Using the Illinois Report Card Data to Teach Statistics

MMC Conference of Workshops

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Contents

1 Variables

The ISBE raw data file *rx17.txt* contains 1,471 variables. The variable definitions are in the Excel file *RC17_layout.xlsx* and have been categorized into the groups shown below. The first number represents available variables in each group while the second is the number actually imported into the processed data file. The import script produces 316 variables from 20 of the 21 categories for all 3,796 Illinois public schools. (None of the NAEP variables were imported.) Usable files will be discussed in section 3.

School information (13 variables;12 imported)
Student demographics (396;71)
ACT (44;11)
Instructional setting (92;2)
Teacher and admin statistics (78;26)
District financial (67;40)
Region and legislative (3;2)
National Assmnt. of Educ. Progress (NAEP) (184;0)
College and Career readiness (16;3) CTE (4;1)
Advanced coursework (12;3)
AP courses (168;42)
IB courses (168;42)
Dual credit (168;42)
AP exams (36;12)
Post secondary remediation (4;1)
Response rate (5E survey) (4;2)
Health and wellness (3;1)
Teacher Attendance (4;1)
Teacher Evaluation (2;1)
School District Count (3;1)

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2 Descriptive Statistics via State Demographics

2.1 Categorical Count (Raw)

```
school_type <- rc17 %>%
  count(SCHOOL_TYPE_NAME, sort = TRUE) %>%
  mutate(rel_freq = n/sum(n))
school_type
```

```
## # A tibble: 4 x 3
##   SCHOOL_TYPE_NAME     n rel_freq
##   <chr>            <int>    <dbl>
## 1 ELEMENTARY        2406   0.634
## 2 HIGH SCHOOL        644   0.170
## 3 MIDDLE SCHL        604   0.159
## 4 CHARTER SCH        142   0.0374
```

2.2 Categorical Count (Formatted)

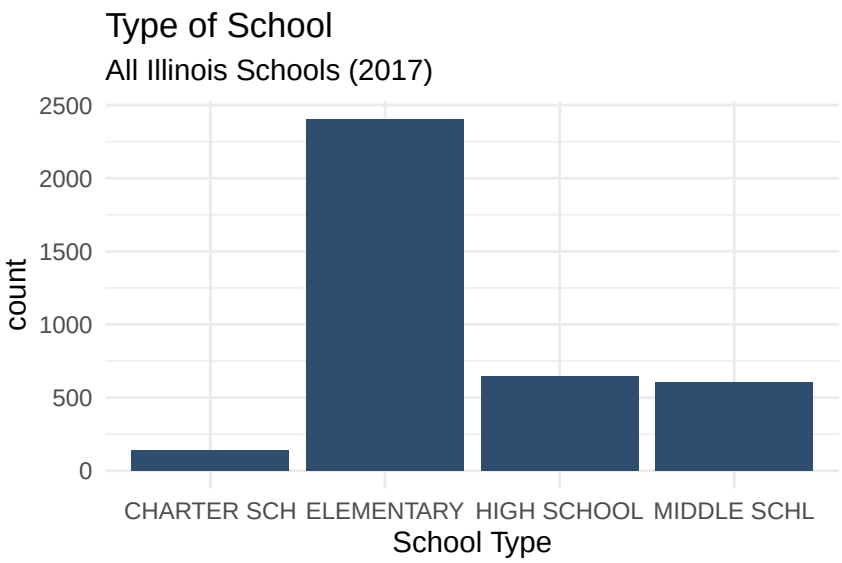
```
kable(school_type) %>%
  kable_styling(bootstrap_options = "striped", full_width = F)
```

SCHOOL_TYPE_NAME	n	rel_freq
ELEMENTARY	2406	0.6338251
HIGH SCHOOL	644	0.1696523
MIDDLE SCHL	604	0.1591149
CHARTER SCH	142	0.0374078

2.3 Categorical Plot

```
ggplot(rc17, aes(x=factor(SCHOOL_TYPE_NAME)))+
  geom_bar(fill="#2F4E6F")+
```

```
  labs(title = "Type of School", x = "School Type", subtitle = "All Illinois Schools (2017)") +
  theme_minimal()
```

