Lecture 6: Improving visualiztion quality using uncertainty

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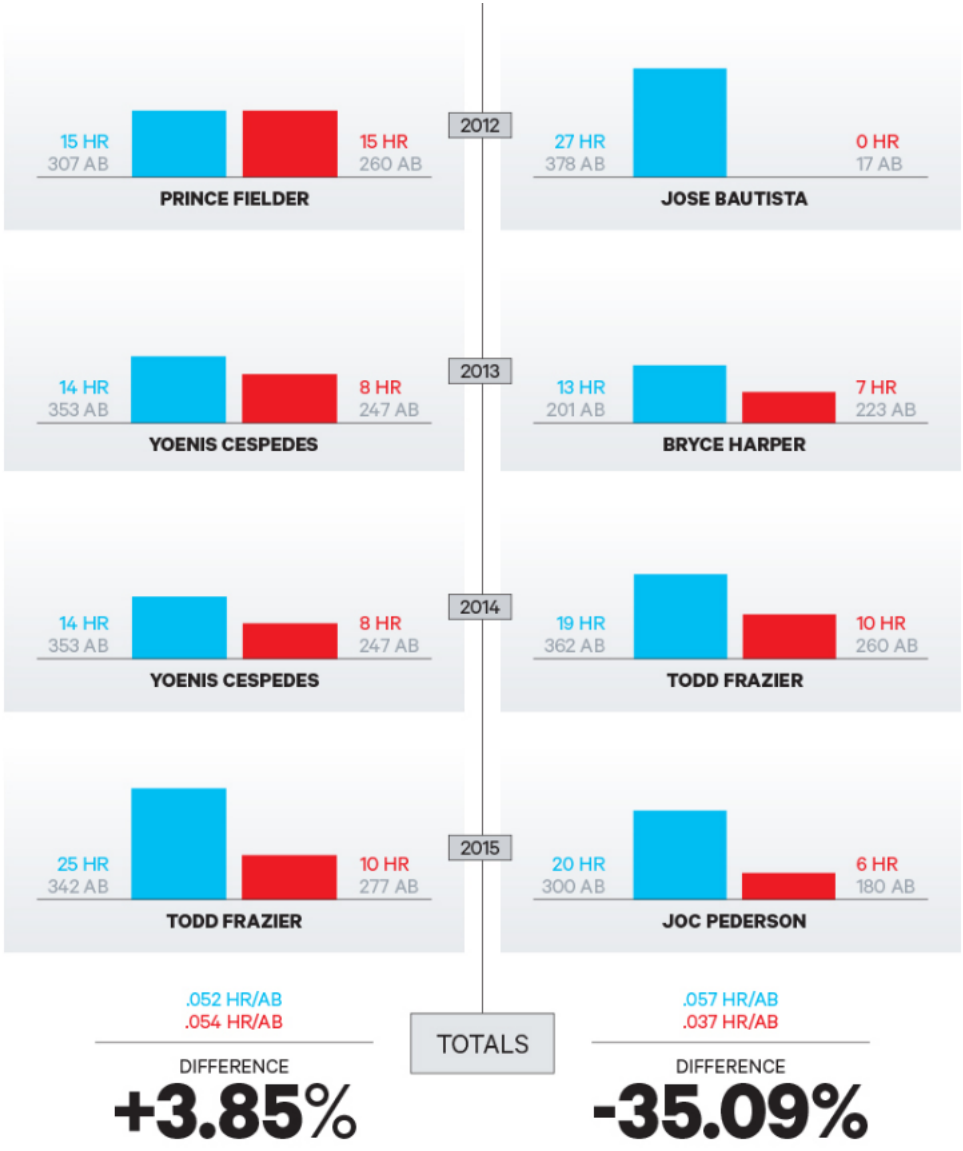
Examples

1. What are the plots trying to show?
2. What are the plots actually showing?
3. Are the plots accurate?
4. Truth continuum
5. Model bugs: audience

Example plot 1

`MLB's real home run derby curse impacts second place`, (link)



Example plot 2

`The web is dead`, (Wired.com)

