
	out << "The number of itrations take to run F(x) using newton's method is\t" << N -1<< endl;
	return x;
}


long double bisection_g(long double err, int NMAX, long double a, long double b) {
	//INPUT: Function f, endpoint values a, b, tolerance TOL, maximum iterations NMAX
	//CONDITIONS: a < b, either f(a) < 0 and f(b) > 0 or f(a) > 0 and f(b) < 0
	//RETURN: value which differs from a root of f(x)=0 by less than TOL
	long double c;
	long double E = 0.0001;
	long double TOL = err, fc; //initialize error to large value
	int N = 1;
	bisec_arr.clear();
	while (N <= NMAX && abs(E)>TOL) {  // limit iterations to prevent infinite loop
		setprecision(8);
		c = (a + b) / 2;// new midpoint
		bisec_arr.push_back(c);
		if (g_x(c) * g_x(a) <= 0) { // compare function values to determine interval side
			E = c - b;	//compute new error
			b = c; // new interval
		}
		else
		{
			E = c - a;	//compute new error
			a = c; // new interval
		}
		N = N + 1; // increment step counter
	}//endWhile
	out << "The number of itrations take to run G(x) using bisection method is\t" << N-1 << endl;
	return c;
}

//Let f : R → R be a differentiable function. The following algorithm computes
// an approximate solution x ∗ to the equation f(x) = 0.

long double newton_g(long double err, int NMAX, long double xo) {
	long double TOL = err, x = xo;
	long double temp, E = 0.0001;
	int N = 1;
	newton_arr.clear();
	while (N <= NMAX && abs(E) > TOL) {	// limit iterations to prevent infinite loop
		temp = x - (g_x(x) / g1_x(x));//newton formula
								//Compute new error | xk + 1 − xk |
		E = (temp - x);
		newton_arr.push_back(temp);
		x = temp;
```

```
			N = N + 1;
		}
		out << "The number of itrations take to run G(x) using newton's method is\t" << N-1 << endl;
		return x;
}


int main() {

		out.open("test.txt");

		out << "----------------------------------------------project1----------------------------------
----------------------" << endl;
		out << "-------------------------------------------Divyashree H B-------------------------------
----------------------" << endl;
		out << "---------------------------------------------Feb 13,2017--------------------------------
----------------------" << endl;
		cout << "----------------------------------------------project1---------------------------------
-----------------------" << endl;
		cout << "-------------------------------------------Divyashree H B------------------------------
-----------------------" << endl;
		cout << "---------------------------------------------Feb 13,2017-------------------------------
-----------------------" << endl;

		int NMAX,i,j;//i->size for bisection array/vector and j for newton
		long double err, a, b,guess;
		cout << "Enter the following details" << endl;
		cout << "The maximum number of iterations:   ";
		cin >> NMAX;
		cout << "The maximum error tolarance value:   ";
		cin >> err;
		out << "The following Method uses " << NMAX << "  as its max iteration and " << err << "as its
error precission" << endl;
		cout << "To calculate f(x)=x^3-5x+1 using bisection method, enter the intervals" << endl;
		out << "calculating f(x)=x^3-5x+1 using bisection method" << endl;
		cin >> a >> b;
		out << "For the interval [ " << a << " , " << b << " ]" << endl;
		bisec_arr.clear();
		long double r = bisection_f(err, NMAX, a, b);
		cout << "result is " << r << endl;
		out << "result = " << r << endl;
		cout << "To calculate f(x)=x^3-5x+1 using newton's method, enter the initial guess" << endl;
		out << "calculating f(x)=x^3-5x+1 using newton's method" << endl;
		cout << "Enter the initial guess" << endl;
		cin >> guess;
		out << "With initial guess " << guess << endl;
		newton_arr.clear();
		long double r1 = newton_f(err, NMAX, guess);
		cout << "result is " << r1 << endl;
		out << "result = " << r1 << endl;
		out << "iteration " << " Bisection\t\t" << "Newton" << endl;
		i = 0; j = 0;
		while (i < bisec_arr.size())
		{
			while (j<newton_arr.size()) {
				out << i + 1 << "\t\t" << bisec_arr[i] << "\t\t" << newton_arr[j] << endl;
				i++;
				j++;
			}
			out << i + 1 << "\t\t" << bisec_arr[i] << endl;
			i++;
		}
		cout << "---------------------------------------------------------------------------------------
--------" << endl;
		cout << "To calculate f(x)=x^3-5x+1 using bisection method, enter the intervals" << endl;
		out << "calculating f(x)=x^3-5x+1 using bisection method" << endl;
```

