Introduction to Normal Distribution

your name

2024-10-3

Math 2265 Sec 4.1 Normal Distribution Part I

- Work as a group!
- You will need to replace `"ans"` or `your_answer` in the source code or answer questions
- Update your name in L3
- Add your group members name below
- Make sure your save and `knit` your work (to html or pdf) before submitting it to Canvas

Question 0. Who are your group members? (List their first names should be sufficient)

Answer:

1. `<name_1>`
2. `<name_2>`

Load Packages

```
## Loading required package: airports
```

```
## Loading required package: cherryblossom
```

```
## Loading required package: usdata
```

```
## Registered S3 method overwritten by 'mosaic':
##   method                           from
##   fortify.SpatialPolygonsDataFrame ggplot2
```

```
##
## The 'mosaic' package masks several functions from core packages in order to add
## additional features.  The original behavior of these functions should not be affected by this.
```

```
##
## Attaching package: 'mosaic'
```

```
## The following objects are masked from 'package:dplyr':
##
##     count, do, tally
```

```
## The following object is masked from 'package:Matrix':
##
##     mean
```

```
## The following object is masked from 'package:ggplot2':
##
##     stat
```

```
## The following object is masked from 'package:openintro':
##
```

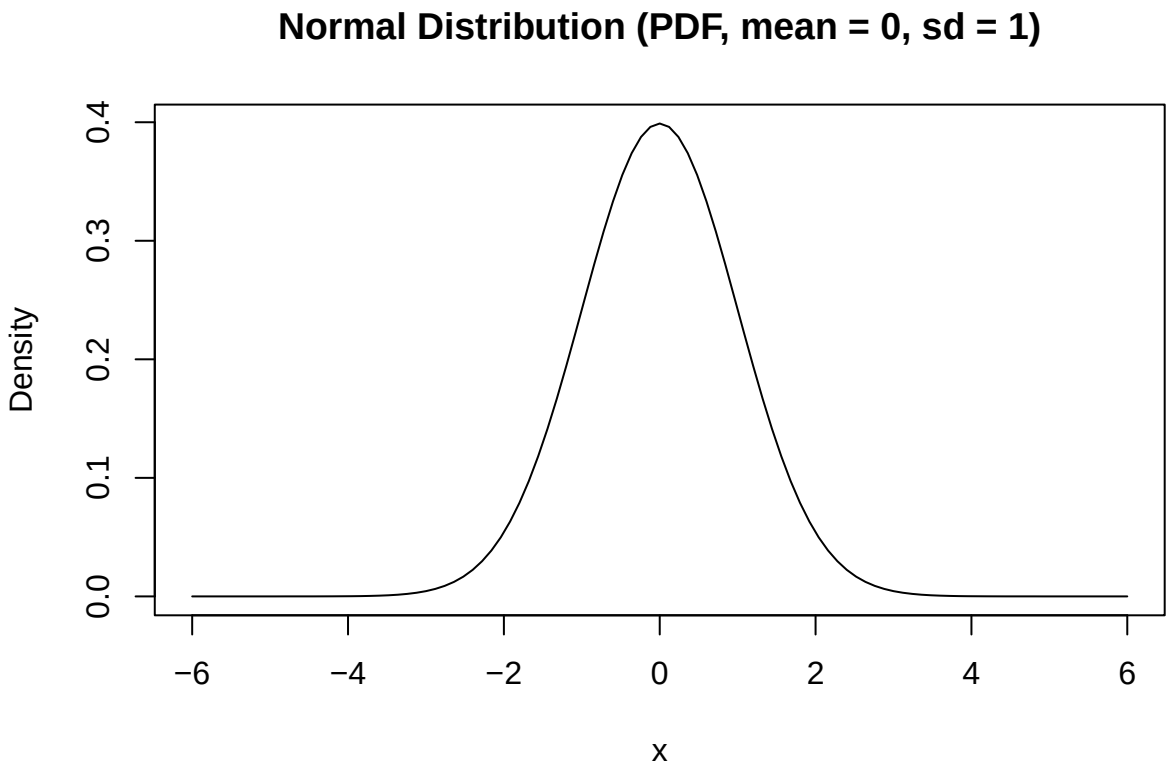
```
##     dotPlot
## The following objects are masked from 'package:stats':
##
##     binom.test, cor, cor.test, cov, fivenum, IQR, median, prop.test,
##     quantile, sd, t.test, var
## The following objects are masked from 'package:base':
##
##     max, mean, min, prod, range, sample, sum
```

If you need more time to get used to `Markdown`, use the `Visual` mode.