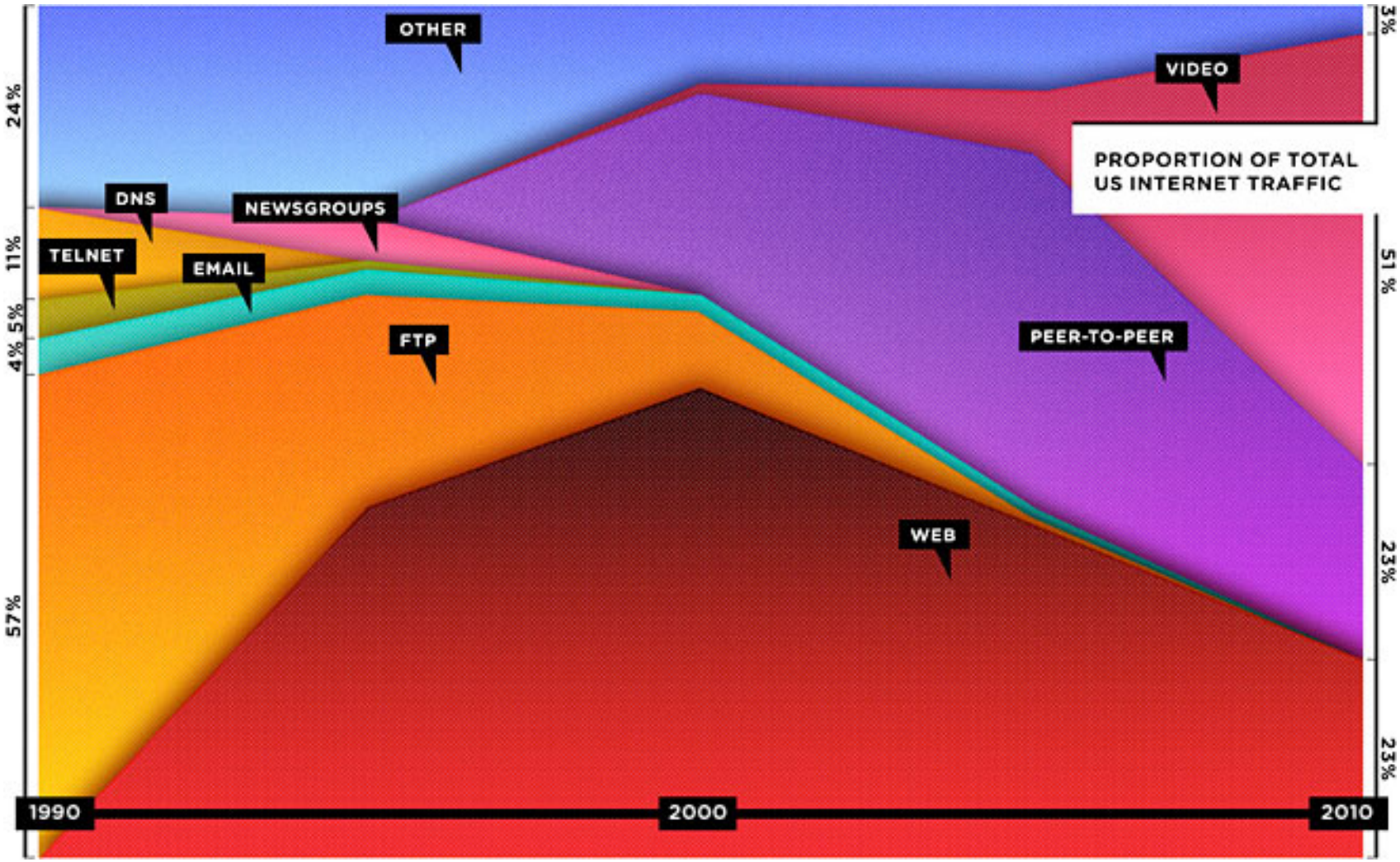
