

SRS document

Introduction

This project is about calculating integral and derivative of functions. This program also enable us to plot the graph of functions using slope calculation and other tools of calculus.

Here are the tools of calculus provided by our program which are used in almost every field of science and technology, The wikipedia definition of integral and derivative has been given below :

The **integral** is an important concept in mathematics. Integration, together with its inverse, differentiation, is one of the two main operations in calculus. Given a function f of a real variable x and an interval $[a, b]$ of the real line, the **definite integral**

$$\int_a^b f(x) dx$$

is defined informally as the signed area of the region in the xy -plane that is bounded by the graph of f , the x -axis and the vertical lines $x = a$ and $x = b$. The area above the x -axis adds to the total and that below the x -axis subtracts from the total.

The term *integral* may also refer to the related notion of the antiderivative, a function $F(x)$ whose derivative is the given function $f(x)$. In this case, it is called an *indefinite integral* and is written

$$F(x) = \int f(x) dx.$$

ref: <http://en.wikipedia.org/wiki/Integral#Introduction>

Differentiation is the action of computing a derivative. The derivative of a function $f(x)$ of a variable x is a measure of the rate at which the value of the function changes with respect to the change of the variable. It is called the *derivative* of f with respect to x . If x and y are real

numbers, and if the graph of f is plotted against x , the derivative is the slope of this graph at

each point.

$$f'(a) = \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}.$$

ref: <http://en.wikipedia.org/wiki/Derivative>

Objective

The main objective of this program is to be able to function as a tool to aid understanding of functions by being capable of differentiating and integrating functions and plotting them in two and in three dimensions. It can also function as a scientific calculator, used for calculating values of exponential and logarithmic functions. Its functionality includes finding solutions for polynomials in one variable.

System requirements

fparser 4.5.1

Can be downloaded from

<http://warp.povusers.org/FunctionParser/>

Note that the library uses a few advanced (but still standard-conforming) C++ techniques which might make it difficult if not impossible to compile it with some old C++ compilers with poorer support for C++ features. The library has been successfully tested with *gcc 4.3.x* and *MS Visual C++ 2005*. Some very old compilers are known to have problems compiling the library (such as *C++ Builder 6* and older, and *gcc 2.x*.)

gnuplot 4.6.6

Downloadable at

<http://sourceforge.net/projects/gnuplot/files/latest/download?source=files>

This is a separate app called gnuplot which can be controlled through C++ using certain functions making it possible to plot 2D and 3D graphs. Also, the system environment variables have been changed and the gnuplot bin directory has been added as a system path to make it easier to access it. The code will not work without this.

Algorithms: Functions for following will be used

Integration

Calculating integral:

Parameters : Function as string , Limits of integration

The program takes a string as input, and calculates the integral of the function within the limits by summing up values of the function at adjacent points. It is an approximate method of finding the integral.

In 3 dimensions, the program can find the integral of a function in a rectangular region. It will use a similar method as the one for 2 dimensions.

Differentiation

The derivative function uses some standard differentiation formulae along with differentiation rules like the product rule and chain rule to find the derivative function.

Finding gradient(3D):

Parameters : function as string

Calls function for derivative

Here, the program differentiates the function in each variable separately while keeping the other variable constant.

Return : gradient as string(functional form)

Gradient at a point(3D):

Parameters : coordinates of points,function as string
uses numerical method for evaluation

Return: value of grad at the point.

Directional derivative(3D):

Parameters : unit direction vector, coordinates of point,function as string
calls function for gradient at a point
uses numerical method for evaluation.

Return : value of directional derivative

Tangent plane + normal(3D):

Parameter : coordinates of points
uses formulae for equation of plane

Return : Equation of Tangent plane , normal(string)

Derivative at a point(For 2D):

Parameters : function as string ,coordinates of point where derivative is to be found

Return : value of derivative

Functional form of 1st-derivative(For 2D):

Parameters: function as string

For example, $[\sin(x+\ln(x))+\cos(x), 3]$

The derivative function uses some standard differentiation formulae along with differentiation rules like the product rule and chain rule to find the derivative function.

Return : string having functional form of 1st- derivative

Plot 1st derivative(For 2D):

Parameter : function as string

Function call to Functional form of 1st-derivative

Function call to graph plotter

Tangent + normal(2D):

Parameter: coordinates of points, value of derivative
Uses formulae to find equations

Return: Equation of tangent , normal(string)

Maxima, minima(2D):

Parameters: Function as string
Finds out points where derivative is zero , and function value at points of non differentiability which may be extreme points

Return: Points of maxima/minima

Finding zeroes of a polynomial:

Parameter:Polynomial as a string
Finds out the zeroes of the polynomial using Newton-Raphson method

Return:The zeroes

***Assumptions*:**

differentiator for 2D assumes finite number of points of non differentiability
differentiator for 3D assumes function is smooth v