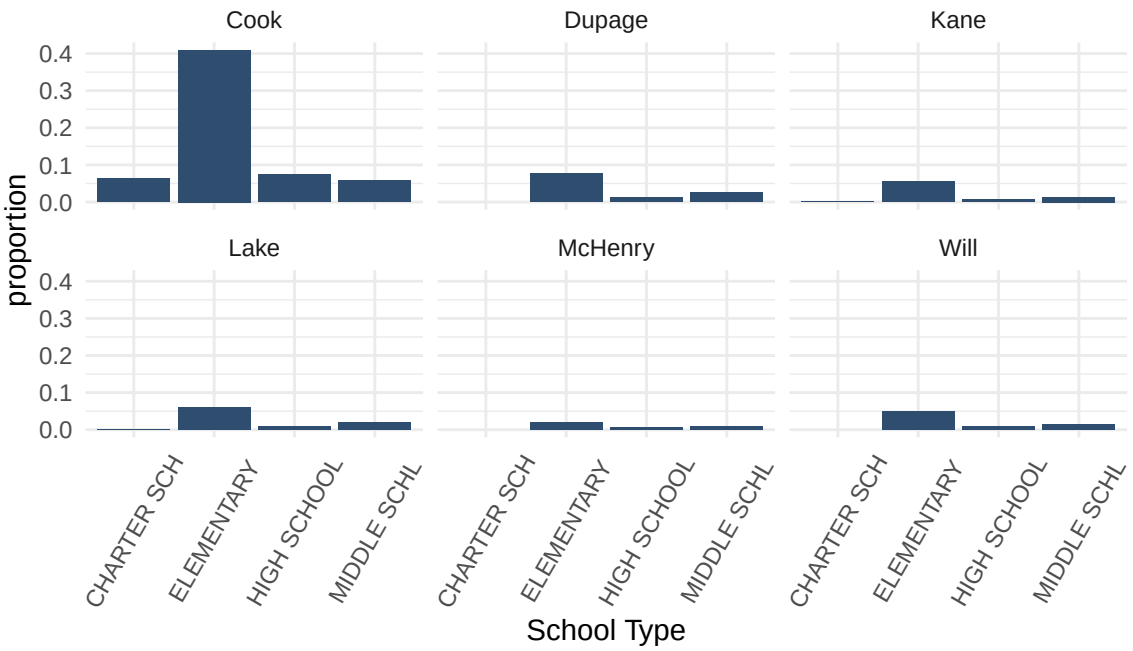


2.4 Categorical Analysis I

Write a short analysis for the types of schools in the state of Illinois.

2.5 Categorical Analysis II

```
rc17 %>%
filter(COUNTY == "Dupage" | COUNTY == "Will" | COUNTY == "Kane" |
         COUNTY == "Lake" | COUNTY == "Cook"| COUNTY == "McHenry") %>%
ggplot(aes(x=factor(SCHOOL_TYPE_NAME), y = (..count..)/sum(..count..))) +
  geom_bar(fill="#2F4E6F")+
  facet_wrap(~COUNTY, nrow = 2) +
  labs(title = "Type of School by County",
       x = "School Type",
       y = "proportion",
       subtitle = "Six Counties in the Chicago Metropolitan Region (2017)") +
  theme_minimal()  +
  theme(axis.text.x = element_text(angle = 60, vjust = 0.5))
```



Write a short analysis for the types of schools in the six county region.

3 Data Import

3.1 Data Files

- ISBE Report Card Data Library [https://www.isbe.net/Pages/Illinois-State-Report-Card-Data.aspx]
  - rc17.txt
  - six_county
- Import script
  - define variables
  - fix issues i.e. "$" and ","
  - load libraries
  - available here

Creating the six county subset:

```
sixco <- rc17 %>%
  filter(COUNTY %in% c("Cook", "Lake", "Will", "Kane", "McHenry", "Dupage"))
```

4 Numeric Summaries (REORDER THESE SECTIONS)

4.1 Lists

4.1.1 Number of High Schools in the Six County Region

```
sixco %>%
  filter(SCHOOL_TYPE_NAME == "HIGH SCHOOL") %>%
  group_by(COUNTY) %>%
  summarise(count = n())
```

```
## # A tibble: 6 x 2
##   COUNTY  count
##   <chr>   <int>
## 1 Cook      151
## 2 Dupage     23
## 3 Kane       16
## 4 Lake       21
## 5 McHenry    14
## 6 Will       17
```

4.1.2 Single List of Scores

```
mchenry_act <- rc17%>% filter(COUNTY == "McHenry", is.na(ACT_COMP_SCHOOL) == FALSE )
mchenry_act$ACT_COMP_SCHOOL
```

```
##  [1] 22.4 19.7 18.1 23.1 22.6 23.8 22.7 24.0 21.1 19.9 22.9 22.9 21.4 21.2
```

4.1.3 Single Values (MAYBE MOVE TO DATA IMPORT SECTION)

4.1.3.1 Finding a School

```
rc17 %>%
  filter(str_detect(SCHOOL_NAME, "Morton")) %>%
  select(SCHOOL_ID, SCHOOL_NAME, ACT_COMP_SCHOOL)
```

```
## # A tibble: 7 x 3
##   SCHOOL_ID       SCHOOL_NAME                       ACT_COMP_SCHOOL
##   <chr>           <chr>                                       <dbl>
## 1 060162010170001 J Sterling Morton East High Sch              18.4
## 2 060162010170002 J Sterling Morton West High Sch              18.7
## 3 060162010170003 J Sterling Morton Freshman Cntr              NA
## 4 070161450022004 Morton Gingerwood Elem School                NA
## 5 150162990252844 Morton Elem Career Academy                   NA
## 6 530907090260006 Morton High School                           23.3
## 7 530907090261005 Morton Jr High School                        NA
```