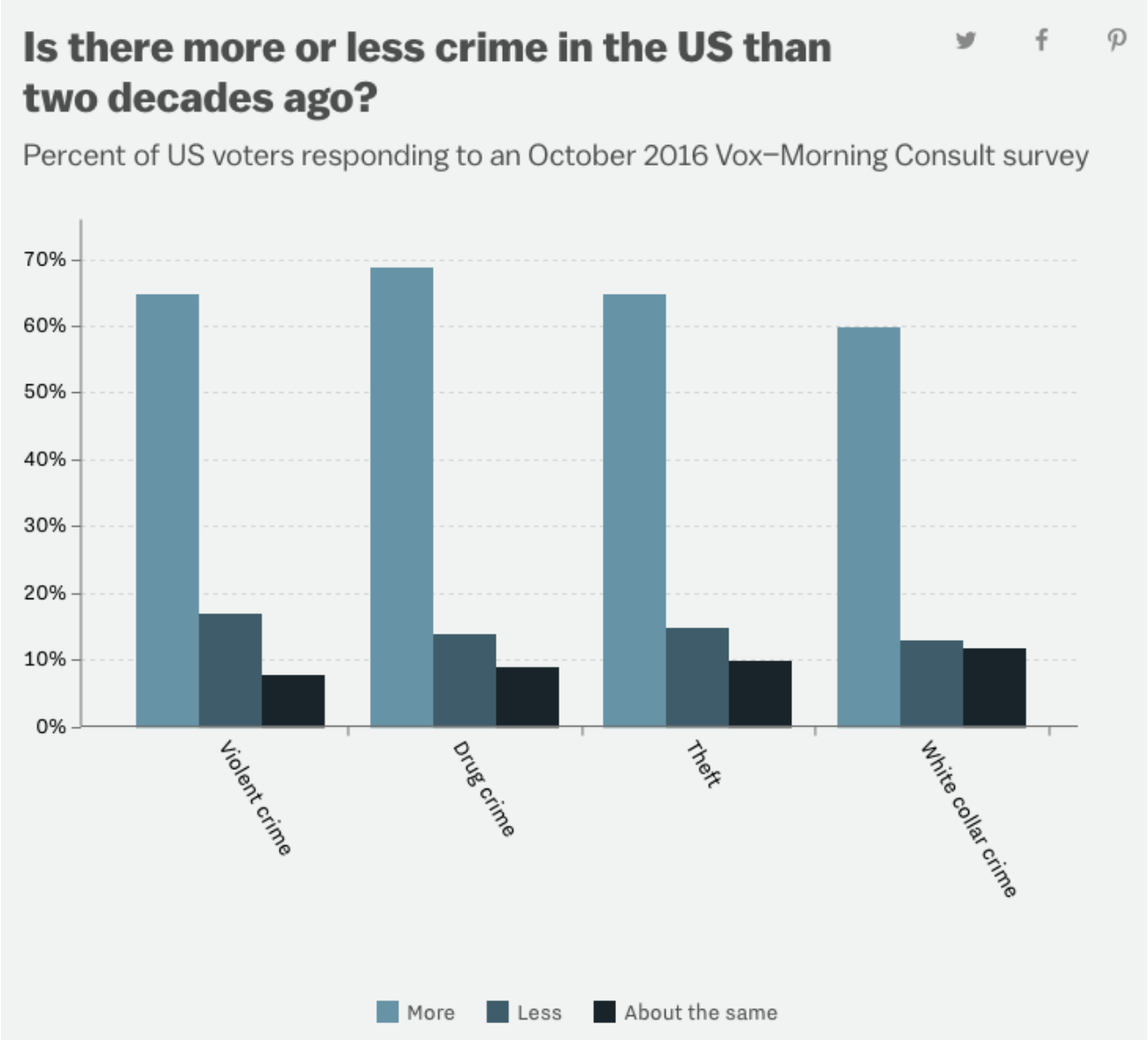