The icon is located in the upper-left corner next to `source`.

Example 1: Plot normal distributions

```r
curve(dnorm(x, mean = 0, sd = 1), from = -6, to = 6,
      main = "Normal Distribution (PDF, mean = 0, sd = 1)",
      xlab = "x", ylab = "Density")
```

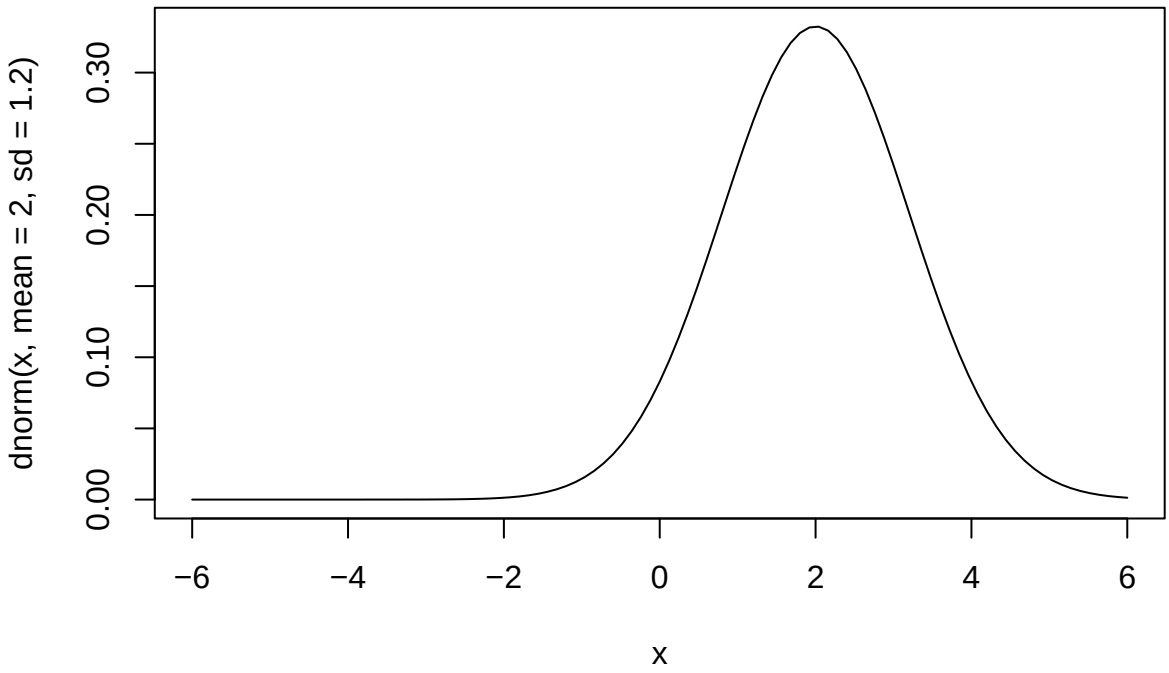


Task 1: Plot some normal distributions with mean and standard deviation of your choice

You may need to change `from` and `to` parameters too.