4.1.3.2 Using a Filter

```
prospect <- rc17 %>%
  filter(str_detect(SCHOOL_NAME, "Prospect High School"))
prospect_act <- prospect$ACT_COMP_SCHOOL
prospect_act
```

```
## [1] 25
```

4.1.3.3 Using a Function

```
phs_value <- function(unk) {
  x <- rc17 %>%
```

```
    filter(SCHOOL_ID == "050162140170005")
  x[unk]
}

phs_value("ACT_COMP_SCHOOL")
```

```
## # A tibble: 1 x 1
##   ACT_COMP_SCHOOL
##             <dbl>
## 1              25
```

4.1.4 Lake County ACT Scores (Ordered and Formatted)

```
lake_ACT <- rc17 %>%
  filter(SCHOOL_TYPE_NAME == "HIGH SCHOOL", COUNTY == "Lake") %>%
  arrange(desc(ACT_COMP_SCHOOL)) %>%
  select(COUNTY, SCHOOL_NAME, ACT = ACT_COMP_SCHOOL)
kable(lake_ACT)
```

COUNTY	SCHOOL_NAME	ACT
Lake	Adlai E Stevenson High School	26.9
Lake	Deerfield High School	26.4
Lake	Lake Forest High School	26.3
Lake	Libertyville High School	25.9
Lake	Highland Park High School	25.2
Lake	Vernon Hills High School	25.1
Lake	Lake Zurich High School	24.9
Lake	Barrington High School	24.8
Lake	Grayslake Central High School	23.3
Lake	Lakes Community High School	22.6
Lake	Grayslake North High School	22.4
Lake	Warren Township High School	22.1
Lake	Wauconda High School	21.8
Lake	Antioch Comm High School	21.7
Lake	Mundelein Cons High School	21.4
Lake	Grant Community High School	21.3
Lake	New Tech High - Zion-Benton East	20.1
Lake	Zion-Benton Twnshp Hi Sch	18.6
Lake	Waukegan High School	17.9
Lake	Round Lake Senior High School	17.8
Lake	North Chicago Community High Sch	17.5

Create a boxplot for Lake County ACT scores. How could you compare to DuPage county?

4.2 Two-Way Tables

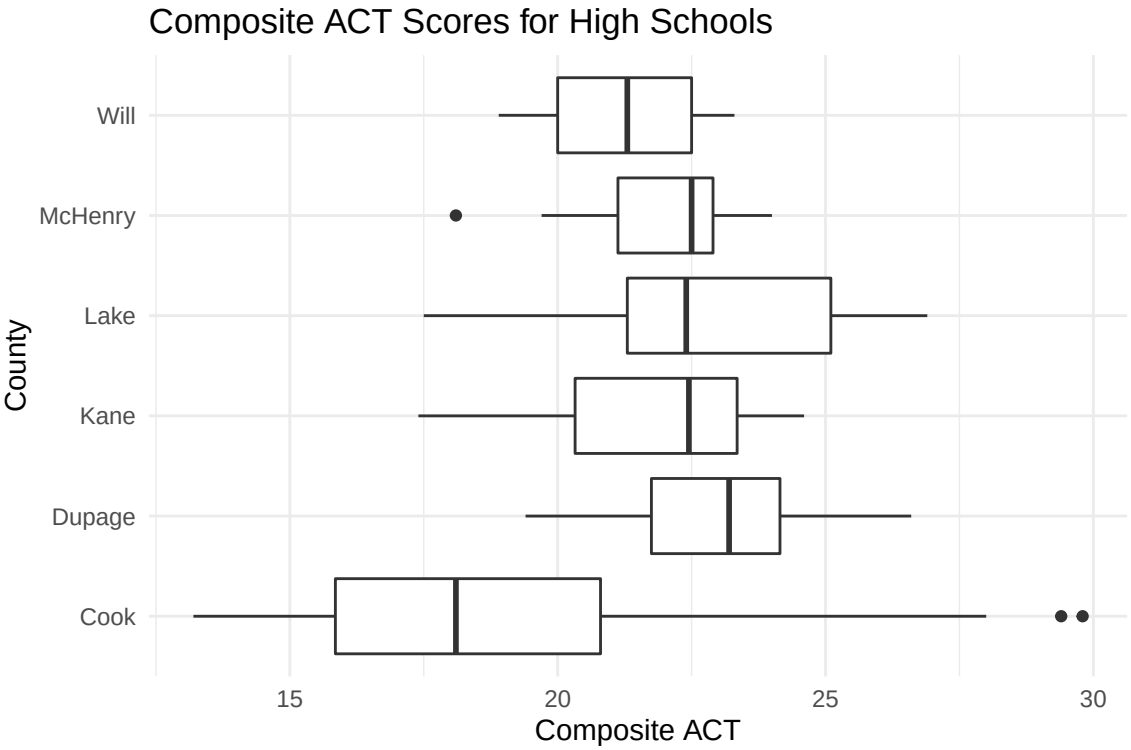
```
district_type <- rc17 %>%
  filter(COUNTY == "Lake" | COUNTY == "Dupage") %>%
  group_by(COUNTY)

two_way <- with(district_type, table(DISTRICT_SIZE_NAME, COUNTY))

kable(two_way, caption = "Types of School Districts") %>%
  kable_styling(bootstrap_options = "striped", full_width = F)
```