Figure 2:Proportion of total internet traffic.

Example plot 3

`More or less crime?`, (Vox.com)



Today's goals

1. Communicating Variability
2. Variability by variable type
3. Graphing variability
4. Communicating change

Accounting for variability - communicating change

An example

Cal-Berkeley admissions, 1973

Table 1:Cal-Berkeley admissions, 1973

	Admitted	Rejected
Male	1198	1493
Female	557	1278

What does this look like? How can we visualize?

An example

```
library(dplyr); library(ggplot2)
cb.df <- data.frame(apply(UCBAdmissions, c(2, 1), sum))
cb.df
```

```
##        Admitted Rejected
## Male       1198     1493
## Female      557     1278
```

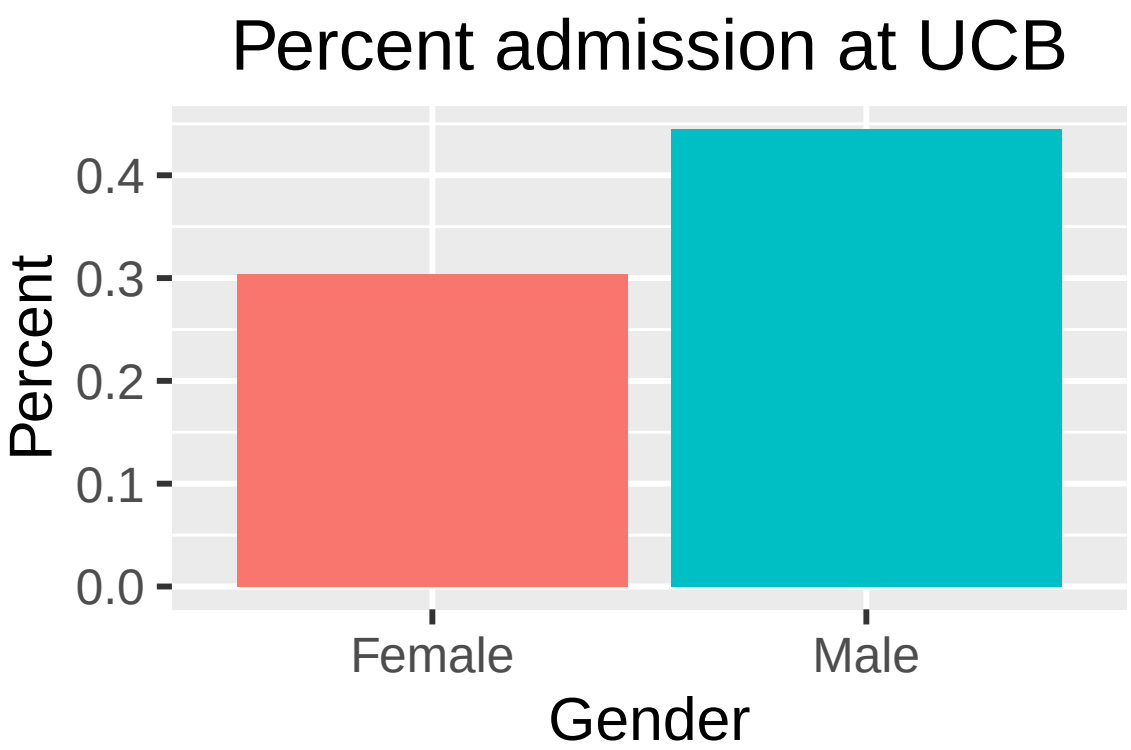
An example

```
cb.df <- cb.df %>%
  mutate(Gender = c("Male", "Female"),
         Percent = Admitted / (Admitted + Rejected),
         n = Admitted + Rejected)
cb.df
```

```
##   Admitted Rejected Gender   Percent    n
## 1     1198     1493   Male 0.4451877 2691
## 2      557     1278 Female 0.3035422 1835
```