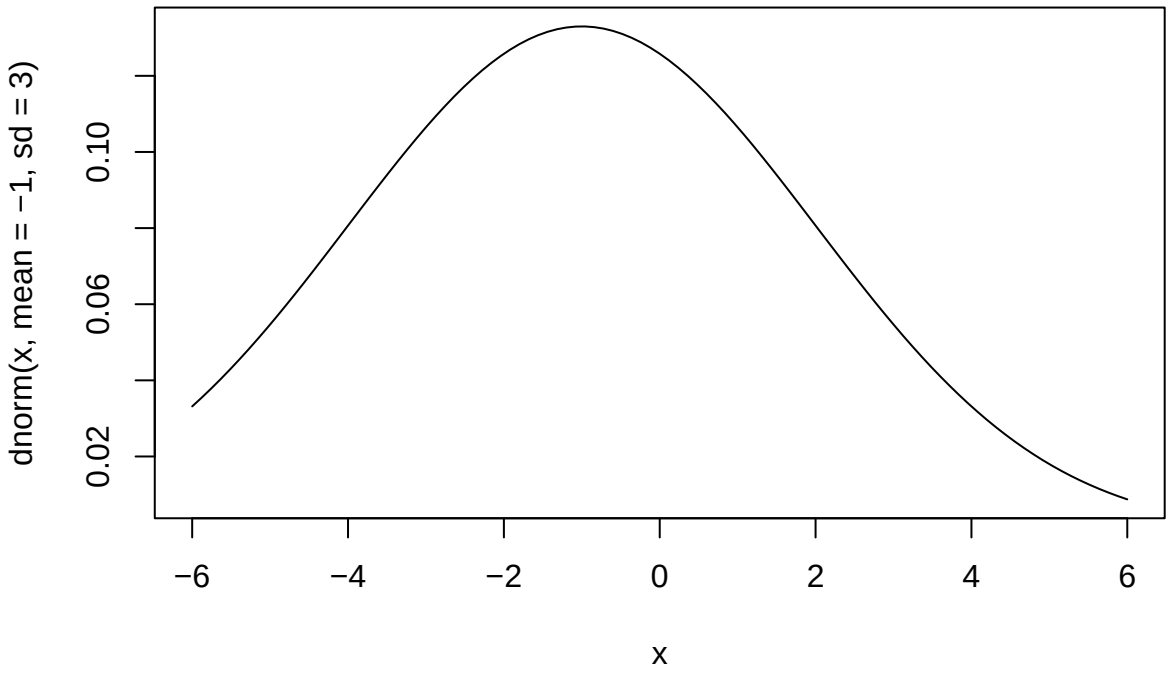
Your Example 1:

```r
curve(dnorm(x, mean = 2, sd = 1.2), from = -6, to = 6)
```