Table 1: Types of School Districts

	Dupage	Lake
LARGE	182	150
MEDIUM	52	38
SMALL	0	4

4.3 Resistant Measures

```
## Warning: Removed 4 rows containing non-finite values (stat_boxplot).
```



4.4 Mean vs Median

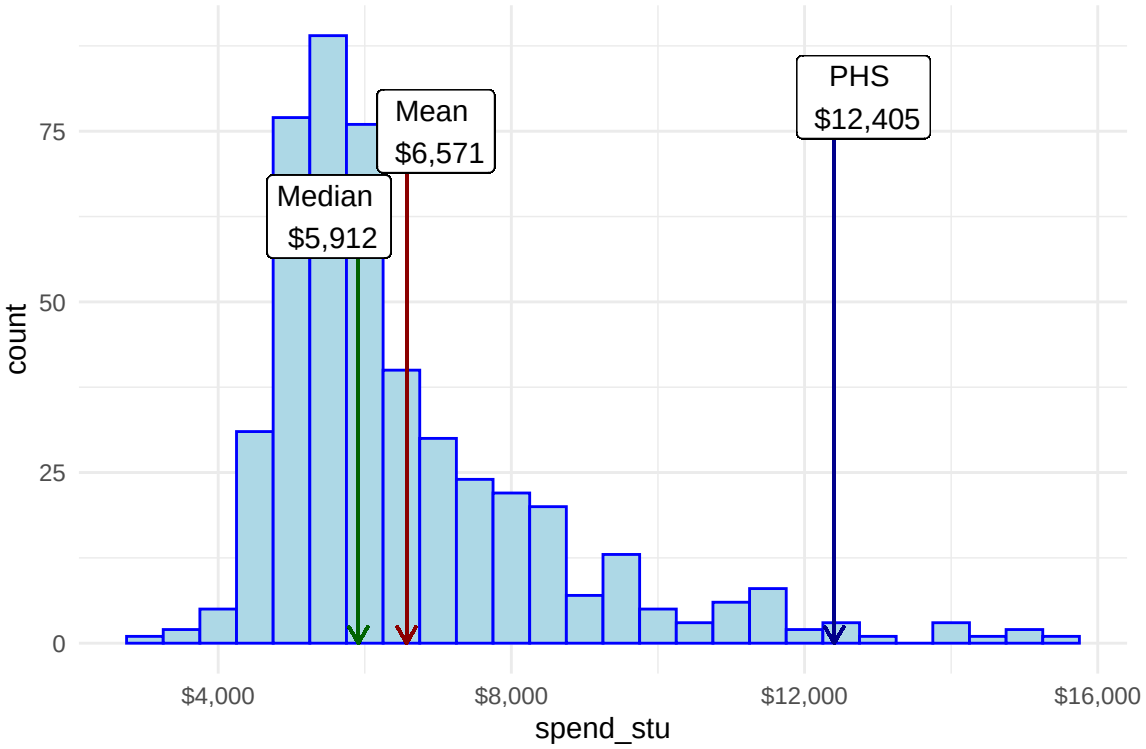
4.4.1 Instructional Spending per Pupil by District

4.4.1.1 Numeric Summary

```
rc17 %>%
  filter(SCHOOL_TYPE_NAME == "HIGH SCHOOL") %>%
  group_by(DISTRICT_NAME) %>%
  summarise(spend_stu = mean(INSTRUCT_EXPEND_PER_PUPIL_DISTRICT201516, na.rm = TRUE)) %>%
  summary()
```

```
##  DISTRICT_NAME        spend_stu
##  Length:473         Min.   : 2975
##  Class :character   1st Qu.: 5263
##  Mode  :character   Median : 5912
##                     Mean   : 6571
##                     3rd Qu.: 7315
##                     Max.   :15535
##                     NA's   :1
```

4.4.1.2 Plot



5 Correlation and Regression

5.1 Guess the Correlation

- ACT Composite vs Chronically Truant (#) Guess:_____ Actual:_____
- ACT Composite vs Chronically Truant (%) Guess:_____ Actual:_____
- ACT Composite vs Student Mobility Guess:_____ Actual:_____
- ACT Composite vs Attendance rate (%) Guess:_____ Actual:_____