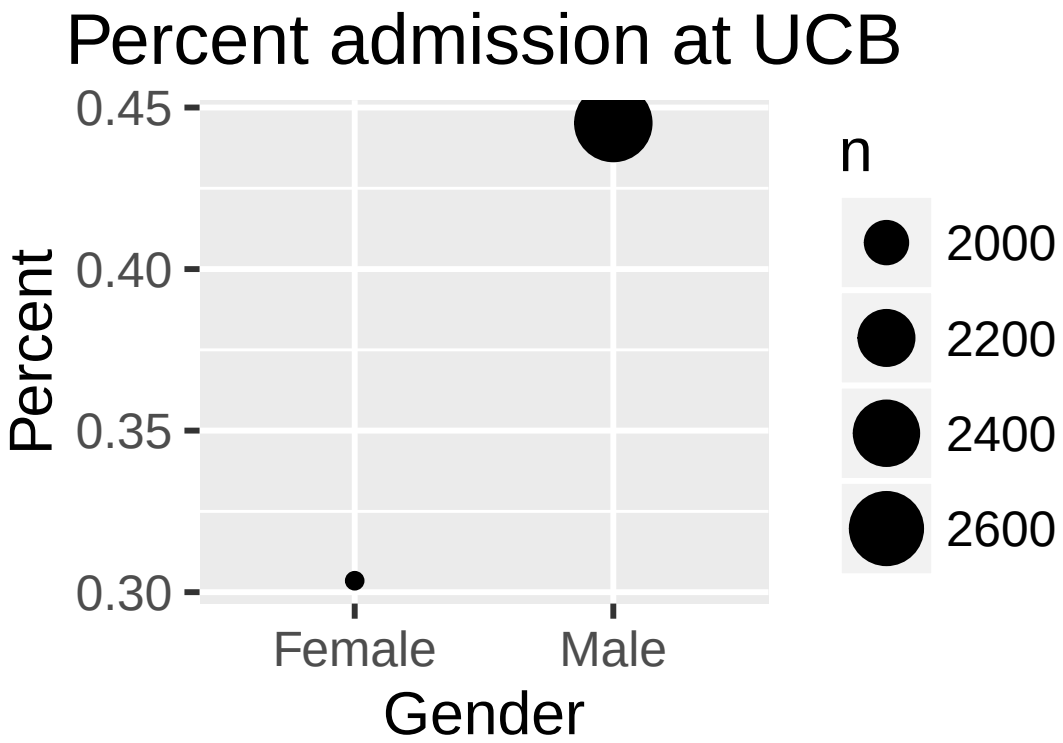
An example

```
ggplot(cb.df, aes(x = Gender, y = Percent, fill = Gender)) +
  geom_bar(stat = "identity") +
  ggtitle("Percent admission at UCB") +
  theme(legend.position = "none")
```



An example

```
ggplot(cb.df, aes(x = Gender, y = Percent, size = n)) +
  geom_point() +
  ggtitle("Percent admission at UCB")
```



Possible explanations?

Definitions in statistics

- Observation/unit
- Standard deviation
- Statistic
- Standard error
- Margin of error

Margins of error + assumptions

- Continuous data
- Proportions
- Trends

An aside

Margin of error for proportions: a proof for the rule of thumb

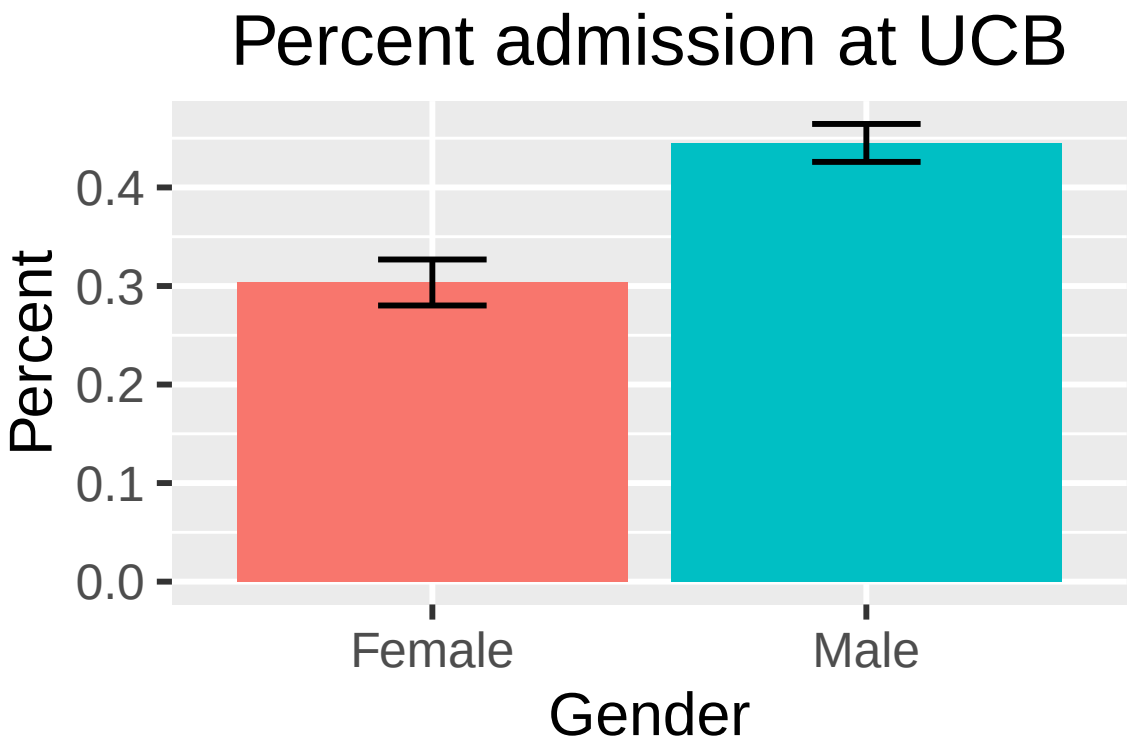
An example

```
cb.df <- mutate(cb.df,  MOE = 1/sqrt(n))
cb.df
```

```
##   Admitted Rejected Gender   Percent    n         MOE
## 1     1198     1493   Male 0.4451877 2691 0.01927716
## 2      557     1278 Female 0.3035422 1835 0.02334436
```