Your Example 2:

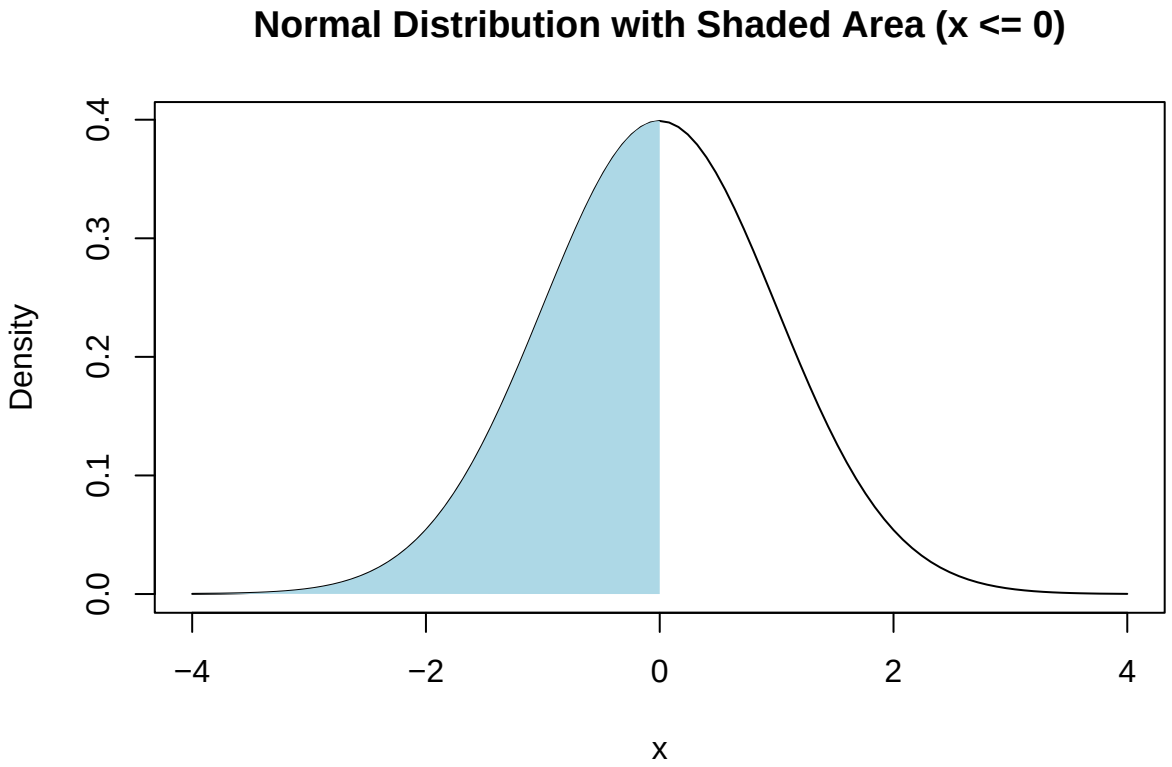
```r
curve(dnorm(x, mean = -1, sd = 3), from = -6, to = 6)
```



