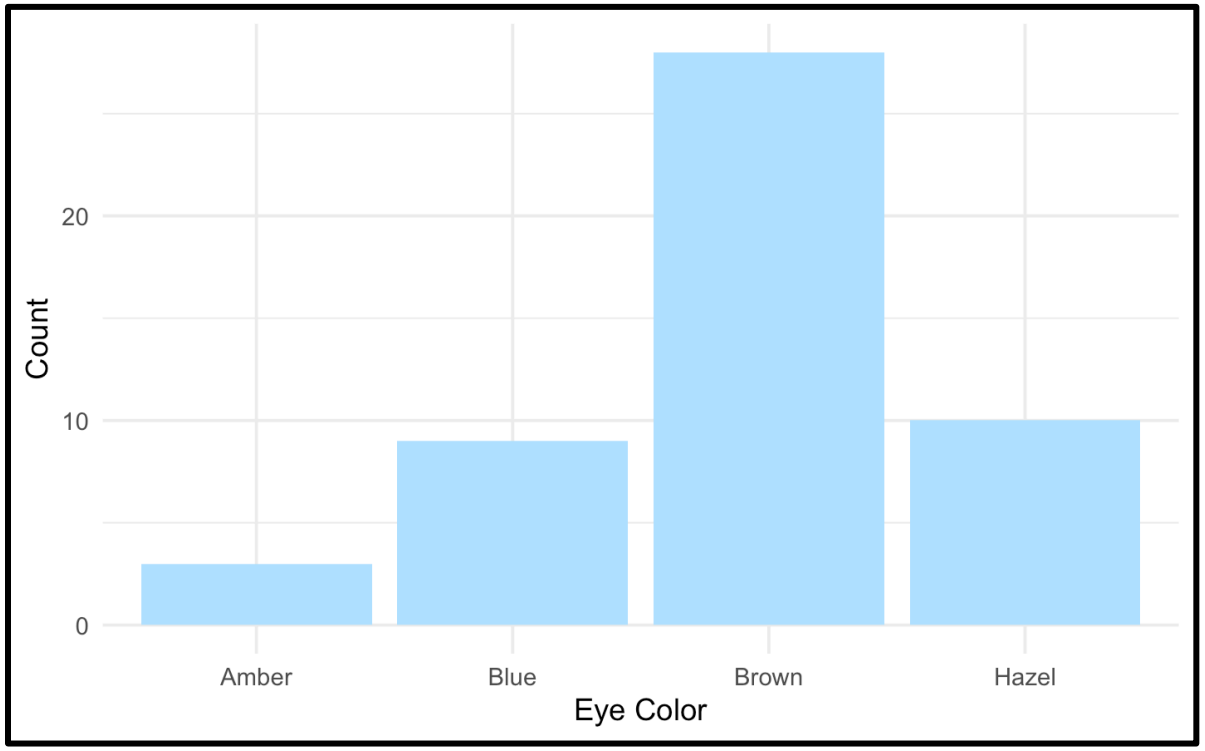
STOR 320.1
Factors

Introduction

- Read Chapter 12 (15 on-line)
- Additional Package
  - `> library(forcats)`
  - Part of the tidyverse
- For Variables with,
  - Fixed Set of Values
  - Known Set of Values
- Factors Are on a New Level

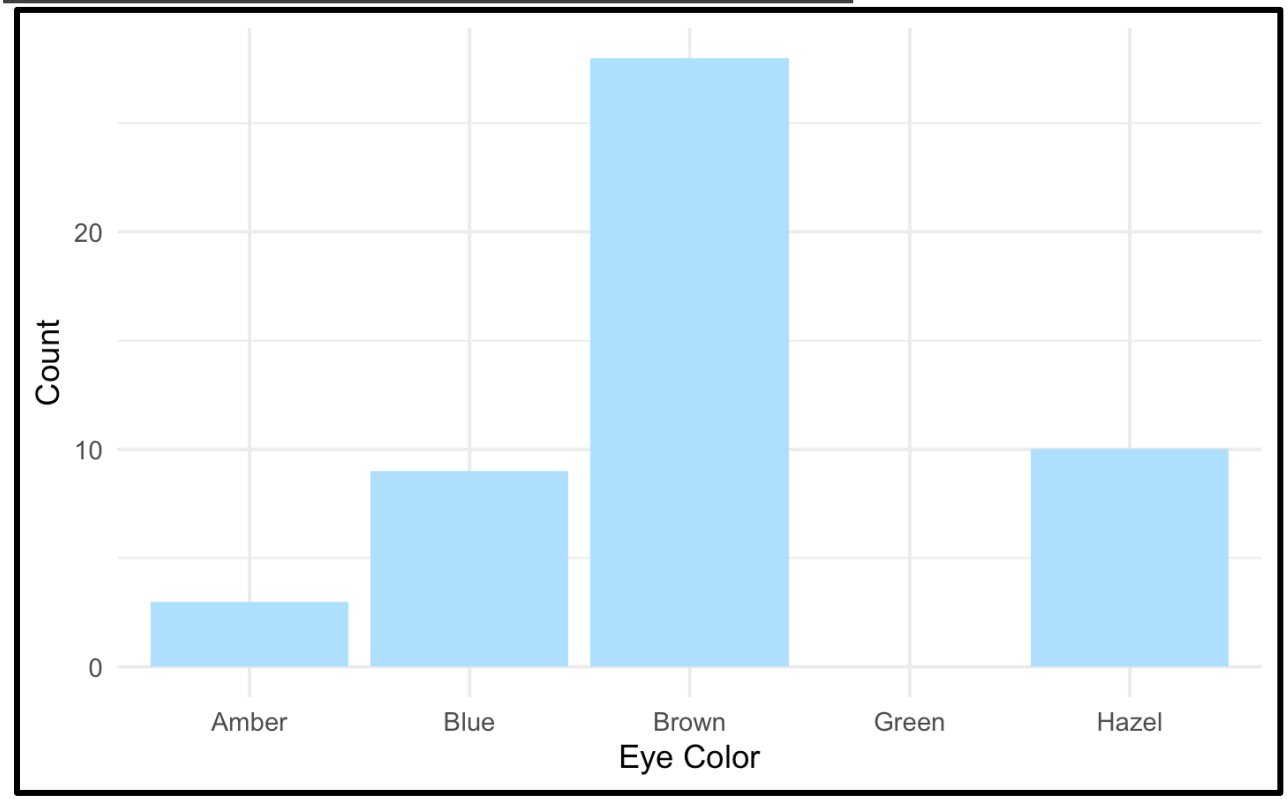
Motivation: Example 1

- Eye Color Distribution
  - Randomly Sample 50 People
  - Distribution via Bar Plot
  - How to Make More Informative?



