DATA 605 - Discussion 14

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Assignment

Using `R`, provide the solution for any exercise in either Chapter 4 or Chapter 7 of the calculus textbook.

Newton's Method

In Exercises 9 – 12, use Newton's Method to approximate all roots of the given functions accurate to 3 places after the decimal. If an interval is given, find only the roots that lie in that interval. Use technology to obtain good initial approximations.

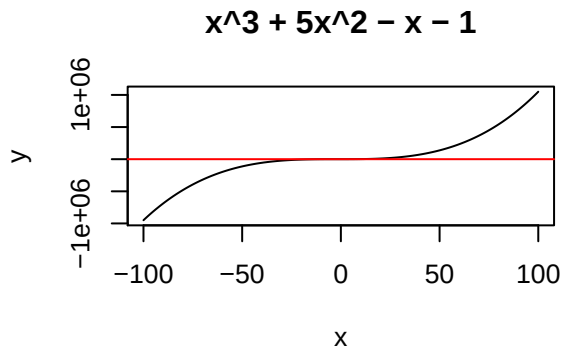
Problem 9

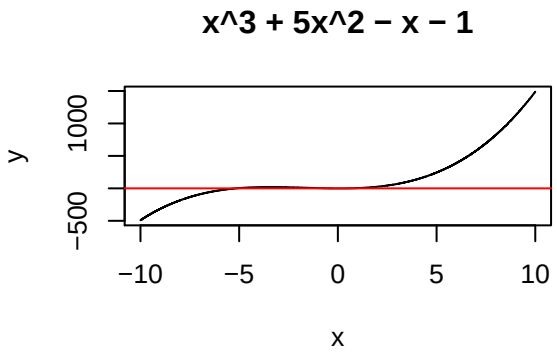
$f(x) = x^3 + 5x^2 - x - 1$

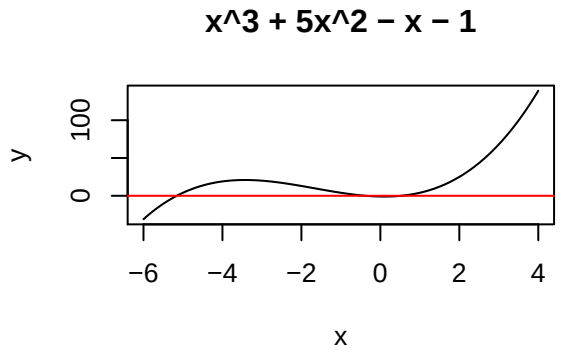
Plot and zoom in. There appear to be three roots at $x \approx \{-5.1, -0.4, 0.51\}$

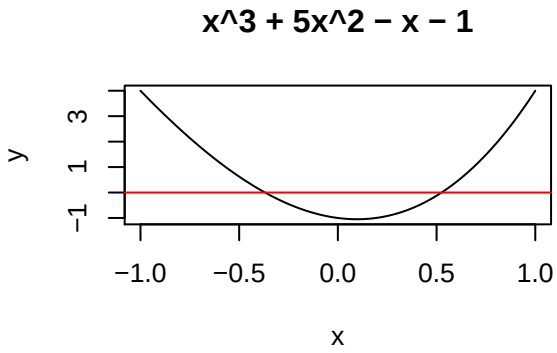
```
f <- function(x) {
  return (x^3 + 5 * x^2 - x - 1)
}

f_prime <- function(x) {
  return (3 * x^2 + 10 * x - 1)
}

par(mfrow = c(2, 2))
x <- seq(from = -100, to = 100, by = 0.1)
y <- f(x)
plot(x, y, type = "l",
     main = "x^3 + 5x^2 - x - 1")
abline(h = 0, col = "red")

x <- seq(from = -10, to = 10, by = 0.001)
y <- f(x)
plot(x, y, type = "l",
     main = "x^3 + 5x^2 - x - 1")
abline(h = 0, col = "red")

x <- seq(from = -6, to = 4, by = 0.001)
y <- f(x)
plot(x, y, type = "l",
     main = "x^3 + 5x^2 - x - 1")
abline(h = 0, col = "red")

x <- seq(from = -1, to = 1, by = 0.001)
y <- f(x)
```

```r
plot(x, y, type = "l",
     main = "x^3 + 5x^2 - x - 1")
abline(h = 0, col = "red")
```










```r
x.0 <- -5.1
x.1 <- x.0 - (f(x.0) / f_prime(x.0))
x.2 <- x.1 - (f(x.1) / f_prime(x.1))
x.3 <- x.2 - (f(x.2) / f_prime(x.2))
x.4 <- x.3 - (f(x.3) / f_prime(x.3))
x.5 <- x.4 - (f(x.4) / f_prime(x.4))

root.1 <- round(x.2, 3)

x.0 <- -0.4
x.1 <- x.0 - (f(x.0) / f_prime(x.0))
x.2 <- x.1 - (f(x.1) / f_prime(x.1))
x.3 <- x.2 - (f(x.2) / f_prime(x.2))
x.4 <- x.3 - (f(x.3) / f_prime(x.3))
x.5 <- x.4 - (f(x.4) / f_prime(x.4))

root.2 <- round(x.1, 3)

x.0 <- 0.51
x.1 <- x.0 - (f(x.0) / f_prime(x.0))
x.2 <- x.1 - (f(x.1) / f_prime(x.1))
```

```
x.3 <- x.2 - (f(x.2) / f_prime(x.2))
x.4 <- x.3 - (f(x.3) / f_prime(x.3))
x.5 <- x.4 - (f(x.4) / f_prime(x.4))

root.3 <- round(x.2, 3)
```

Answer

- Root 1: -5.156
- Root 2: -0.37
- Root 3: 0.525

The visual estimates from my initial plots were very close, got me to a good start.

Post Script

Nice to have

- This was a manual approach worked out with copying and pasting. A return to this would motivate refactoring.
  - Iteration.
  - Test condition in loop to fall out once desired precision is reached.
  - Need to specify maximum number of iterations. Must exit the loop even if Newton's Method diverges.
- Plots.
  - It would be nice to see visuals of the tangent.
  - Would Shiny do this? What I'd really like to see is an animation. A second or two on each estimate. Watch the estimates move.

Lessons learned

It might not seem like much, but those plots (which were required in the assignment anyway) helped me a lot. My whole life I've been a "hero" when it comes to drawing, meaning I don't bother to do it. I think I should be able to see what's going on and simply go straight to coding. Not good. I don't write enough, either, unless it's a procedure that requires an outline.

This was one of my big self-confrontations in this course. **Draw pictures! A lot!** A lot of the difficulties I've experienced in this course have been about not having a baseline understanding of the problem at hand.

New habits

- Daily working of solved problems whose answers I can check. I spend four hours a day on just this.
- Keep a pad of paper and pen at hand. Always. Use them as much as the computer keyboard.
- Draw a picture first. Every. Time. (Or plot in `R`.) See everything. I'm not a baby if I need that.

This course has been very developmental for me.