Example 2: Normal distribution with colors

```r
# Plot the normal distribution curve
curve(dnorm(x, mean = 0, sd = 1), from = -4, to = 4,
      main = "Normal Distribution with Shaded Area (x <= 0)",
      xlab = "x", ylab = "Density")
```

```r
# Shade the area under the curve for x <= 0
x_vals <- seq(-4, 0, length.out = 100)  # Sequence of x values from -4 to 0
y_vals <- dnorm(x_vals, mean = 0, sd = 1)  # Corresponding y values for the curve
polygon(c(x_vals, 0), c(y_vals, 0), col = "lightblue", border = NA)  # Fill the area
```

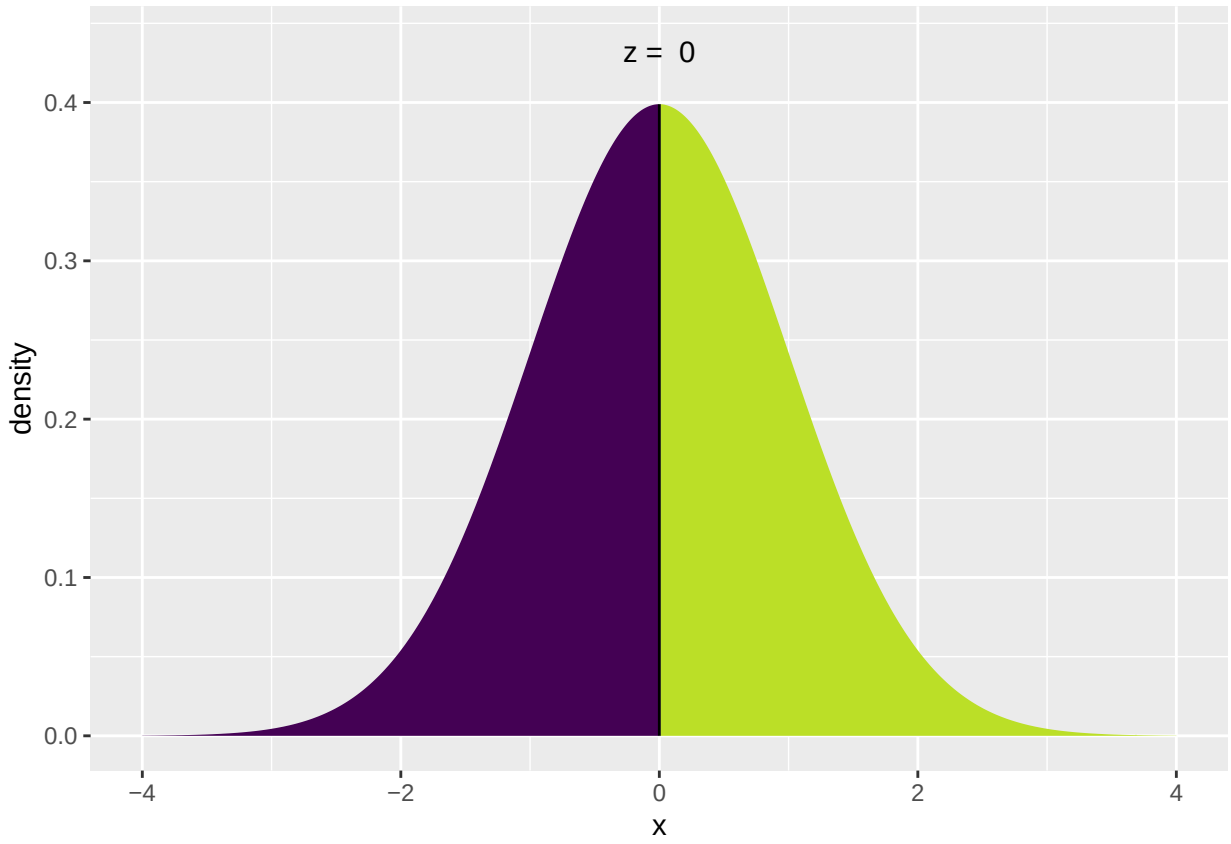


This example is excellent but a bit involved. We will use another package `mosaic` for plotting normal distributions.

Example with the `Mosaic` pacakge

```r
xpnorm(0) # if we skip mean and sd, the default values are mean = 0 and sd = 1
```

```
##
## If X ~ N(0, 1), then
##  P(X <= 0) = P(Z <= 0) = 0.5
##  P(X >  0) = P(Z >  0) = 0.5
##
```

