STAT 33A Homework 1

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This homework is due **Sep 10, 2020** by 11:59pm PT.

Homeworks are graded for correctness.

As you work, write your answers in this notebook. Answer questions with complete sentences, and put code in code chunks. You can make as many new code chunks as you like.

Please do not delete the exercises already in this notebook, because it may interfere with our grading tools.

You need to submit your work in two places:

- Submit this Rmd file with your edits on bCourses.
- Knit and submit the generated PDF file on Gradescope.

Exercise 1

For each function below, state whether the function is vectorized and provide a code example to support your claim.

1. `median()`
2. `exp()`
3. `^`
4. `nchar()`
5. `sd()`

YOUR ANSWER GOES HERE:

1. Not vectorized (Ex. `median(c(1,2,3,4,4))`)
2. Vectorized (Ex. `exp(c(1,2,3,4,5))`)
3. Vectorized (Ex. `c(1,2,3)^6`)
4. Vectorized (Ex. `nchar(c("hi","my","name","lithuania"))`)
5. Not Vectorized (Ex. `sd(c(3,4,5,6))`)

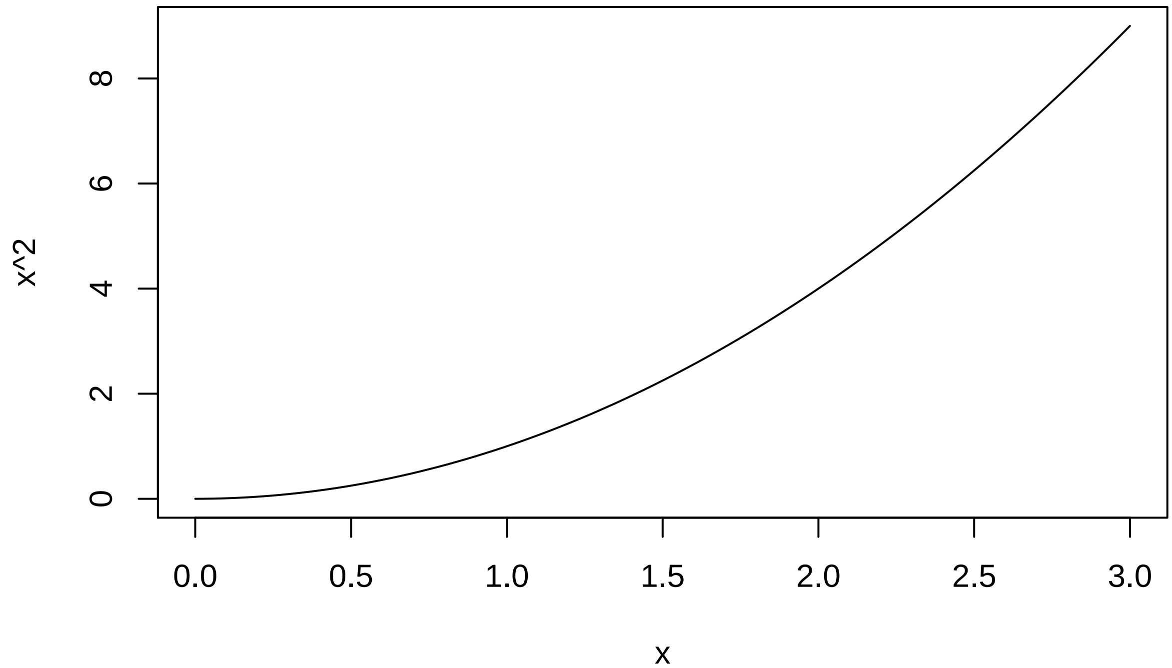
Exercise 2

Note: In R Markdown formatting, a dollar sign `$` marks the beginning of a (LaTeX) mathematical expression. For example, to format a linear equation nicely, you can write $ax + b = 0$. You don't need to know LaTeX for this class, so if you don't understand something written inside `$`, knit the PDF and read that instead.

The `curve()` function plots a curve based on an expression. The basic syntax is `curve(expr, from, to)` where `from` and `to` are the limits of the x-axis.

For example, to plot x^2 between 0 and 3:

```r
curve(x^2, 0, 3)
```



The `curve()` function makes it possible to use R as a graphing calculator.

For each expression below:

1. Plot the expression so that all points where it is 0 are visible. Experiment to find appropriate limits for the x-axis.
2. At which point(s) is the expression zero? Estimate (within 1 unit) based on your plot rather than computing these mathematically.