An example

```
limits <- aes(ymin = Percent - MOE, ymax = Percent + MOE)
ggplot(cb.df, aes(x = Gender, y = Percent, fill = Gender)) +
  geom_bar(stat = "identity") +
  geom_errorbar(limits, width=0.25) +
  ggtitle("Percent admission at UCB") +
  theme(legend.position = "none")
```



Example, continuous data

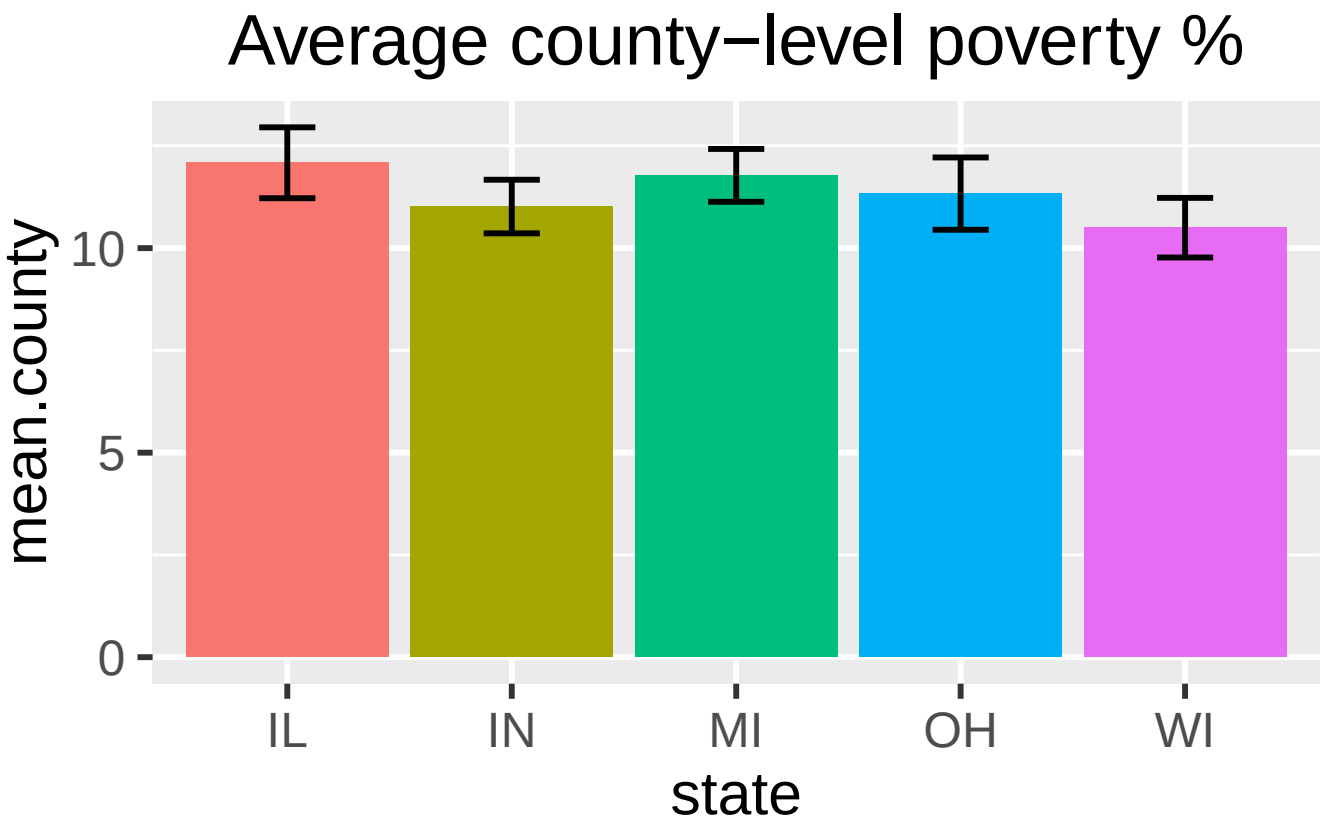
Midwest data - county-level percentages of elderly in poverty, by state.

```
midwest1 <- midwest %>%
  group_by(state) %>%
  summarise(mean.county = mean(percelderlypoverty),
            sd.county = sd(percelderlypoverty),
            n.county = n()) %>%
  mutate(moe.county = 2*sd.county/sqrt(n.county))
midwest1
```

```
## Source: local data frame [5 x 5]
##
##   state mean.county sd.county n.county moe.county
##   (chr)       (dbl)     (dbl)    (int)      (dbl)
## 1    IL    12.08606  4.372512      102  0.8658863
## 2    IN    11.01617  3.141212       92  0.6549881
## 3    MI    11.77796  2.940704       83  0.6455683
## 4    OH    11.33227  4.145811       88  0.8838898
## 5    WI    10.49910  3.092291       72  0.7288600
```

