

Write a program that calculates the numerical derivative and second derivative of a function. For the first derivative use three point differencing methods. Use forward differencing at the first point and backward differencing at the last point.

For the second derivative use three point differencing except at the first and last points. Use five point forward and backward differencing at the first and last points respectively. Use mathematica to find the five point differencing formula.

Use your program with the given input file to create a file containing values of the function, the derivative and its second derivative at the given points. Use gnuplot to plot the given function together with its derivative and second derivative.

Turn in:

- This problem sheet with your name.
- A summary sheet explaining what you did, how you approached the problem, what was accomplished, what was not accomplished, etc.
- A single plot for the graphs of f , f' and f'' .
- The formula for all the differencing methods.
- Printout of your mathematica notebook used to find the five point differencing formula.

Website:

- Create a directory called `8derivative` on your web site and make all your input, output and source files available in this directory. Write the url for the website on this problem sheet.

Input:

Two columns containing $x, f(x)$ pairs. The x -values are equally spaced.

Output:

Four columns containing $x, f(x), f'(x), f''(x)$ values.

Sample input:

```
0 0
1 1
2 4
3 9
```

Sample output:

```
0 0 0 2
1 1 2 2
2 4 4 2
3 9 6 2
4 16 8 2
```

Hints:

- Do not hardwire the distance h between the x -values. Calculate it from the first two points.
- Try to use the makefile I created for this project.
- The second derivative is not very smooth at the two ends with the three point differencing method. This is why we need the five point differencing formula to fix this problem.