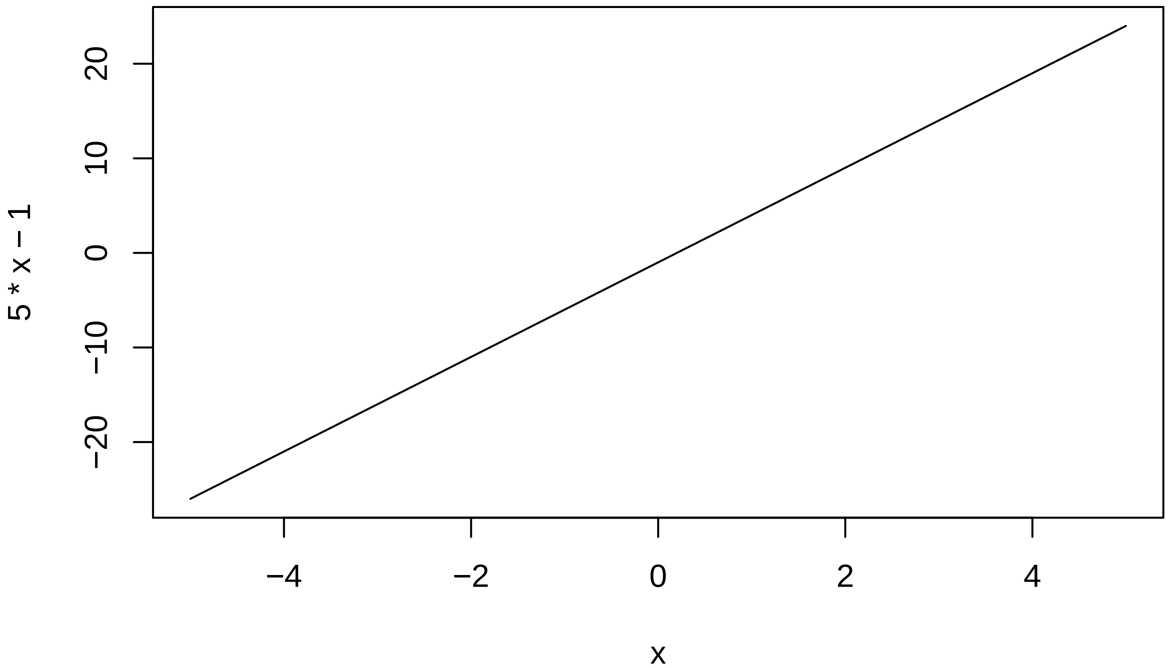
Here are the expressions:

1. $5x - 1$
2. $3x^2 - 2x - 8$
3. $\sqrt{3x} - 4$

YOUR ANSWER GOES HERE:

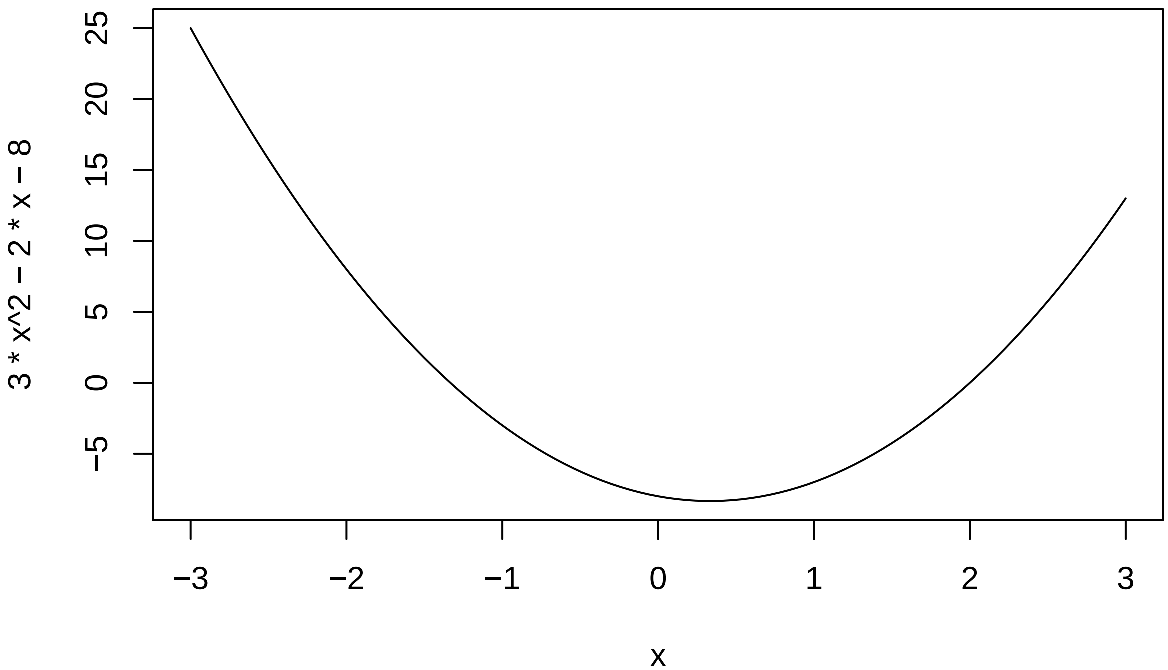
1. Plot $5x - 1$.
2. The expression is zero at x = $1/5$.

```r
curve(5*x-1, -5, 5)
```