Example, continuous data

```
limits <- aes(ymin = mean.county - moe.county, ymax = mean.county + moe.county)
ggplot(midwest1, aes(x = state, y = mean.county, fill = state)) +
  geom_bar(stat = "identity") +
  geom_errorbar(limits, width=0.25) +
  ggtitle("Average county-level poverty %") +
  theme(legend.position = "none")
```



Back to the UCB data

```
admitted.males <- UCBAdmissions[1,,][1,]
applicants.males <- UCBAdmissions[1,,][1,] + UCBAdmissions[2,,][1,]
admitted.females <- UCBAdmissions[1,,][2,]
applicants.females <- UCBAdmissions[1,,][2,] + UCBAdmissions[2,,][2,]
df.UCB <- data.frame(Department = letters[1:6],
                     Admitted = c(admitted.males, admitted.females),
                     Applied = c(applicants.males, applicants.females),
                     Gender = c(rep("Male", 6), rep("Female", 6)))
df.UCB
```

```
##    Department Admitted Applied Gender
## 1           a      512     825   Male
## 2           b      353     560   Male
## 3           c      120     325   Male
## 4           d      138     417   Male
## 5           e       53     191   Male
## 6           f       22     373   Male
## 7           a       89     108 Female
## 8           b       17      25 Female
## 9           c      202     593 Female
## 10          d      131     375 Female
## 11          e       94     393 Female
## 12          f       24     341 Female
```

