

**Umeå University**

Department of Mathematics and Mathematical Statistics

Calculus in One Variable 7.5 p  
5MA009 HT17

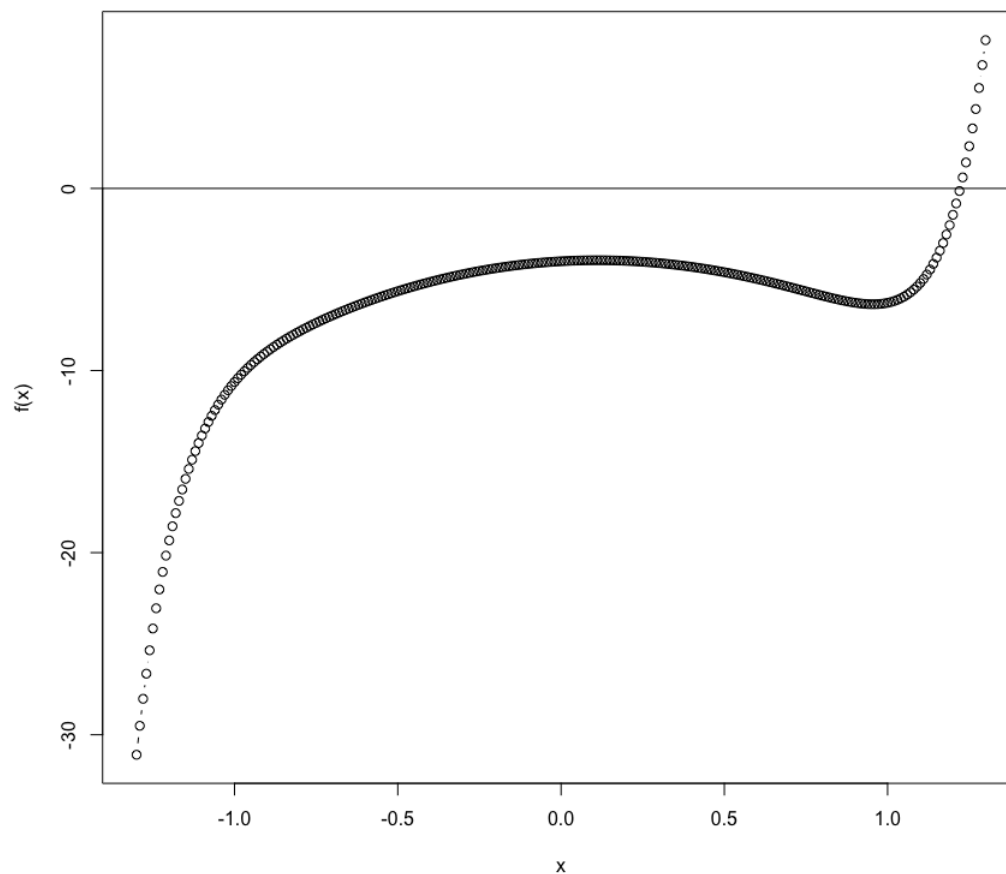
**Computer Laboration**

Submitted 2017-11-19

Author: Lorenz Gerber (dv15lgr@cs.umu.se)

Instructor: Per Åhag

## 1 Plot of the function $f(x) = x^{11} - 5x^2 + e^x - 5$



**Figure 1:** Plot of function  $f(x) = x^{11} - 5x^2 + e^x - 5$  in the range from -1.3 to 1.3. Further, a horizontal line was plotted at  $y = 0$  to facilitate finding a start value for the newton method.

## 2 Code Listings

All calculations were done in R [1].

### 2.1 nderiv

```
nderiv = function (f, x, h) (f(x+h)-f(x))/h
```

### 2.2 newton

```
newton = function (f, x, n) {
  for(i in 1:n){
    x <- x-f(x)/nderiv(f,x,0.0001)
  }
}
```

```

    return (x)
}

```

### 3 Numeric Solution of $x^{11} - 5x^2 + e^x = 5$

From the graph in exercise 1, one zero solution was expected and the start approximation for the newton method was chosen as  $x = 1$ . The iteration was run with  $n = \{1, 10, 100, 1000\}$  which resulted for the two last values in identical approximations (7 significant digits, results rounded to 3 significant after coma digits):  $x = \{1.222\}$ .

### 4 Local minima of $f(x) = x^{11} - 5x^2 + e^x - 5$

From the graph in exercise 1,  $f'$  is expected to have 2 zero solutions. A local maximum of the function  $f$  should be close to  $x = 0$ , hence this value was used as start approximation with the newton method applied to  $f'$ . The obtained result with  $n = \{10, 100\}$  was  $(0.112, -3.944)$ .

### 5 Find $f^{-1}(3)$ where $f(x) = x^{11} - 5x^2 + e^x - 5$

From the graph,  $f(x)$  was expected to evaluate to  $y = 3$  around  $f(1.2)$ . The original equation  $f$  was shifted down to  $g(x) = x^{11} - 5x^2 + e^x - 8$  and solved numerically with the newton method. Hence,  $f^{-1}(3) = 1.257$ . The result was tested by evaluating  $f(1.257)$  which yielded  $y = 2.994$ .

## References

- [1] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2015.