1. Plot $3x^2 - 2x - 8$
2. The expression is zero at x = -1, 2.

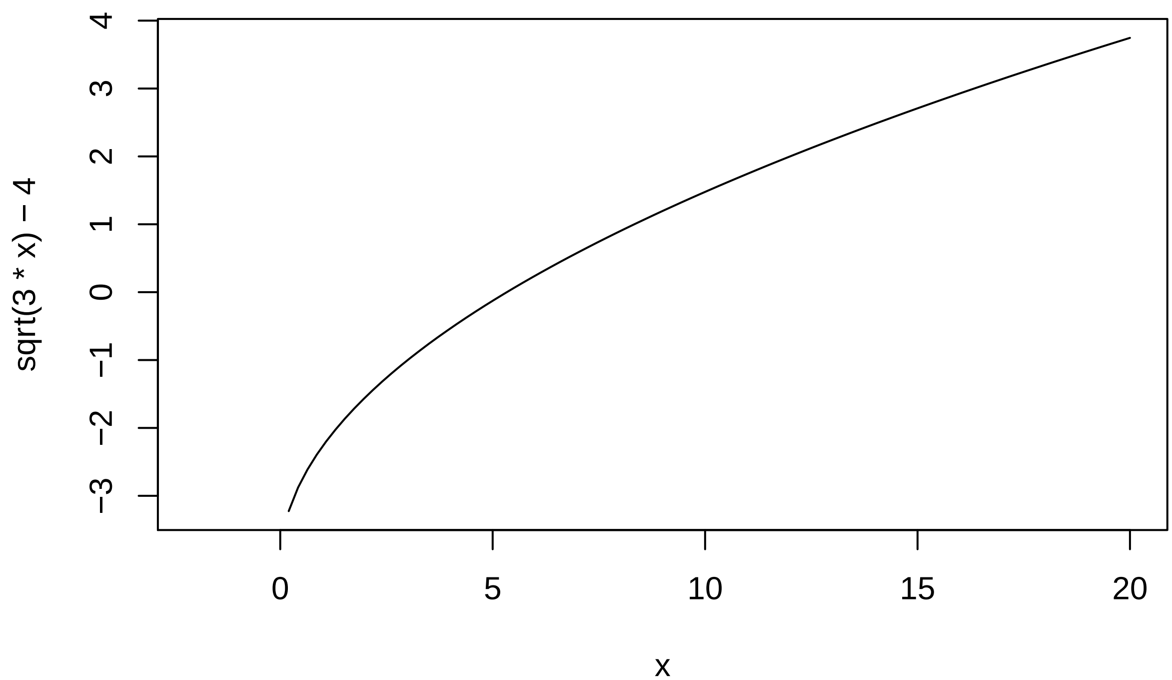
```r
curve(3*x^2-2*x-8, -3, 3)
```



1. Plot $\sqrt{3x} - 4$
2. The expression is zero at x = 16/3.

```
curve(sqrt(3*x)-4, -2, 20)
```

```
## Warning in sqrt(3 * x): NaNs produced
```



Exercise 3

The quadratic formula is a straightfoward way to find the solutions to a quadratic equation $ax^2 + bx + c = 0$. You can view the formula and read more about it here.

The goal of this exercise is to implement the quadratic formula in R. You'll use variables so that the code is reusable.