```
	cin >> a >> b;
	out << "For the interval [ " << a << " , " << b << " ]" << endl;
	bisec_arr.clear();
	long double r3 = bisection_f(err, NMAX, a, b);
	cout << "result is " << r3 << endl;
	out << "result = " << r3 << endl;
	cout << "To calculate f(x)=x^3-5x+1 using newton's method, enter the initial guess" << endl;
	out << "calculating f(x)=x^3-5x+1 using newton's method" << endl;
	cout << "Enter the initial guess" << endl;
	cin >> guess;
	out << "With initial guess " << guess << endl;
	newton_arr.clear();
	long double r2= newton_f(err, NMAX, guess);
	cout << "result is " << r2 << endl;
	out << "result = " << r2 << endl;
	out << "iteration " << " Bisection\t\t" << "Newton" << endl;
	i = 0; j = 0;
	while (i < bisec_arr.size())
	{
		while (j<newton_arr.size()) {
			out << i + 1 << "\t\t" << bisec_arr[i] << "\t\t" << newton_arr[j] << endl;
			i++;
			j++;
		}
		out << i + 1 << "\t\t" << bisec_arr[i] << endl;
		i++;
	}
	cout << "---------------------------------------------------------------------------------
-------" << endl;
	cout << "To calculate g(x)=3sin(x)-x using bisection method, enter the intervals" << endl;
	out << "calculating g(x)=3sin(x)-x using bisection method" << endl;
	cin >> a >> b;
	out << "For the interval [ " << a << " , " << b << " ]" << endl;
	bisec_arr.clear();
	long double r4 = bisection_g(err, NMAX, a, b);
	cout << "result is " << r4 << endl;
	out << "result = " << r4 << endl;
	cout << "To calculate g(x)=3sin(x)-x using newton's method, enter the initial guess" << endl;
	out << "calculating g(x)=3sin(x)-x using newton's method" << endl;
	cout << "Enter the initial guess" << endl;
	cin >> guess;
	out << "With initial guess " << guess << endl;
	newton_arr.clear();
	long double r5 = newton_g(err, NMAX, guess);
	cout << "result is " << r5 << endl;
	out << "result = " << r5 << endl;
	out << "iteration " << " Bisection\t\t" << "Newton" << endl;
	i = 0; j = 0;
	while (i < bisec_arr.size())
	{
		while (j<newton_arr.size()) {
			out << i + 1 << "\t\t" << bisec_arr[i] << "\t\t" << newton_arr[j] << endl;
			i++;
			j++;
		}
		out << i + 1 << "\t\t" << bisec_arr[i] << endl;
		i++;
	}
	cout << "---------------------------------------------------------------------------------
--------" << endl;
	cout << "To calculate g(x)=3sin(x)-x using bisection method, enter the intervals" << endl;
	out << "calculating g(x)=3sin(x)-x using bisection method" << endl;
	cin >> a >> b;
	out << "For the interval [ " << a << " , " << b << " ]" << endl;
	bisec_arr.clear();
	long double r6 = bisection_g(err, NMAX, a, b);
```

```cpp
        cout << "result is " << r6 << endl;
        out << "result = " << r6 << endl;
        cout << "To calculate g(x)=3sin(x)-x using newton's method, enter the initial guess" << endl;
        out << "calculating g(x)=3sin(x)-x using newton's method" << endl;
        cout << "Enter the initial guess" << endl;
        cin >> guess;
        out << "With initial guess " << guess << endl;
        newton_arr.clear();
        long double r7 = newton_g(err, NMAX, guess);
        cout << "result is " << r7 << endl;
        out << "result = " << r7 << endl;
        out << "iteration " << " Bisection\t\t" << "Newton" << endl;
        i = 0; j = 0;
        while (i < bisec_arr.size())
        {
               while (j<newton_arr.size()) {
                      out << i+1  << "\t\t" << bisec_arr[i] << "\t\t" << newton_arr[j] << endl;
                      i++;
                      j++;
               }
               out << i+1 << "\t\t" << bisec_arr[i] << endl;
               i++;
        }
        out.flush();
        out.close();
        return 0;
}
```



C:\Users\divya\onedrive\documents\visual studio 2015\Projects\ConsoleApplication1\Debug\ConsoleApplication1.exe

```
---------------------------------------------project1-------------------------------------------------------
----------------------------------------Divyashree H B------------------------------------------------------
------------------------------------------Feb 13,2017------------------------------------------------------
Enter the following details
The maximum number of iterations:   20
The maximum error tolarance value:   0.00001
To calculate f(x)=x^3-5x+1 using bisection method, enter the intervals
-3 -1
result is -2.33006
To calculate f(x)=x^3-5x+1 using newton's method, enter the initial guess
Enter the initial guess
-3
result is -2.33006
-------------------------------------------------------------------------------------------
To calculate f(x)=x^3-5x+1 using bisection method, enter the intervals
0  1
result is 0.201637
To calculate f(x)=x^3-5x+1 using newton's method, enter the initial guess
Enter the initial guess
0
result is 0.20164
------------------------------------------------------------------------------------------
To calculate g(x)=3sin(x)-x using bisection method, enter the intervals
-3.141596  -1.570796
result is -2.27887
To calculate g(x)=3sin(x)-x using newton's method, enter the initial guess
Enter the initial guess
-3.141596
result is -2.27886
-------------------------------------------------------------------------------------------
To calculate g(x)=3sin(x)-x using bisection method, enter the intervals
1.570796  3.141596
result is 2.27887
To calculate g(x)=3sin(x)-x using newton's method, enter the initial guess
Enter the initial guess
1.570796
result is 2.27886
Press any key to continue . . .
```