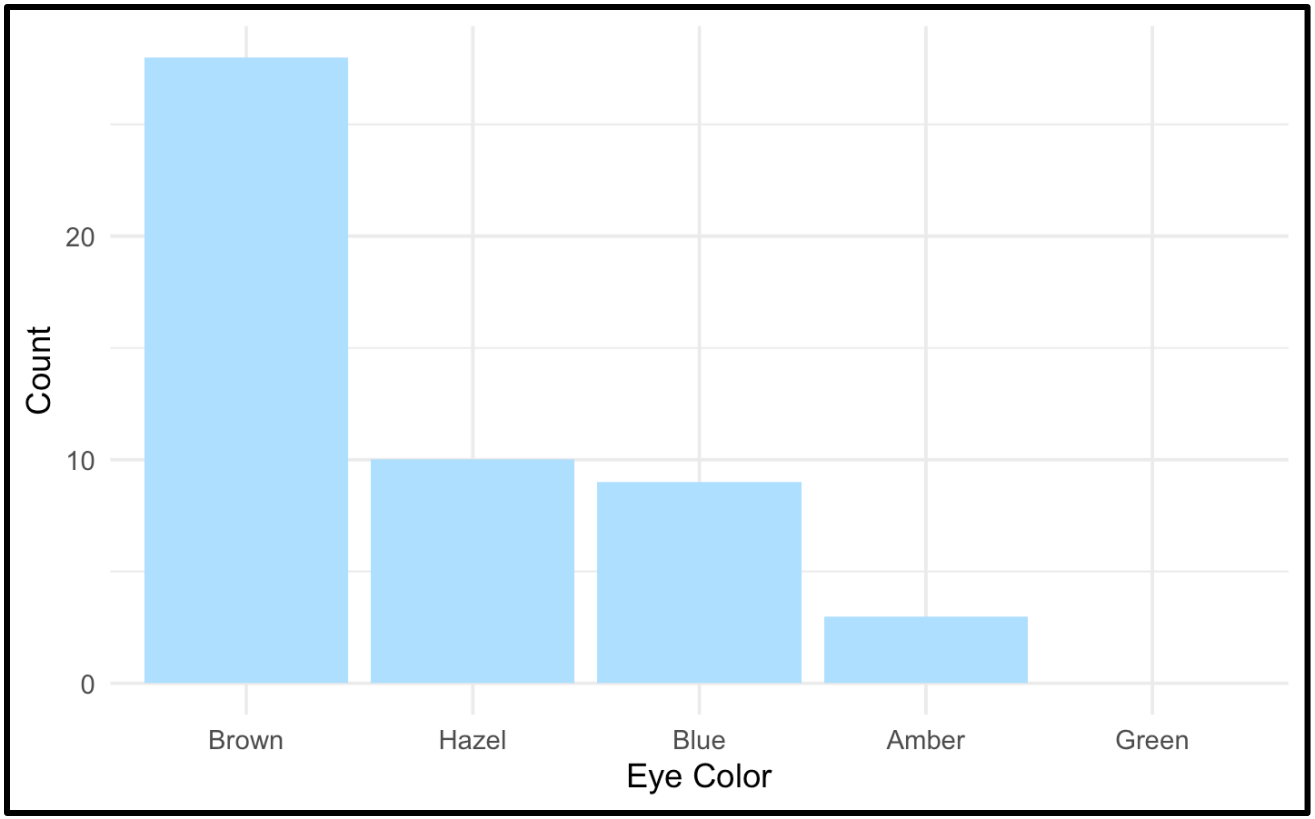
Motivation: Example 1

- Eye Color Distribution (Cont.)
  - Display Eye Colors Absent From Sample
  - `> scale_x_discrete(drop=F)`



Motivation: Example 1

- Eye Color Distribution (Cont.)
  - Display in order

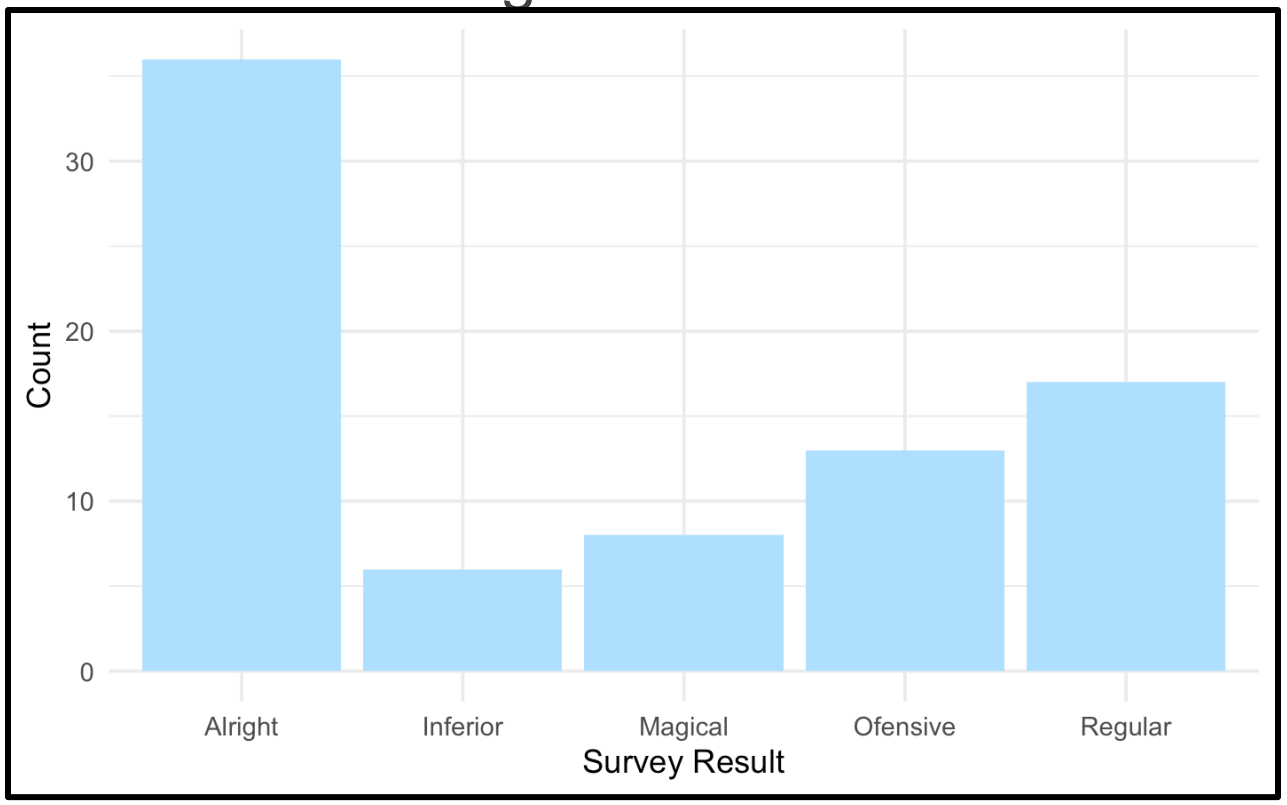


Motivation: Example 2

- Survey Results
  - How Would You Describe Dr. Example's Teaching?
    - Magical
    - Alright
    - Regular
    - Inferior
    - Offensive
  - Class of 80 Students Answer End-of-the-Year Survey

