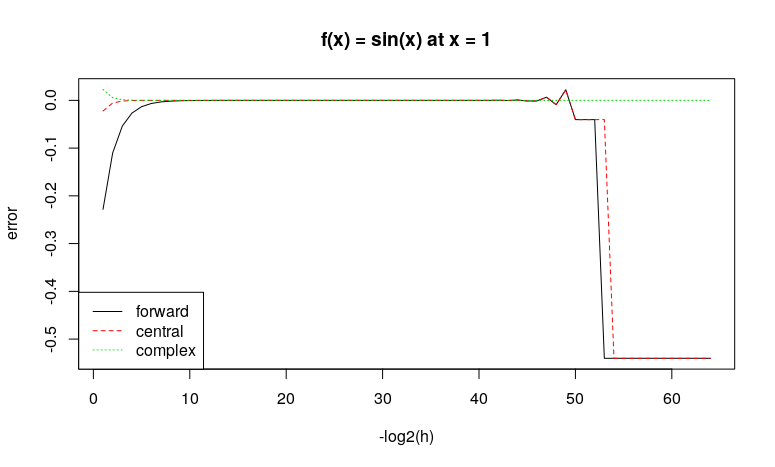
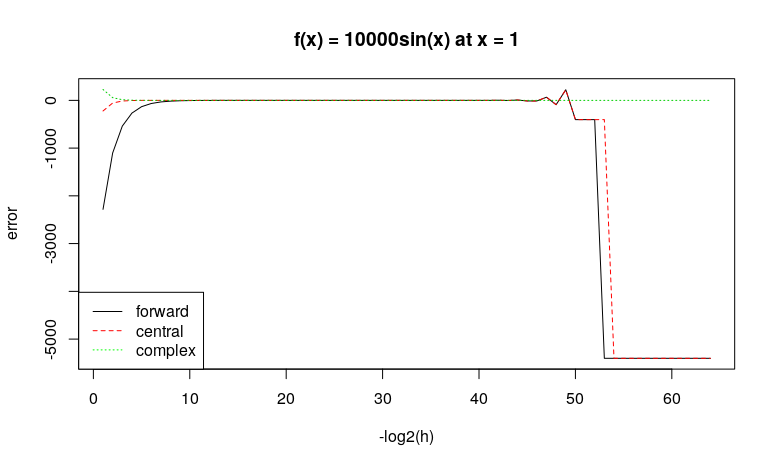
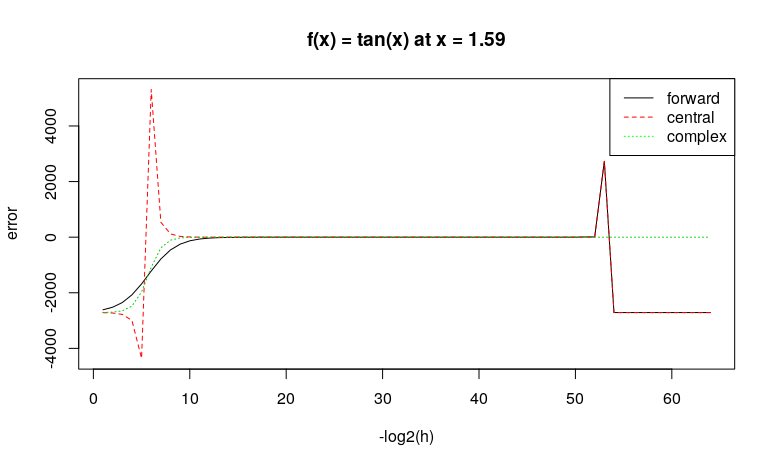
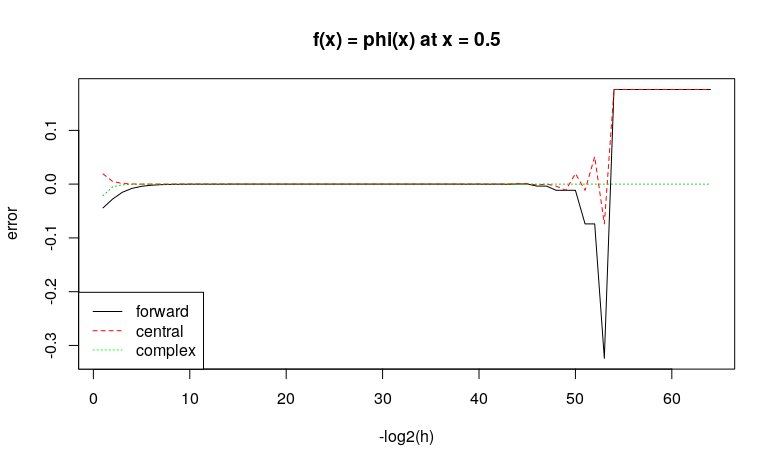
**Problem 1**

Four graphs of approximation errors againstare plotted in R respectively.









As we can see from the graphs, if the step size is too large, the approximation is not accurate. Similarly, the approximation errors will also build up due to round-off errors if the step size if too small. Among the three methods, complex differences are more stable with different step sizes. In general, central method performs better than forward method. To be concluded, a step size in the smooth area (aroundto ) of the graphs should be more appropriate for approximation.

**Problem 2**

The C program *paretodensDotC.c* and R program *paretodensDotC.R* are attached in Appendix. I used the following code to compile *paretodensDotC.c* and create shared objects for loading into R.

R CMD SHLIB paretodensDotC.c -Wall -pedantic

In Rstudio, I used dyn.load("paretodensDotC.so") to load the shared object file I just created. Then I can use the R function paretodensDotC I defined in *paretodensDotC.R* with .C interface to call my C function. I used the following code to test it.

paretodensDotC(3, 2, 1)

paretodensDotC(1, 2, 3)

paretodensDotC(3, -2, 1)

paretodensDotC(3, 2, -1)

paretodensDotC(3 : 5, 2, 1)

paretodensDotC(1 : 5, 2, 1)

paretodensDotC(6, 2 : 4, 1)

paretodensDotC(3, 2, 1, log = TRUE)

The results are as follows.

> paretodensDotC(3, 2, 1)

[1] 0.2222222

> paretodensDotC(1, 2, 3)

[1] 0

> paretodensDotC(3, -2, 1)

[1] NaN

Warning message:

In paretodensDotC(3, -2, 1) : NaNs produced

> paretodensDotC(3, 2, -1)

[1] NaN

Warning message:

In paretodensDotC(3, 2, -1) : NaNs produced

> paretodensDotC(3 : 5, 2, 1)

[1] 0.2222222 0.1250000 0.0800000

> paretodensDotC(1 : 5, 2, 1)

[1] 0.0000000 0.0000000 0.2222222 0.1250000 0.0800000

> paretodensDotC(6, 2 : 4, 1)

[1] 0.05555556 0.08333333 0.11111111

> paretodensDotC(3, 2, 1, log = TRUE)

[1] -1.504077