5.2 Predicting ACT Scores

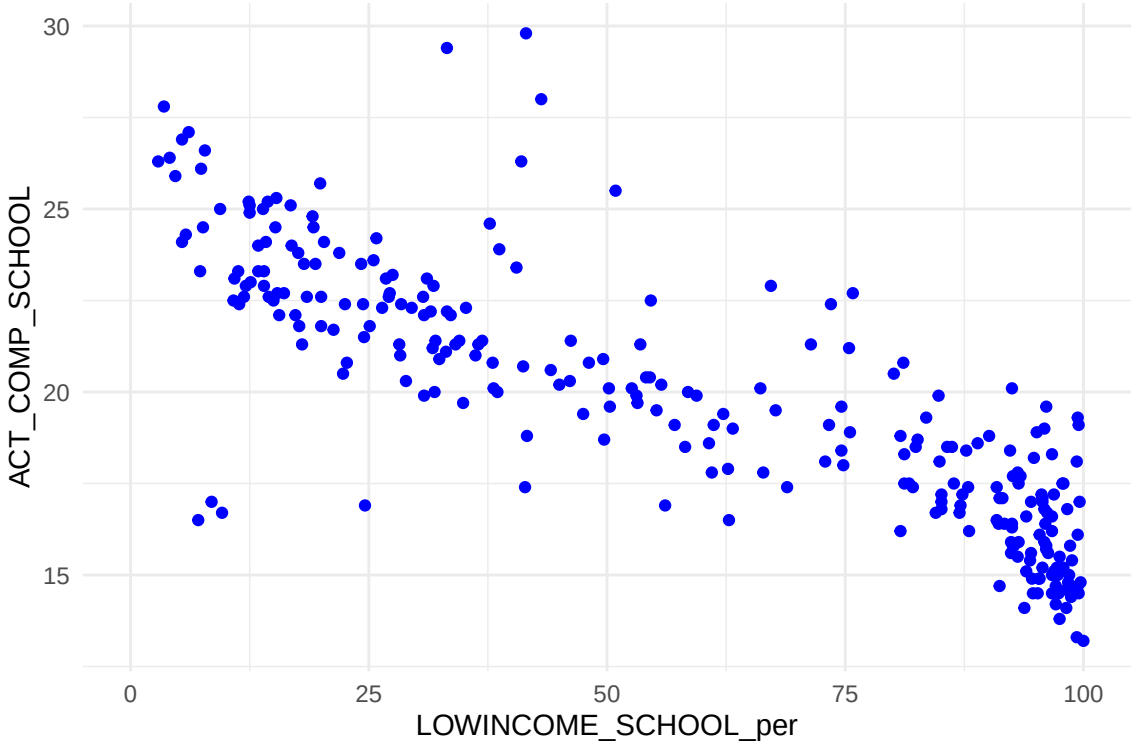
Suppose you choose 3 variables (Composite ACT Score, Enrollment and Attendance Rate) for all schools in the Six County region. What question(s) and display(s) would you explore?

5.3 Scatterplot Analysis

5.3.1 Outliers and Influential

```
ACTvLI <- sixco %>%
  ggplot(mapping = aes(x = LOWINCOME_SCHOOL_per, y = ACT_COMP_SCHOOL)) +
  geom_point(color="Blue") +
  theme_minimal()
ACTvLI
```

```
## Warning: Removed 1779 rows containing missing values (geom_point).
```