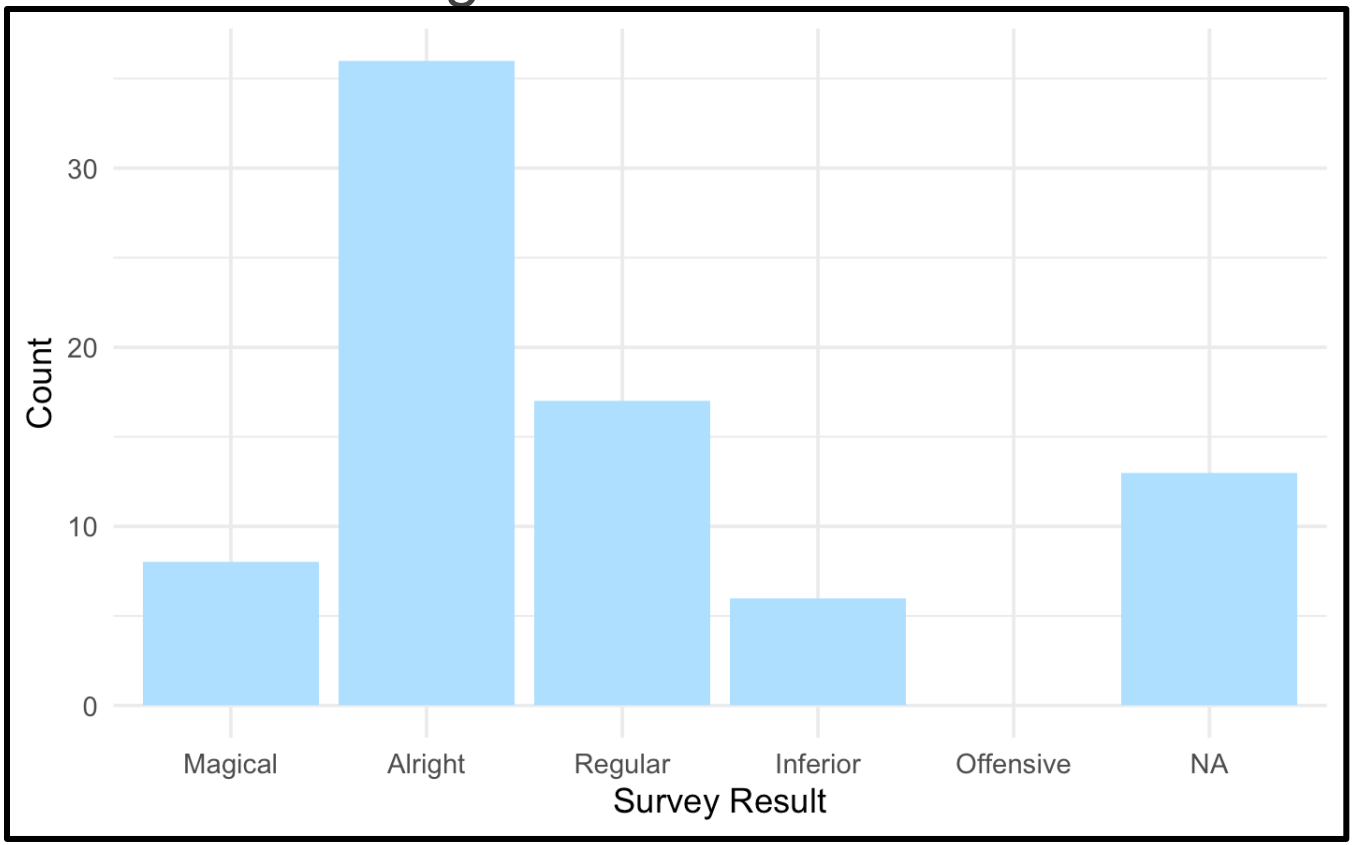
Motivation: Example 2

- Survey Results (Cont.)
  - Distribution of Results
  - What is Wrong?



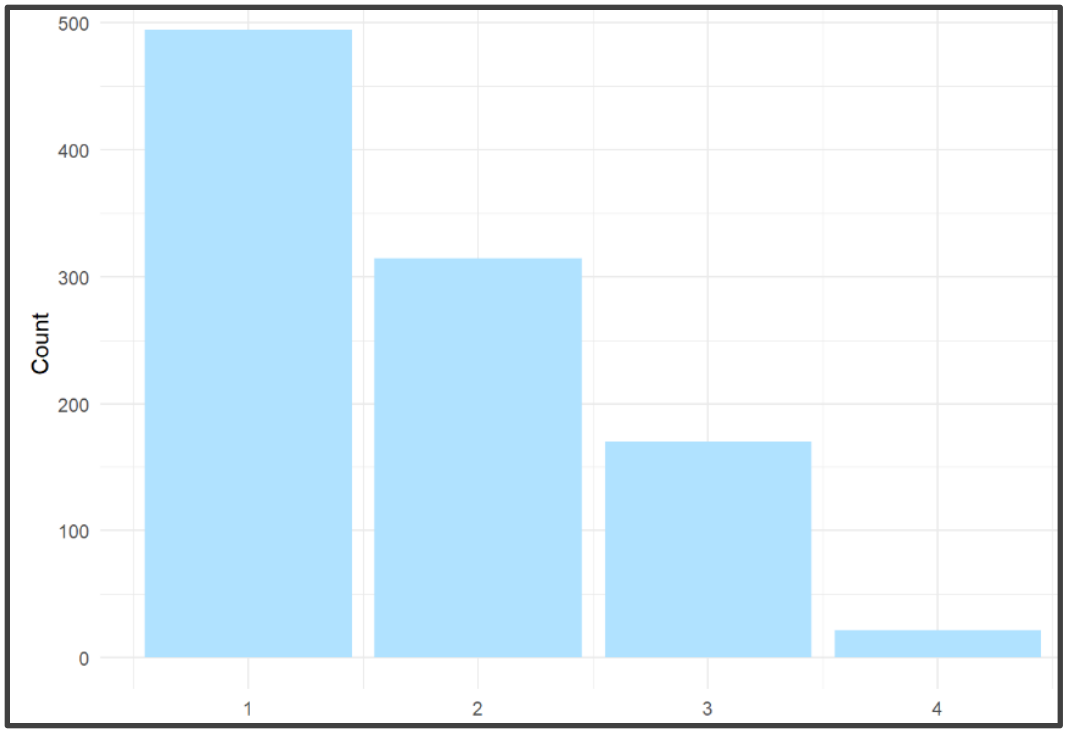
Motivation: Example 2

- Survey Results (Cont.)
  - Ordinal Categorical Variable



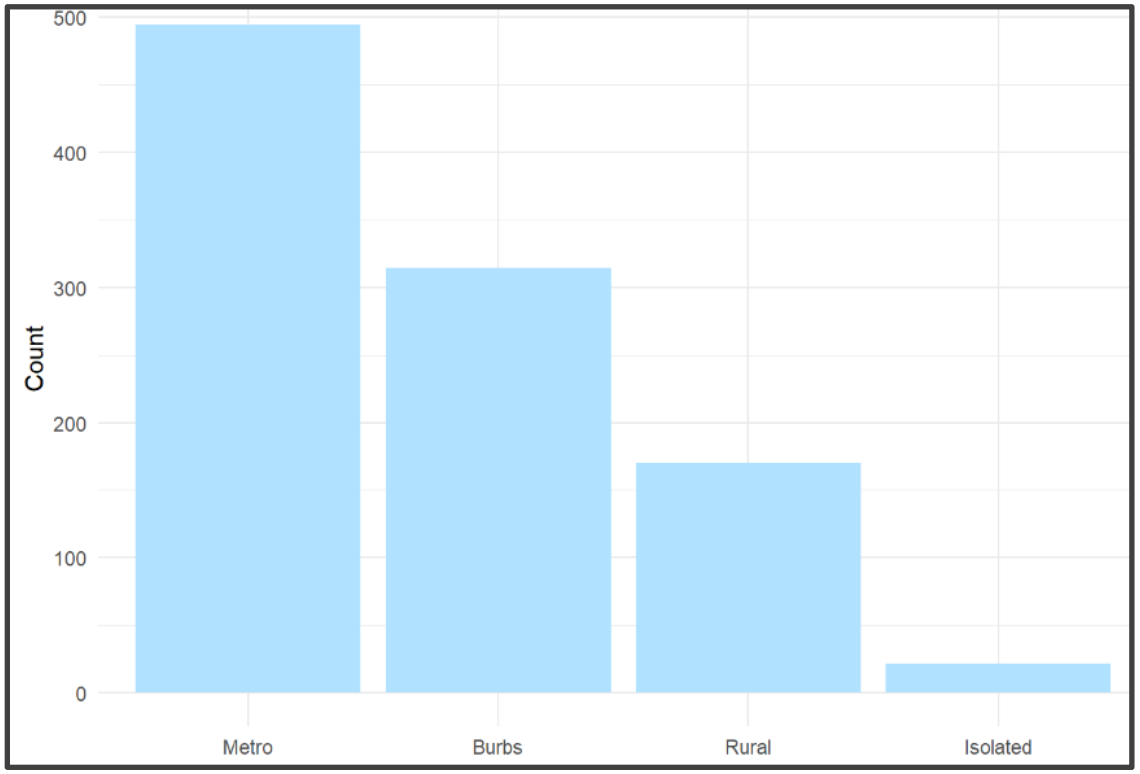
Motivation: Example 3

- Urbanicity
  - Classification {1,2,3,4}
  - Sample 1000 Households and Record Their Urbanicity
  - What Would Make this Better?