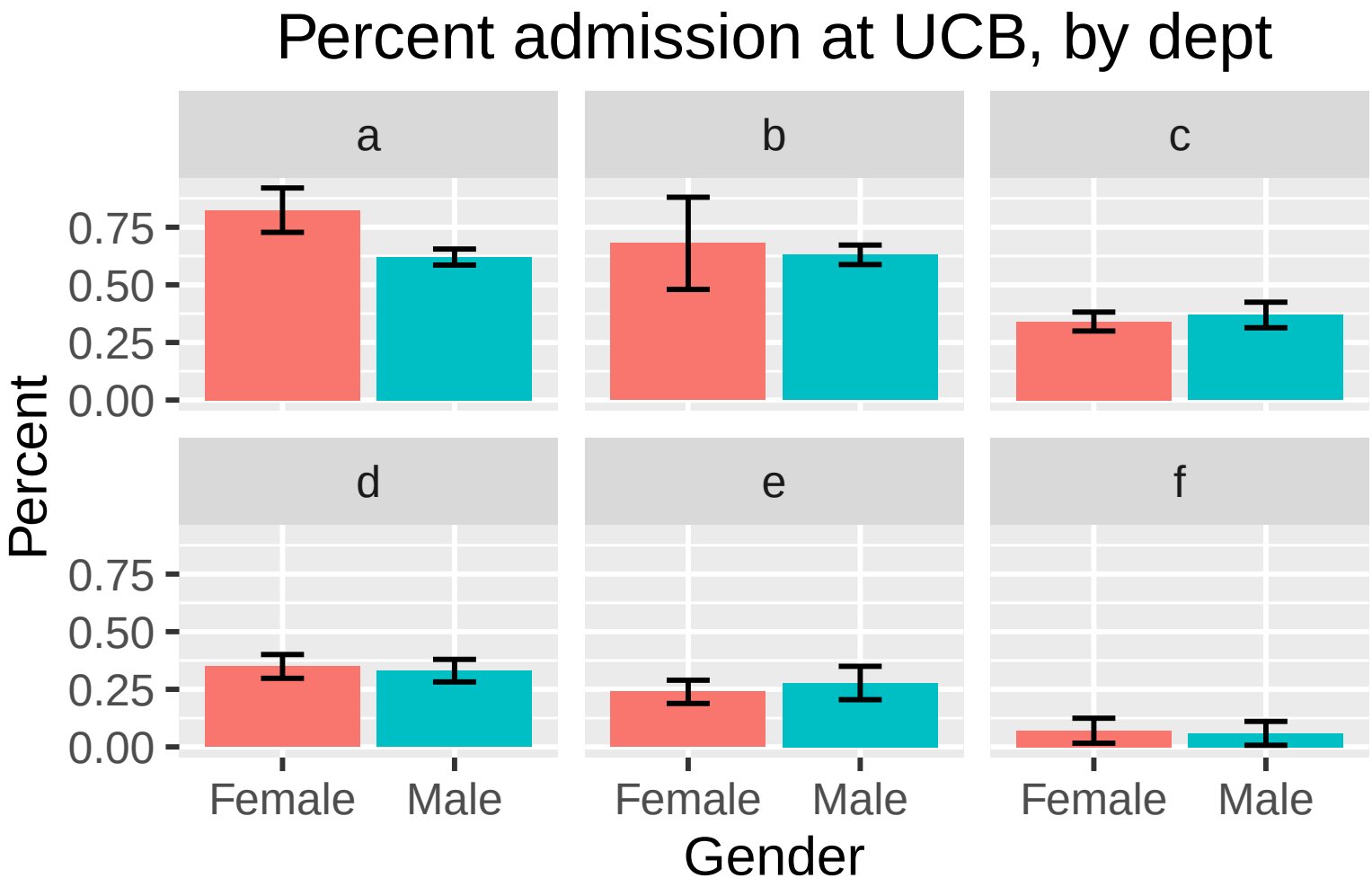
Back to the UCB data

```
df.UCB <- df.UCB %>%
  mutate(Percent = Admitted/Applied, MOE = 1/sqrt(Applied)) %>%
  arrange(Department)
df.UCB
```

```
##    Department Admitted Applied Gender    Percent        MOE
## 1           a      512     825   Male 0.62060606 0.03481553
## 2           a       89     108 Female 0.82407407 0.09622504
## 3           b      353     560   Male 0.63035714 0.04225771
## 4           b       17      25 Female 0.68000000 0.20000000
## 5           c      120     325   Male 0.36923077 0.05547002
## 6           c      202     593 Female 0.34064081 0.04106508
## 7           d      138     417   Male 0.33093525 0.04897021
## 8           d      131     375 Female 0.34933333 0.05163978
## 9           e       53     191   Male 0.27748691 0.07235746
## 10          e       94     393 Female 0.23918575 0.05044333
## 11          f       22     373   Male 0.05898123 0.05177804
## 12          f       24     341 Female 0.07038123 0.05415304
```

Back to the UCB data

```
limits <- aes(ymin = Percent - MOE, ymax = Percent + MOE)
ggplot(df.UCB, aes(x = Gender, y = Percent, fill = Gender)) +
  geom_bar(stat = "identity") +
  geom_errorbar(limits, width=0.25) +
  ggtitle("Percent admission at UCB, by dept") +
  facet_wrap(~Department)+
  theme(legend.position = "none")
```



Conclusions