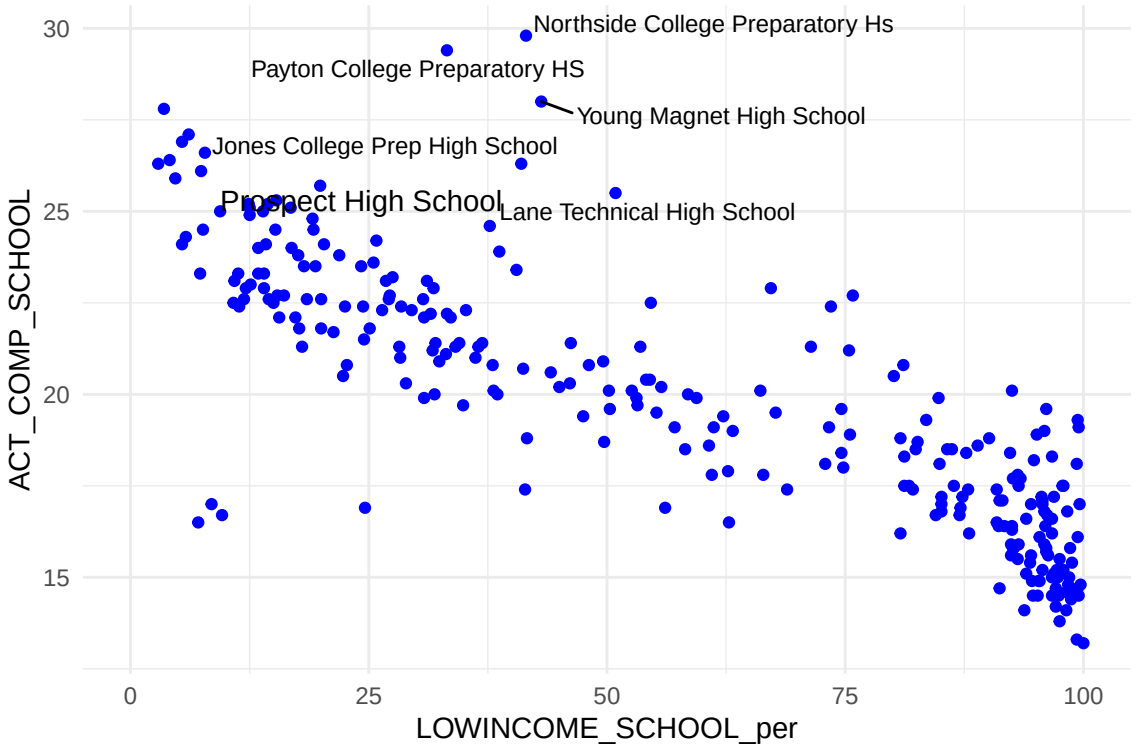


Add some labels using the `ggrepel` package. (Also notice the layering of information.)

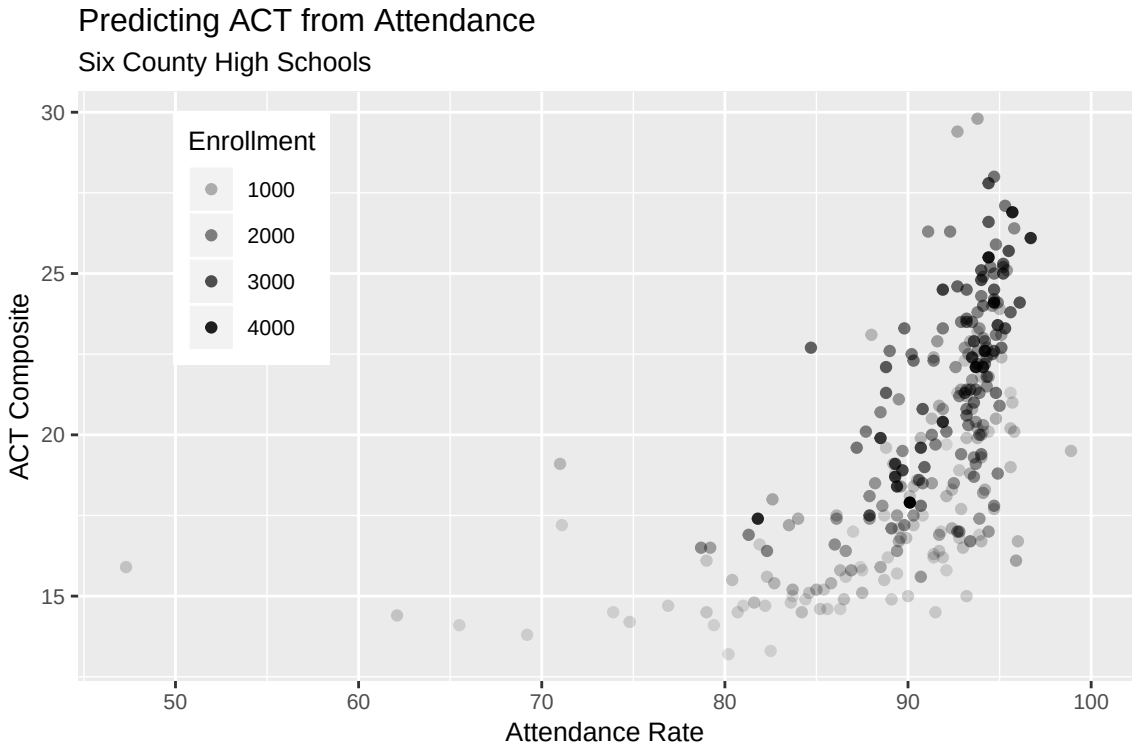
```
library(ggrepel)
```

```
ACTvLI +
  geom_text(aes(label=ifelse(SCHOOL_ID =="050162140170005",
                             as.character(SCHOOL_NAME),'')),hjust=0,vjust=0) +
  geom_text_repel(aes(LOWINCOME_SCHOOL_per, ACT_COMP_SCHOOL,
                      label = ifelse(ACT_COMP_SCHOOL >25 &
                                       LOWINCOME_SCHOOL_per>25,
                                       SCHOOL_NAME, "")), size = 3)
```

```
## Warning: Removed 1779 rows containing missing values (geom_point).
## Warning: Removed 1779 rows containing missing values (geom_text).
## Warning: Removed 1779 rows containing missing values (geom_text_repel).
```