Motivation: Example 3

- Urbanicity
  - Data Dictionary
    - 1 = Metropolitan
    - 2 = Burbs
    - 3 = Rural
    - 4 = Isolated



Factor Variable Architecture

- Factor Variables Have Levels

```
Height = c("Tall","Short","Tall",
           "Tall","Short","Medium",
           "Short","Medium","Tall")
Height.fct = as.factor(Height)
print(Height)
```

```
## [1] "Tall"   "Short"  "Tall"   "Tall"   "Short"  "Medium" "Short"  "Medium"
## [9] "Tall"
```

```
levels(Height)
```

```
## NULL
```

```
print(Height.fct)
```

```
## [1] Tall   Short  Tall   Tall   Short  Medium Short  Medium Tall
## Levels: Medium Short Tall
```

```
levels(Height.fct)
```

```
## [1] "Medium" "Short"  "Tall"
```

Default: Alphabetical

Factor: Level Order

- Level Order May Be Specified

```
Height2.fct = factor(Height,levels=c("Short","Medium","Tall"))
levels(Height2.fct)
```

```
## [1] "Short"  "Medium" "Tall"
```

```
print(Height2.fct)
```

```
## [1] Tall   Short  Tall   Tall   Short  Medium Short  Medium Tall

## Levels: Short Medium Tall
```

Factor: Label

- Levels May Be Labeled

```
Height3.fct = factor(Height,levels=c("Short","Medium","Tall"),
                     labels=c("S","M","T"))
levels(Height3.fct)
```

```
## [1] "S" "M" "T"
```

```
print(Height3.fct)
```

```
## [1] T S T T S M S M T
## Levels: S M T
```

```
Height4.fct = factor(Height,levels=c("Short","Medium","Tall"),
                     labels=c("Short","Not Short","Not Short"))
levels(Height4.fct)
```

```
## [1] "Short"     "Not Short"
```

```
print(Height4.fct)
```

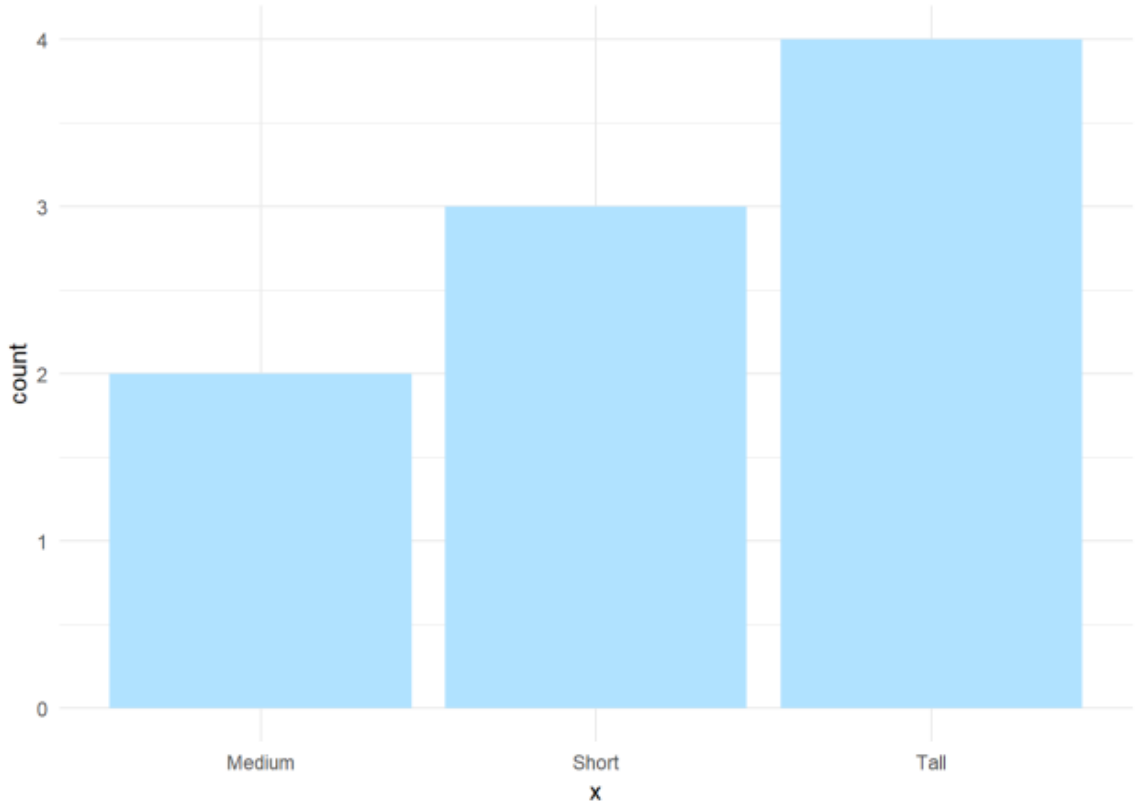
```
## [1] Not Short Short     Not Short Not Short Short     Not Short Short

## [8] Not Short Not Short
## Levels: Short Not Short
```

Graphic Comparison

```
Height.fct = as.factor(Height)
```

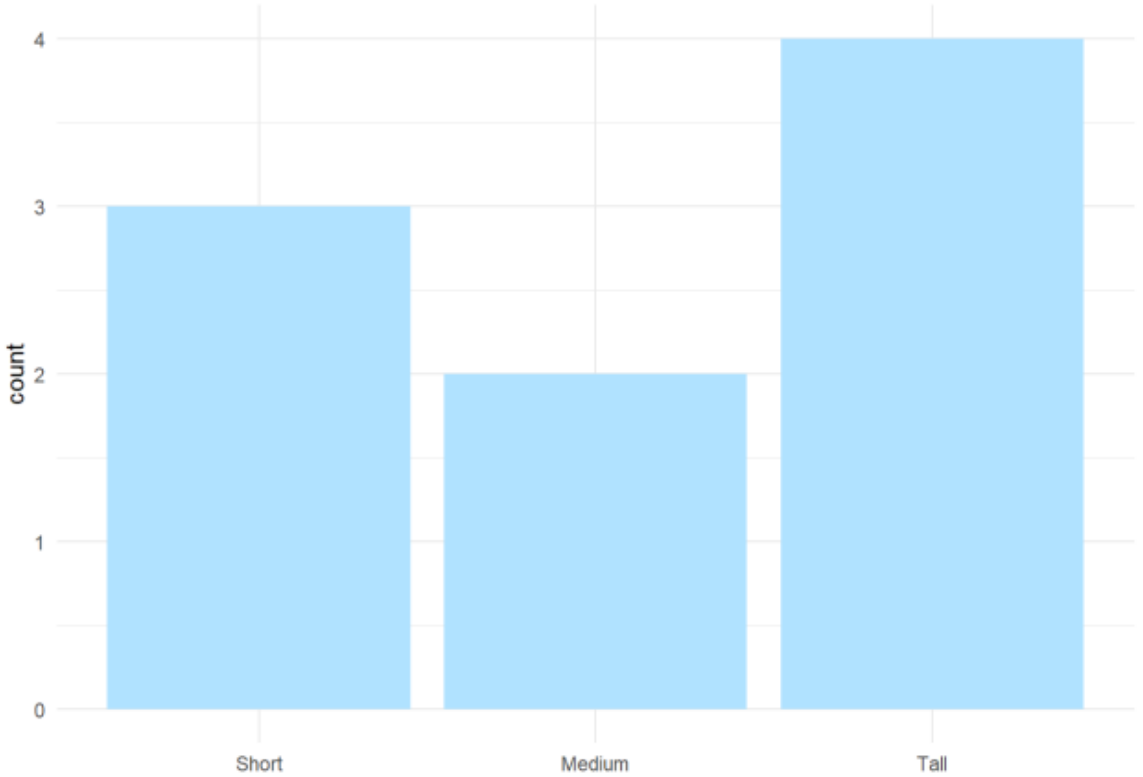
```
ggplot(data=tibble(x=Height.fct)) +
  geom_bar(aes(x),fill="lightskyblue1") +
  theme_minimal()
```



Graphic Comparison

```
Height2.fct = factor(Height,levels=c("Short","Medium","Tall"))
```