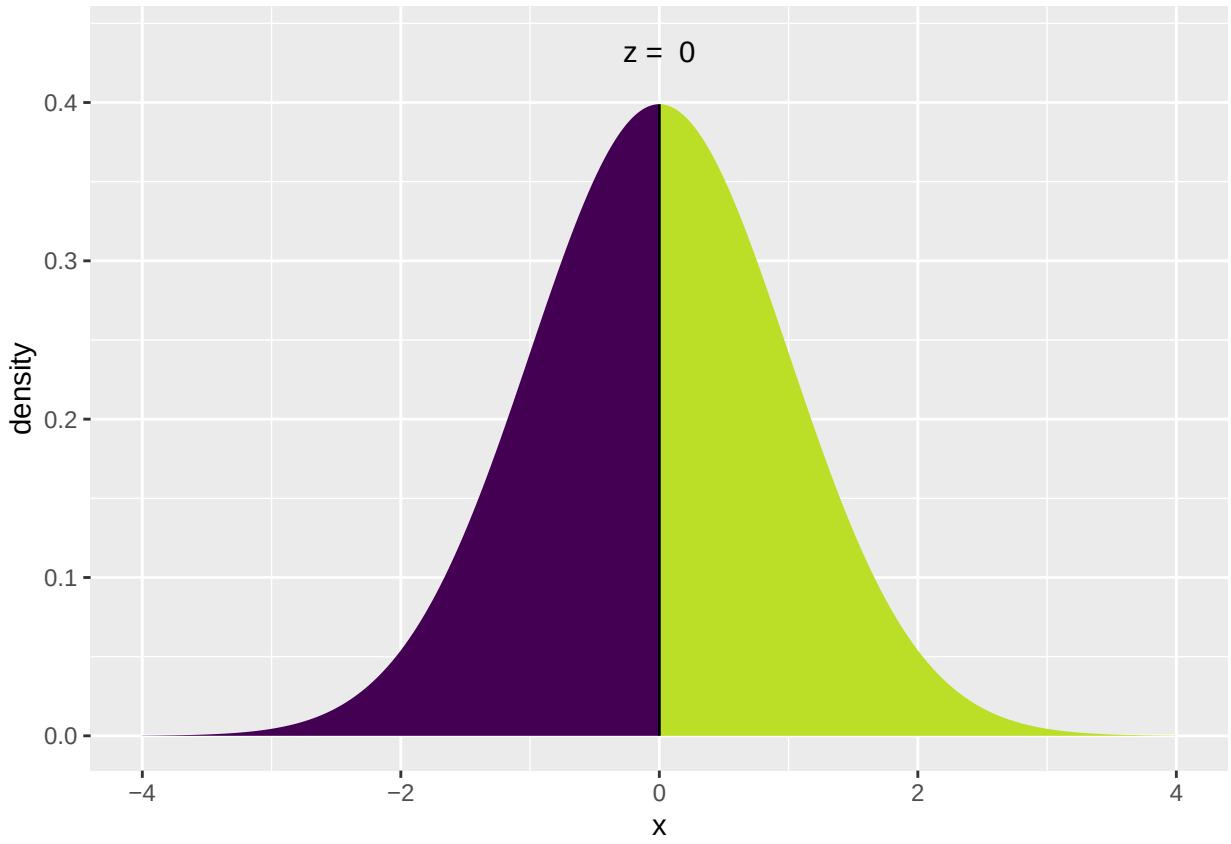



```
## [1] 0.5
```

So the following is the same as above.

```
xpnorm(0, mean = 0, sd = 1)
```

```
##
## If X ~ N(0, 1), then
##  P(X <= 0) = P(Z <= 0) = 0.5
##  P(X >  0) = P(Z >  0) = 0.5
##
```




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

The first argument (0 in the example) is the x-value or Z-score when mean = 0 and sd = 1.

Z-Score

The possums example in the video follows the normal distribution with mean 92.6 and sd 3.6.

Recall the Z-score formula.

$$Z = \frac{x - \mu}{\sigma},$$

where μ is the mean and σ is the standard deviation.

Task 2: Therefore, when $x = 98$, the Z-score is

```
(98 -92.6)/3.6
```

```
## [1] 1.5
```

Therefore, when $x = 89$, the Z-score is

```
(89 -92.6)/3.6
```

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

Task 3: Compute the Z-Score and percentile (with table and `pnorm`)

The `pnorm` function will give you the percentile of the Z-score. Here is an example.

```
pnorm(0)
```

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

Use `pnorm` to compute the percentile for the two Z-score you computed for x = 98 and x = 89.