5.3.2 Adding a Third Variable



5.4 Regression Output

5.4.1 All Schools

```
summary(lm(sixco$ACT_COMP_SCHOOL~sixco$ATTENDANCE_RATE_SCHOOL_perALL))
```

```
##
```

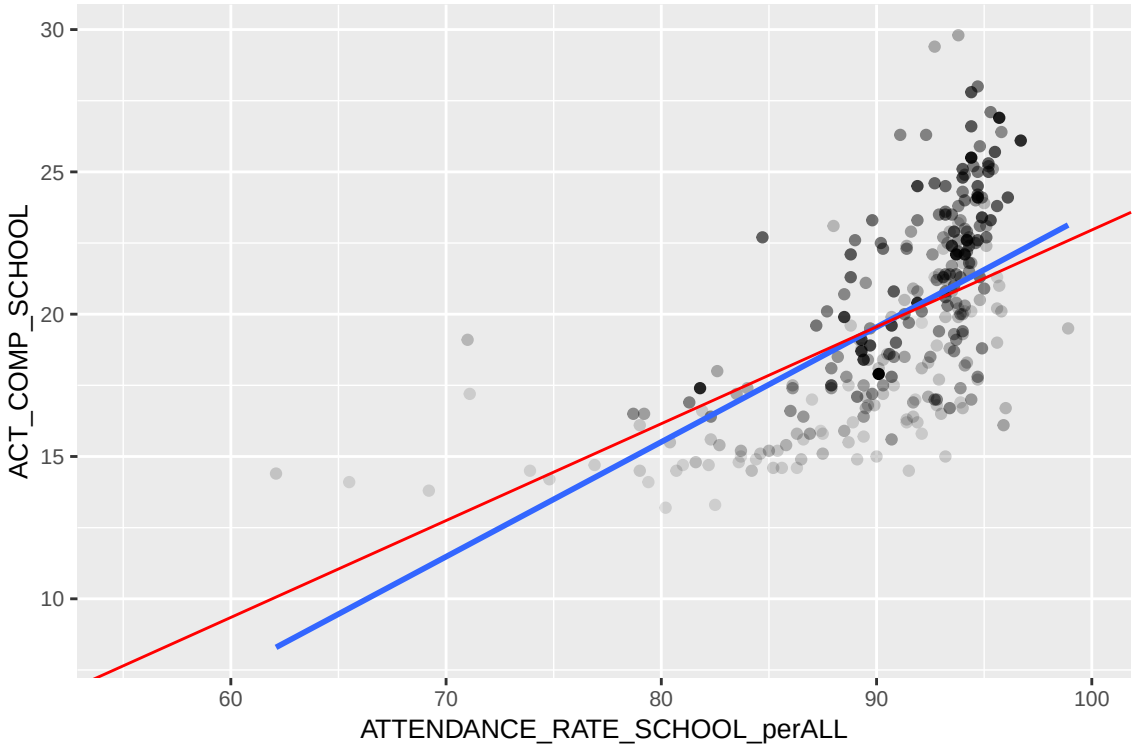
```
## Call:
## lm(formula = sixco$ACT_COMP_SCHOOL ~ sixco$ATTENDANCE_RATE_SCHOOL_perALL)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.7088 -2.2108 -0.2343  1.8209 10.9398
##
## Coefficients:
##                                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)                       -11.26875    2.61192  -4.314 2.25e-05
## sixco$ATTENDANCE_RATE_SCHOOL_perALL   0.34311    0.02887  11.886  < 2e-16
##
## (Intercept)                       ***
## sixco$ATTENDANCE_RATE_SCHOOL_perALL ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.844 on 268 degrees of freedom
##   (1779 observations deleted due to missingness)
## Multiple R-squared:  0.3452, Adjusted R-squared:  0.3427
## F-statistic: 141.3 on 1 and 268 DF,  p-value: < 2.2e-16
```