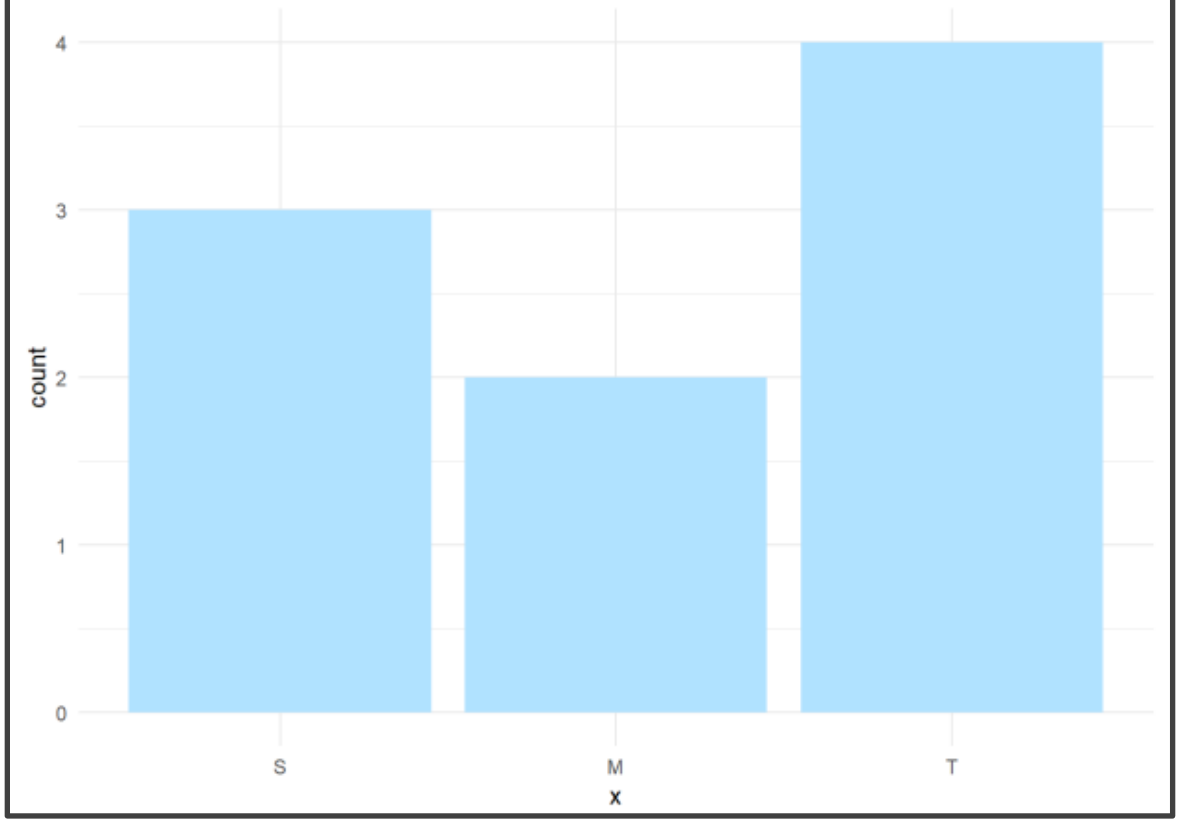
```
ggplot(data=tibble(x=Height2.fct)) +
  geom_bar(aes(x),fill="lightskyblue1") +
  theme_minimal()
```



Graphic Comparison

```
Height3.fct = factor(Height,levels=c("Short","Medium","Tall"),
                     labels=c("S","M","T"))
```

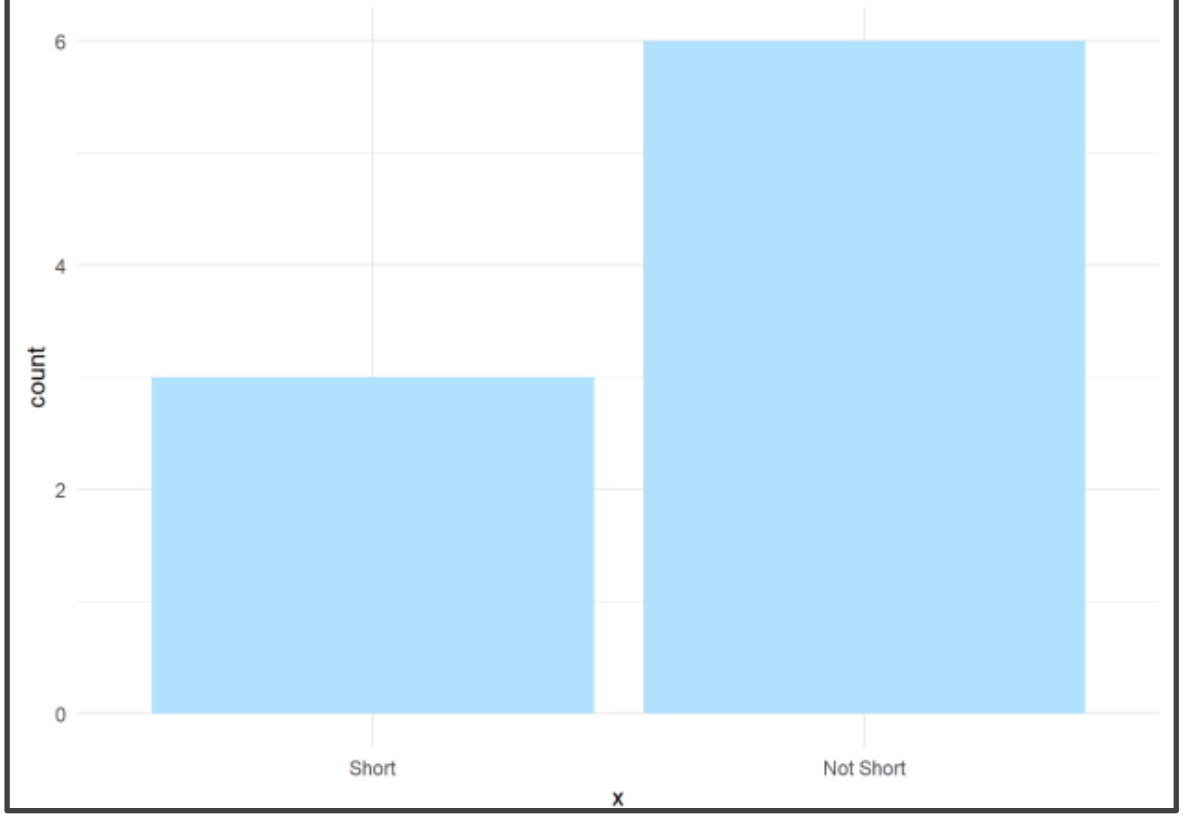
```
ggplot(data=tibble(x=Height3.fct)) +
  geom_bar(aes(x),fill="lightskyblue1") +
  theme_minimal()
```



Graphic Comparison

```
Height4.fct = factor(Height,levels=c("Short","Medium","Tall"),
                     labels=c("Short","Not Short","Not Short"))
```

```
ggplot(data=tibble(x=Height4.fct)) +
  geom_bar(aes(x),fill="lightskyblue1") +
  theme_minimal()
```



General Social Survey

- University of Chicago

General Social Survey

- Sample Provided in gss_cat

- Factor Variables Included
  - Marital
  - Race
  - Income Range
  - Political Party
  - Religion
  - Denomination

```
Social=gss_cat
glimpse(Social)
```

```
## Observations: 21,483
## Variables: 9
## $ year    <int> 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, 2000, ...
## $ marital <fct> Never married, Divorced, Widowed, Never married, Divor...
## $ age     <int> 26, 48, 67, 39, 25, 25, 36, 44, 44, 47, 53, 52, 52, 51...
## $ race    <fct> White, White, White, White, White, White, White, White...
## $ rincome <fct> $8000 to 9999, $8000 to 9999, Not applicable, Not appl...
## $ partyid <fct> Ind,near rep, Not str republican, Independent, Ind,nea...
## $ relig   <fct> Protestant, Protestant, Protestant, Orthodox-christian...
## $ denom   <fct> Southern baptist, Baptist-dk which, No denomination, N...
## $ tvhours <int> 12, NA, 2, 4, 1, NA, 3, NA, 0, 3, 2, NA, 1, NA, 1, 7, ...
```

Modifying Factor Order

- Summary by Race

```
race.summary = Social %>%
            group_by(race) %>%
            summarize(
              n=n(),
              avg.age=mean(age,na.rm=T),
              avg.tv=mean(tvhours,na.rm=T)
            )
race.summary
```

```
## # A tibble: 3 x 4
##   race      n avg.age avg.tv
##   <fct> <int>   <dbl>  <dbl>
## 1 Other  1959    39.5   2.76
## 2 Black  3129    43.9   4.18
## 3 White 16395    48.7   2.77
```

```
levels(Social$race)
```

```
## [1] "Other"          "Black"          "White"          "Not applicable"
```