For x = 98,

```
pnorm(1.5)
```

```
## [1] 0.9331928
```

For x = 89,

```
pnorm(-1)
```

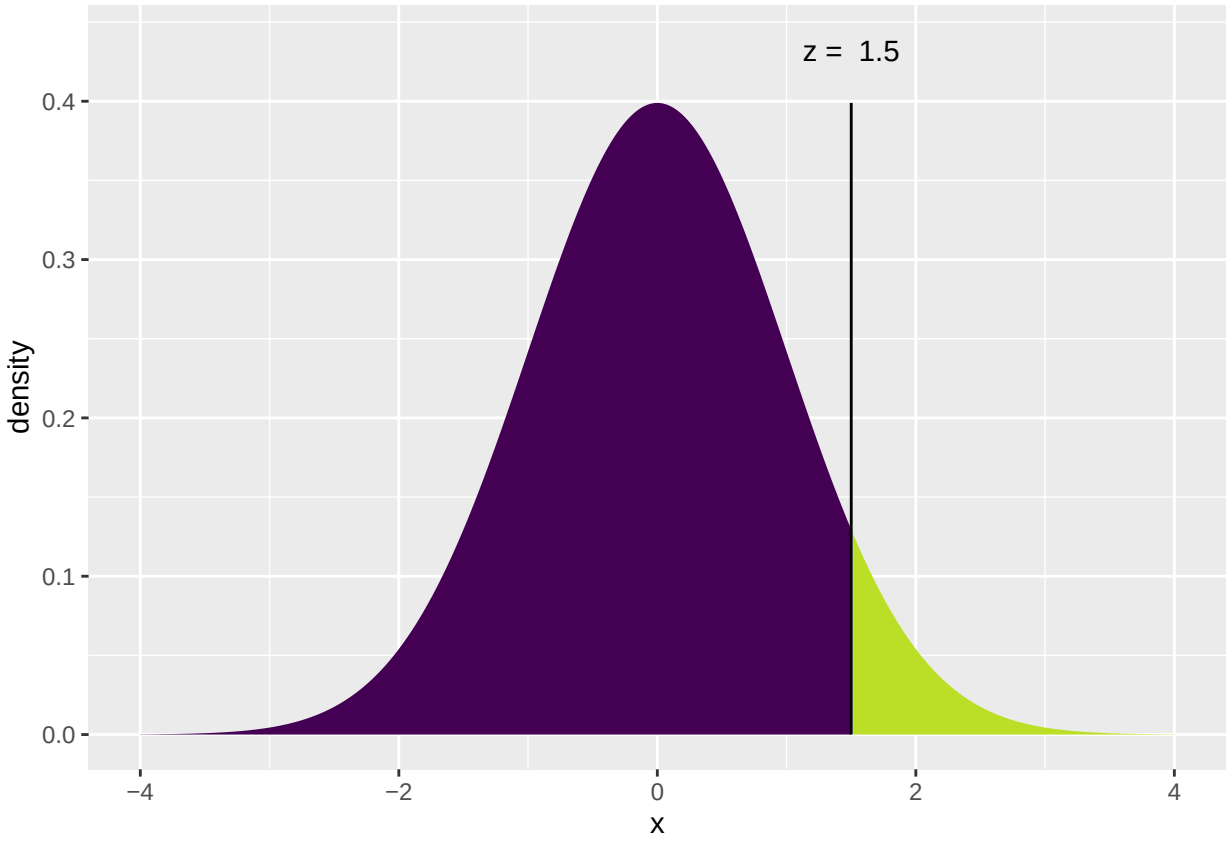
```
## [1] 0.1586553
```

Task 4: Sketch the normal distribution graphs using the function `xpnorm`

For x = 98,

```
xpnorm(1.5)
```

```
##
## If X ~ N(0, 1), then
##  P(X <= 1.5) = P(Z <= 1.5) = 0.9332
##  P(X >  1.5) = P(Z >  1.5) = 0.06681
##
```



```
## [1] 0.9331928
```

For x = 89,

```
xpnorm(-1)
```

```
##
## If X ~ N(0, 1), then
##  P(X <= -1) = P(Z <= -1) = 0.1587
##  P(X >  -1) = P(Z >  -1) = 0.8413
##
```


```
## [1] 0.1586553
```

Task 5: Try the first HW problem.

Question 1:

3.1 Area under the curve, Part I: Find the probability of each of the following, if $Z \sim N(\mu = 0, \sigma = 1)$.

a) P(Z<-1.35) =

```
q1_a <- pnorm(-1.35)
q1_a
```

```
## [1] 0.08850799
```

b) P(Z>1.48) =

```r
q1_b <- 1-pnorm(1.48)
q1_b
```

```
## [1] 0.06943662
```

c) P(-0.4< Z< 1.5) =

```r
q1_c <- pnorm(1.5) - pnorm(-0.4)
q1_c
```

```
## [1] 0.5886145
```

d) P(|Z|>2) =

```r
q1_d <- 2*pnorm(-2)
q1_d
```

```
## [1] 0.04550026
```

Task 6. Knit your code and check your outcomes.

You are only allowed to upload pdf or html

Task 7. Check your answer

```r
if(sum((c(q1_a, q1_b, q1_c, q1_d) - c(0.0885,0.0694,0.5886,0.0455))<0.001)==4) {
  print("Your answers are correct")
} else {
  print("Check your answers")
}
```

```
## [1] "Your answers are correct"
```

Share your work and help your group members before uploading your work to Canvas