1. Create R variables `a`, `b`, and `c` that correspond to the coefficients in the quadratic equation $x^2 - 16 = 0$.

The quadratic formula computes two different values, depending on whether you add or subtract the radical. We'll call these the "plus" and "minus" solutions.

2. Use R to compute the "plus" solution of the quadratic formula for the variables you created in step 1. Make sure to **use the variables**, not hard-coded numbers.

   Assign the result to a variable named `plus`.

3. Use R to check that the computed `plus` solution is in fact a solution. In other words, use R to compute the value of $ax^2 + bx + c$ for x equal to `plus`. Once again, make sure to **use the variables** from step 1 and 2, not hard-coded numbers.

4. Repeat steps 2-3 for the "minus" solution. This time, name the step 2 variable `minus`.

   What are the two solutions?

5. Now compute solutions for $3x^2 - 2x - 8 = 0$. Copy and paste your code from steps 1-4 into a new code chunk. In the copied code, edit the values of `a`, `b`, and `c` in step 1. Do not edit the code for any other step.

   Run your code line-by-line to check that it still produces the correct solutions.

   What are the two solutions?

YOUR ANSWER GOES HERE:

1. Create R variables `a`, `b`, and `c` that correspond to the coefficients in the quadratic equation $x^2 - 16 = 0$.

```
a = 1
b = 0
c = -16
```

2. Compute the "plus" solution of the quadratic formula.

```
plus = (-b + sqrt(b^2-4*a*c)) / (2*a)
```

3. Check that the computed `plus` solution is in fact a solution.

```
a*plus^2 + b*plus + c == 0
```

```
## [1] TRUE
```

4. Compute the "minus" solution of the quadratic formula.

```
minus = (-b - sqrt(b^2-4*a*c)) / (2*a)
```

Check that the computed `minus` solution is in fact a solution.

```
a*minus^2 + b*minus + c == 0
```

```
## [1] TRUE
```

5. Now compute solutions for $3x^2 - 2x - 8 = 0$. Copy and paste your code from steps 1-4 into a new code chunk. In the copied code, edit the values of `a`, `b`, and `c`. Run your code line-by-line to check that it still produces the correct solutions. What are the two solutions?

```
a = 3
b = -2
c = -8
plus = (-b + sqrt(b^2-4*a*c)) / (2*a)
a*plus^2 + b*plus + c == 0
```

```
## [1] TRUE
```

```r
minus = (-b - sqrt(b^2-4*a*c)) / (2*a)
a*minus^2 + b*minus + c == 0
```

```
## [1] TRUE
```

```r
plus
```

```
## [1] 2
```

```r
minus
```

```
## [1] -1.333333
```

Exercise 4

1. Are all of the functions and operators you used in step 2 of Exercise 3 vectorized?
2. Is the code you wrote for step 2 of Exercise 3 vectorized in the variables `a`, `b`, and `c`? Give an example to justify your argument.

   Hint: what happens if `a`, `b`, and `c` are vectors?

YOUR ANSWER GOES HERE:

1. Yes all the functions and operators (sqrt, +, -, *, /) for plus are vectorized.
2. Yes.

   Example #1

```r
a = c(2,2)
b = c(5,5)
c = c(2,2)
plus = (-b + sqrt(b^2-4*a*c)) / (2*a)
a*plus^2 + b*plus + c == 0
```

```
## [1] TRUE TRUE
```

```r
minus = (-b - sqrt(b^2-4*a*c)) / (2*a)
a*minus^2 + b*minus + c == 0
```

```
## [1] TRUE TRUE
```

```r
plus
```

```
## [1] -0.5 -0.5
```

```r
minus
```

```
## [1] -2 -2
```

   Example #2.Sometimes it would return NaN values because it would sqrt a negative.

```r
a = c(5,9)
b = c(9,10)
c = c(4,7)
plus = (-b + sqrt(b^2-4*a*c)) / (2*a)
```

```
## Warning in sqrt(b^2 - 4 * a * c): NaNs produced
```

```r
a*plus^2 + b*plus + c == 0
```

```
## [1] FALSE    NA
```

```r
minus = (-b - sqrt(b^2-4*a*c)) / (2*a)
```

```
## Warning in sqrt(b^2 - 4 * a * c): NaNs produced
```

```r
a*minus^2 + b*minus + c == 0
```

```
## [1] TRUE   NA
```

```r
plus
```

```
## [1] -0.8  NaN
```

```r
minus
```

```
## [1]  -1 NaN
```