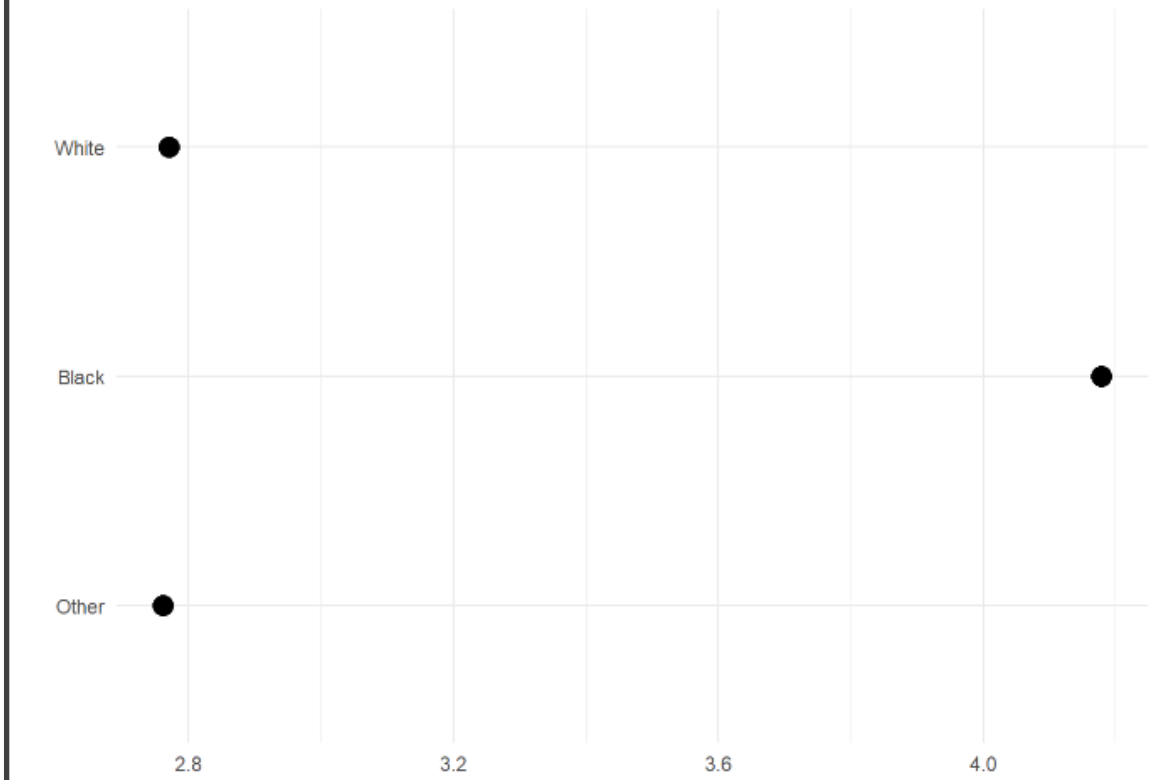
```
levels(race.summary$race)
```

```
## [1] "Other"          "Black"          "White"          "Not applicable"
```

Modifying Factor Order

- Comparing TV Hours

```
ggplot(race.summary) +
  geom_point(aes(x=avg.tv,y=race),size=4) +
  xlab("") + ylab("") +
  theme_minimal()
```



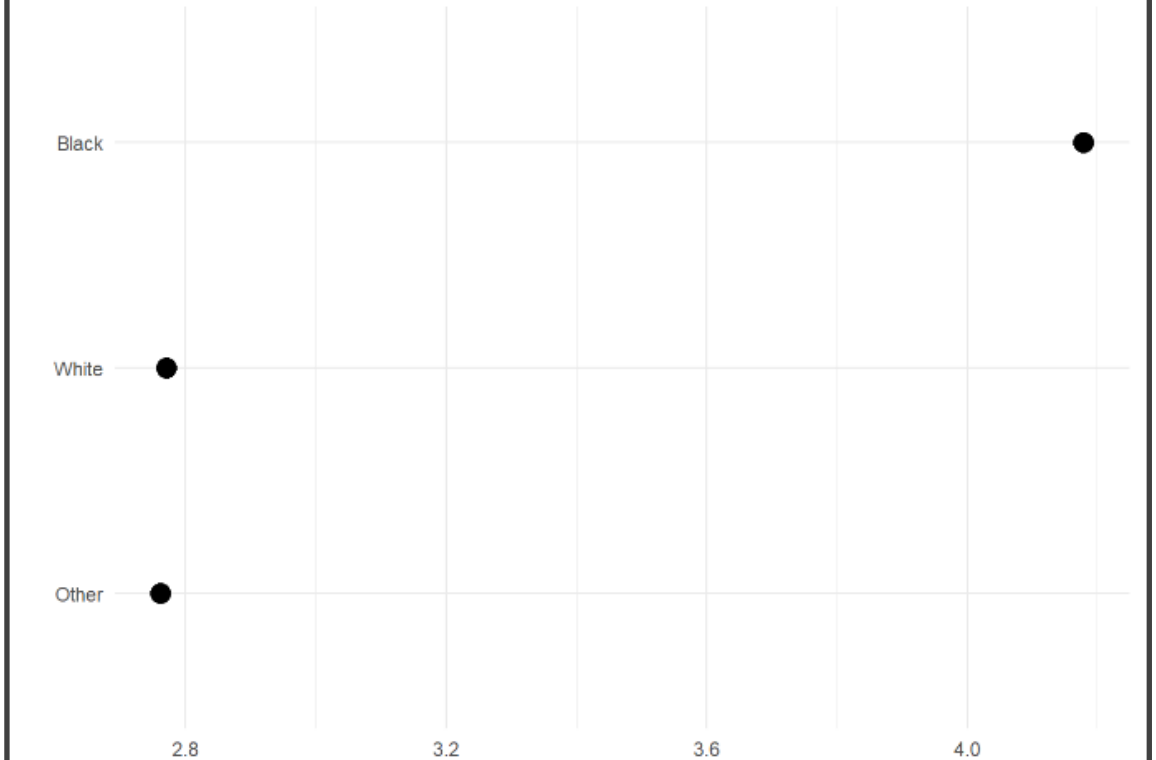
Modifying Factor Order

- fct_reorder()
  - f = Factor Variable
  - x = Numeric Vector
  - fun = Optional Function If Multiple Values of x for Each Value of f (Default: Median)

Modifying Factor Order

- Example 1: Reorder

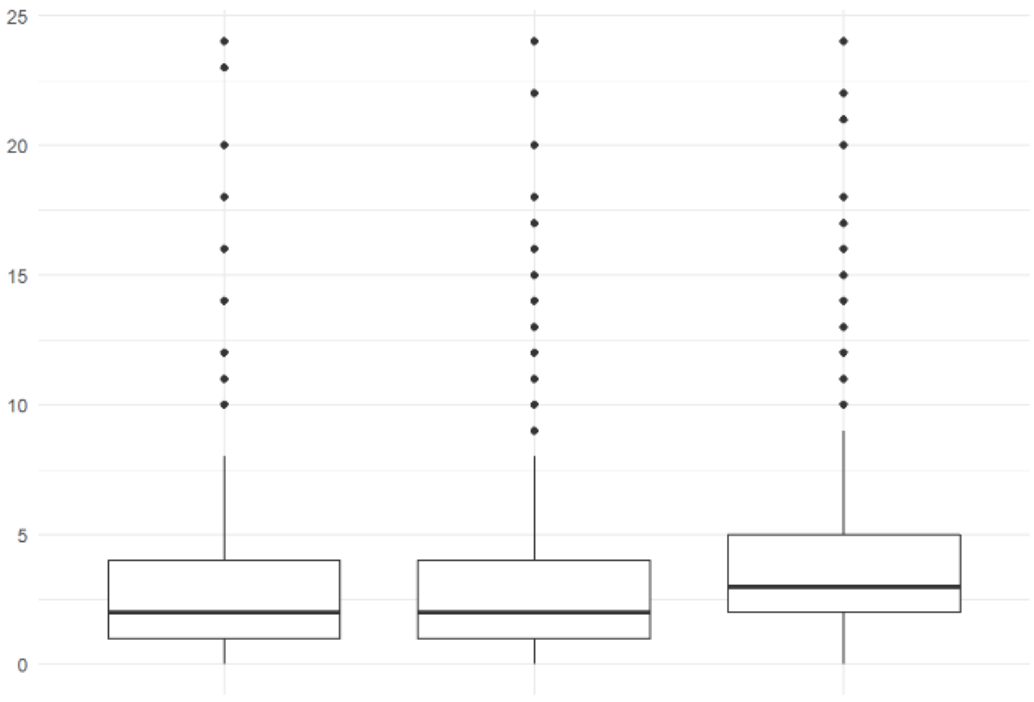
```
ggplot(race.summary) +
  geom_point(aes(x=avg.tv,y=fct_reorder(race,avg.tv)),size=4) +
  xlab("") + ylab("") +
  theme_minimal()
```



Modifying Factor Order: Example 2

- Example 2: Reorder

```
ggplot(Social) +
  geom_boxplot(aes(x=fct_reorder(race,tvhours,fun=median,na.rm=T)
,
                   y=tvhours)) +
  xlab("") + ylab("") +
  theme_minimal()
```



Useful Functions

- Other Useful Functions
  - fct_relevel() = Specify Variable and the Specific Levels You Want in The Front
  - fct_rev() = Specify Variable and Reverses the Level Order
  - fct_infreq() = Order Levels Based on Increasing Frequency
- Combine Functions as Necessary

Types of Ordering

- Different Types of Ordering
  - Nominal = “Arbitrary”
  - Ordinal = “Principled”
- Example: Race vs Income
  - Race Levels are Arbitrary
  - Income Levels are Principled

Modifying Factor Order: Example 3

```
head(Social[,c("race","rincome")])
```

```
## # A tibble: 6 x 2
##   race  rincome
##   <fct> <fct>
## 1 White $8000 to 9999
## 2 White $8000 to 9999
## 3 White Not applicable
## 4 White Not applicable
## 5 White Not applicable
## 6 White $20000 - 24999
```

```
str(Social[,c("race","rincome")])
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    21483 obs. of  2 variables:
##  $ race   : Factor w/ 4 levels "Other","Black",..: 3 3 3 3 3 3 3 3 3 3 ...
##  $ rincome: Factor w/ 16 levels "No answer","Don't know",..: 8 8 16 16 16 5
 4 9 4 4 ...
```

```
levels(Social$race)
```

```
## [1] "Other"          "Black"          "White"          "Not applicable"
```

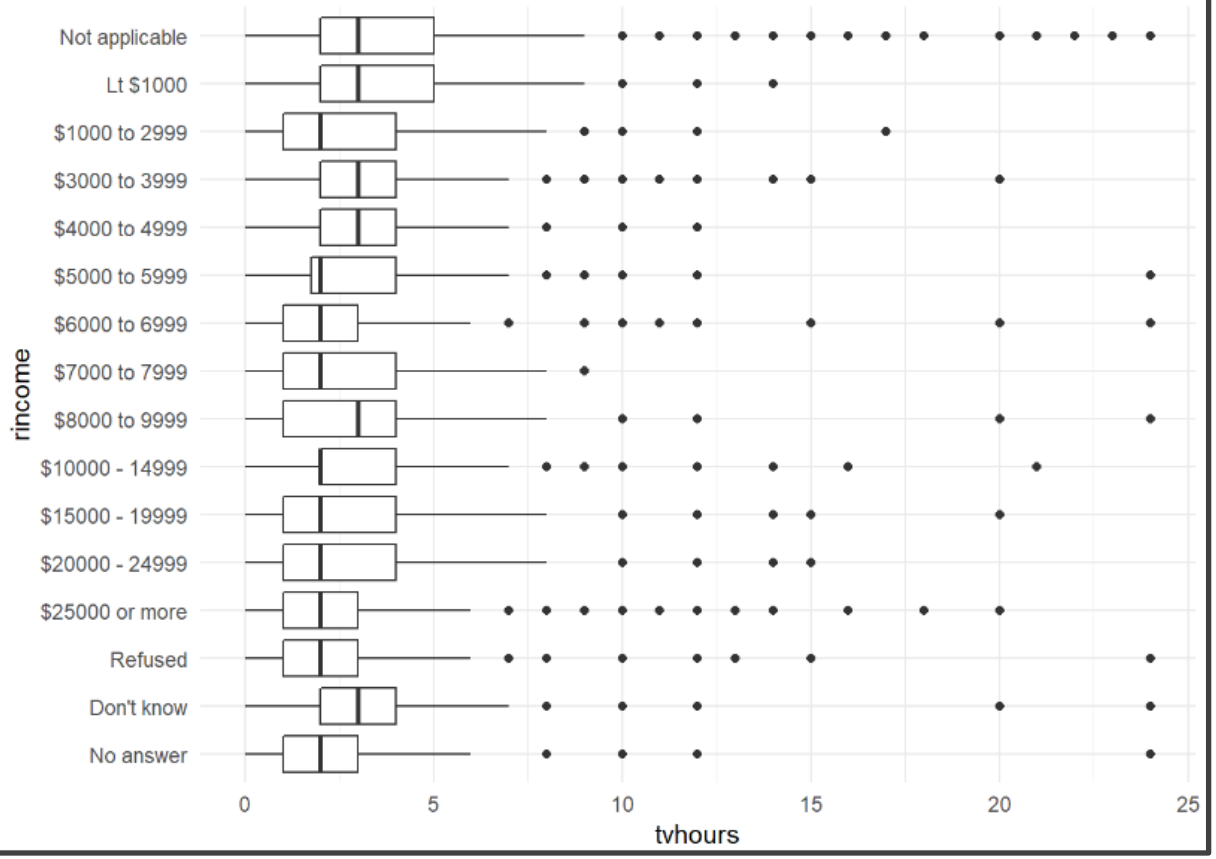
```
levels(Social$rincome)
```

```
##  [1] "No answer"      "Don't know"     "Refused"        "$25000 or more"
##  [5] "$20000 - 24999" "$15000 - 19999" "$10000 - 14999" "$8000 to 9999"
##  [9] "$7000 to 7999"  "$6000 to 6999"  "$5000 to 5999"  "$4000 to 4999"
## [13] "$3000 to 3999"  "$1000 to 2999"  "Lt $1000"       "Not applicable"
```

Modifying Factor Order: Example 3

- Original Boxplot

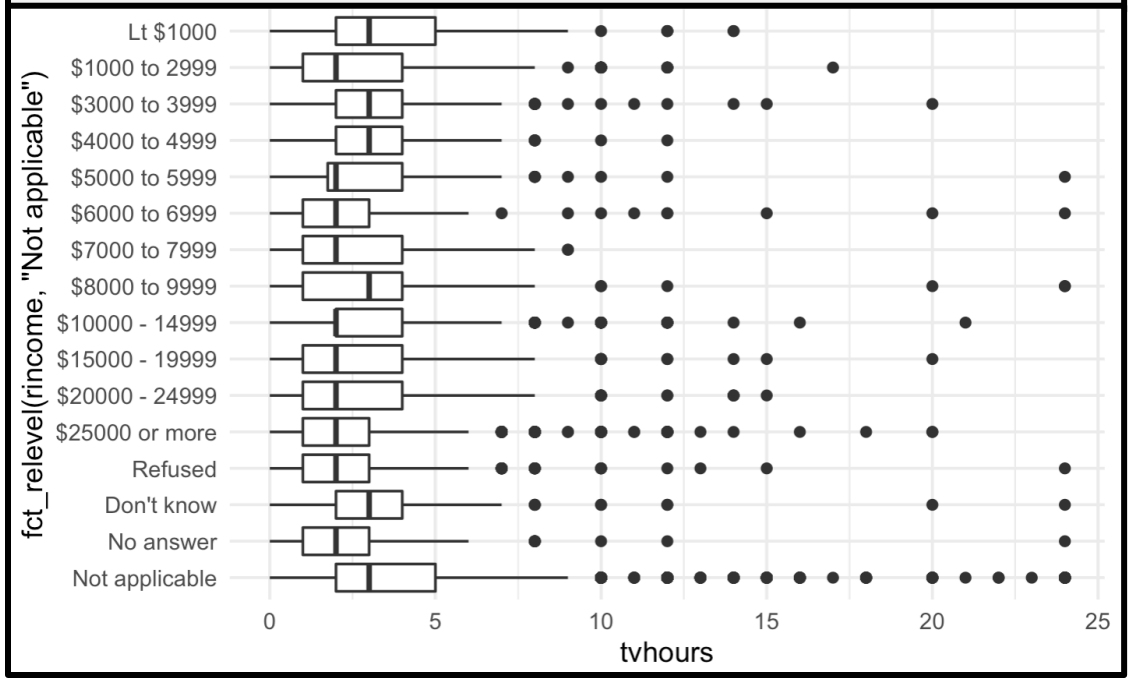
```
ggplot(Social) +
  geom_boxplot(aes(x=rincome,y=tvhours)) +
  coord_flip() +
  theme_minimal()
```



Modifying Factor Order: Example 3

- Pull `Not applicable` to the front

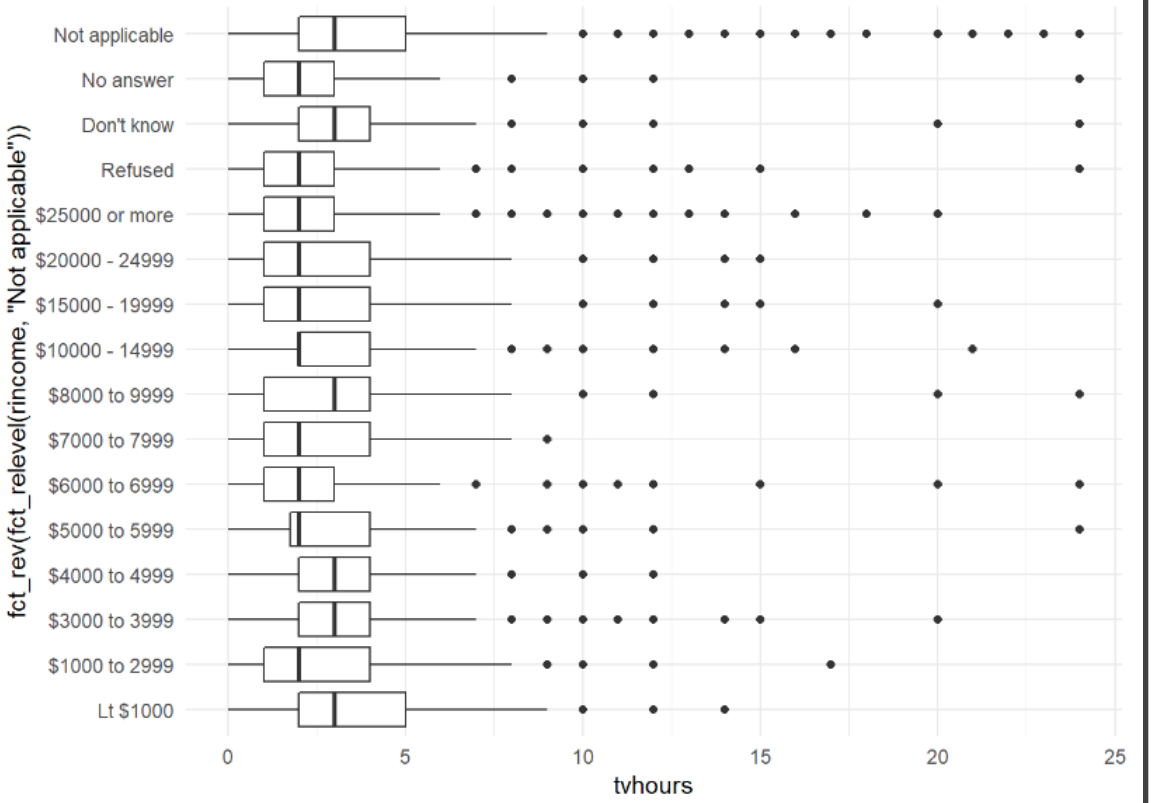
```r
ggplot(Social) +
  geom_boxplot(aes(x=fct_relevel(rincome,"Not applicable"),
                   y=tvhours)) +
  coord_flip() +
  theme_minimal()
```



Modifying Factor Order: Example 3

- Level Change + Rev

```
ggplot(Social) +
  geom_boxplot(aes(x=fct_rev(fct_relevel(rincome,"Not applicable")),
                   y=tvhours)) +
  coord_flip() +
  theme_minimal()
```



Modifying Factor Levels

- Purpose for Modifying Levels
  - Abbreviate or Better Names
  - Collapse Unimportant Levels
  - Group Categories
- Useful Functions
  - fct_recode() = Rename Levels
  - fct_collapse() = Collapse Levels
  - fct_lump() = Create Subgroups

Modifying Factor Levels

- Marital Counts

```
Marriage = Social %>%
              count(marital) %>%
              mutate(prop=n/sum(n))
print(Marriage)
```

```
## # A tibble: 6 x 3
##   marital           n     prop
##   <fct>         <int>    <dbl>
## 1 No answer        17 0.000791
## 2 Never married  5416 0.252
## 3 Separated       743 0.0346
## 4 Divorced       3383 0.157
## 5 Widowed        1807 0.0841
## 6 Married       10117 0.471
```

Recode Levels

- Example 1: Recode Levels

```
Marriage2 = Social %>%
              mutate(marital2=fct_recode(marital,
                     "Unknown" = "No answer",
                     "Single" = "Never married"
              )) %>%
              count(marital,marital2) %>%
              mutate(prop=n/sum(n))
print(Marriage2)
```

```
## # A tibble: 6 x 4
##   marital       marital2      n     prop
##   <fct>         <fct>     <int>    <dbl>
## 1 No answer     Unknown      17 0.000791
## 2 Never married Single     5416 0.252
## 3 Separated     Separated   743 0.0346
## 4 Divorced      Divorced   3383 0.157
## 5 Widowed       Widowed    1807 0.0841
## 6 Married       Married   10117 0.471
```

Collapse Levels

- Example 2: Collapse Levels

```
levels(Social$marital)
```

```
## [1] "No answer"     "Never married" "Separated"     "Divorced"

## [5] "Widowed"       "Married"
```

```
Marriage3 = Social %>%
              mutate(marital2=fct_collapse(marital,
                      Alone = levels(marital)[c(2,4,5)],
                      Together = levels(marital)[c(6)],
                      Confused = levels(marital)[c(1,3)]
              )) %>%
              group_by(marital,marital2) %>%
              summarize(n=n()) %>%
              ungroup() %>%
              mutate(prop=n/sum(n))
print(Marriage3)
```

```
## # A tibble: 6 x 4
##   marital       marital2     n     prop
##   <fct>         <fct>    <int>    <dbl>
## 1 No answer     Confused    17 0.000791
## 2 Never married Alone     5416 0.252
## 3 Separated     Confused   743 0.0346
## 4 Divorced      Alone     3383 0.157
## 5 Widowed       Alone     1807 0.0841
## 6 Married       Together 10117 0.471
```

Lumping Levels

- Example 3: Lumping Levels

```
Marriage4 = Social %>%
              mutate(marital2=fct_lump(marital)) %>%
              count(marital,marital2) %>%
              mutate(prop=n/sum(n))
print(Marriage4)
```

```
## # A tibble: 6 x 4
##   marital       marital2          n     prop
##   <fct>         <fct>         <int>    <dbl>
## 1 No answer     Other            17 0.000791
## 2 Never married Never married  5416 0.252
## 3 Separated     Other           743 0.0346
## 4 Divorced      Divorced       3383 0.157
## 5 Widowed       Other          1807 0.0841
## 6 Married       Married       10117 0.471
```

Lumping Levels

- Example 3: Lumping Levels

```
Marriage5 = Social %>%
              mutate(marital2=fct_lump(marital,2)) %>%
              count(marital,marital2) %>%
              mutate(prop=n/sum(n))
print(Marriage5)
```

```
## # A tibble: 6 x 4
##   marital       marital2          n     prop
##   <fct>         <fct>         <int>    <dbl>
## 1 No answer     Other            17 0.000791
## 2 Never married Never married  5416 0.252
## 3 Separated     Other           743 0.0346
## 4 Divorced      Other          3383 0.157
## 5 Widowed       Other          1807 0.0841
## 6 Married       Married       10117 0.471
```