5.4.2 Influential Removed

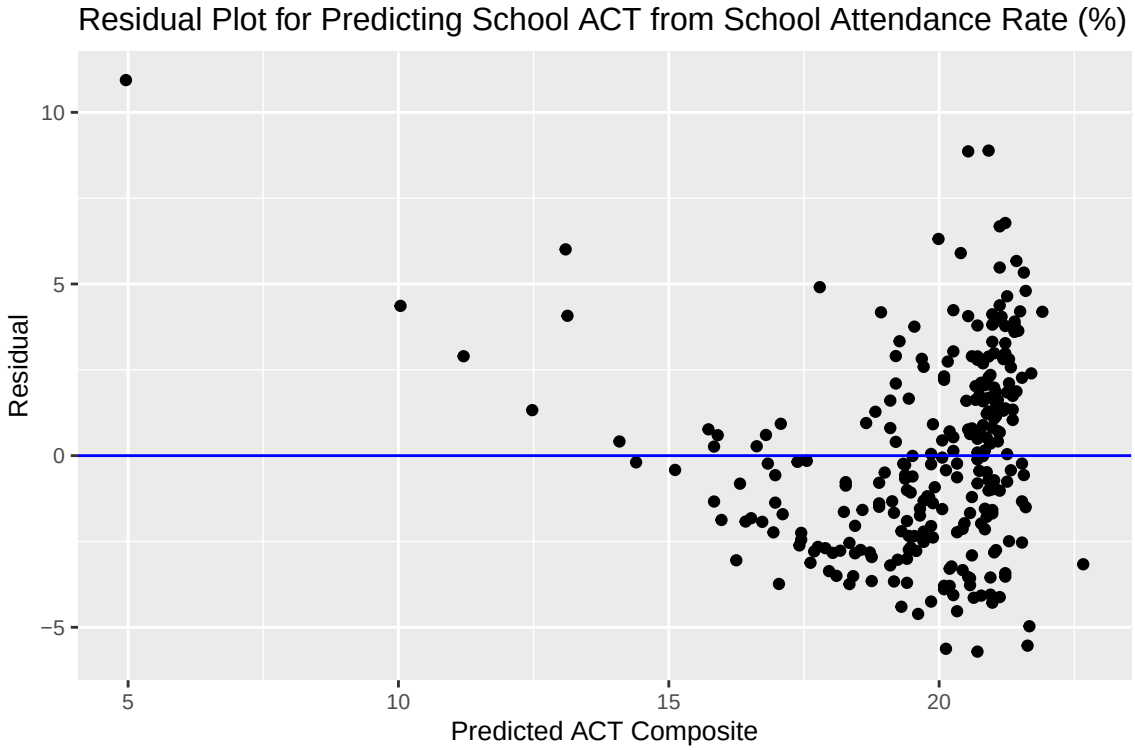
```
sixco_removed <- sixco %>%
  filter(ATTENDANCE_RATE_SCHOOL_perALL>50)

  summary(lm(sixco_removed$ACT_COMP_SCHOOL~sixco_removed$ATTENDANCE_RATE_SCHOOL_perALL))
```

```
##
## Call:
## lm(formula = sixco_removed$ACT_COMP_SCHOOL ~ sixco_removed$ATTENDANCE_RATE_SCHOOL_perALL)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.8340 -2.1147 -0.1728  1.6627  8.7676
##
## Coefficients:
##                                             Estimate Std. Error t value
## (Intercept)                                -16.74644    2.81182  -5.956
## sixco_removed$ATTENDANCE_RATE_SCHOOL_perALL   0.40322    0.03104  12.993
##                                            Pr(>|t|)
## (Intercept)                                8.13e-09 ***
## sixco_removed$ATTENDANCE_RATE_SCHOOL_perALL  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.75 on 267 degrees of freedom
##   (1778 observations deleted due to missingness)
## Multiple R-squared:  0.3873, Adjusted R-squared:  0.385
## F-statistic: 168.8 on 1 and 267 DF,  p-value: < 2.2e-16
```

5.4.3 Both Models



5.4.4 Residual Plot



6 Random Selection and Simulation

6.1 Rolling a die

```
set.seed(2020)
one_die <- sample(1:6, 10, replace = TRUE)
one_die
```

```
##  [1] 4 4 6 1 1 4 2 6 1 5
```

6.2 Random Selection

```
four_schools <-  sample_n(rc17, 4)
four_schools[c("SCHOOL_NAME", "SCHOOL_TOTAL_ENROLLMENT")]
```

```
## # A tibble: 4 x 2
##   SCHOOL_NAME                   SCHOOL_TOTAL_ENROLLMENT
##   <chr>                                          <dbl>
## 1 South Side Elementary School                     312
## 2 Coventry Elem School                             565
## 3 Plano High School                                714
## 4 Wanda Kendall Elem School                        236
```

```
mean(four_schools$SCHOOL_TOTAL_ENROLLMENT)
```

```
## [1] 456.75
```

6.3 Stratified Sample

```
strat_samp <- sixco %>%
  filter(SCHOOL_TYPE_NAME == "HIGH SCHOOL") %>%
  group_by(COUNTY) %>%
  sample_n(3)
strat_samp[c("SCHOOL_NAME", "COUNTY", "SCHOOL_TOTAL_ENROLLMENT")]
```

```
## # A tibble: 18 x 3
## # Groups:   COUNTY [6]
##    SCHOOL_NAME                       COUNTY  SCHOOL_TOTAL_ENROLLMENT
##    <chr>                             <chr>                     <dbl>
##  1 Marshall Metropolitan High School Cook                        358
##  2 Proviso West High School          Cook                       1850
##  3 Chicago Vocational Career Acad HS Cook                        901
##  4 Westmont High School              Dupage                      449
##  5 Glenbard East High School         Dupage                     2244
##  6 Hinsdale South High School        Dupage                     1507
##  7 Kaneland Senior High School       Kane                       1342
##  8 East High School                  Kane                       3848
##  9 St Charles North High School      Kane                       1985
## 10 Highland Park High School         Lake                       2040
## 11 Libertyville High School          Lake                       1935
## 12 Zion-Benton Twnshp Hi Sch         Lake                       2263
## 13 Woodstock North High School       McHenry                     942
## 14 Huntley High School               McHenry                    2996
## 15 Crystal Lake South High School    McHenry                    1527
## 16 Bolingbrook High School           Will                       3469
## 17 Lincoln-Way Central High School   Will                       2157
## 18 Wilmington High School            Will                        465
```

6.4 Confidence Interval Simulation

```
rand_samp <- function(samp_size, vari) {
  dat_fra <- sample_n(rc17, samp_size)
  a <- c(0,1, TRUE)
  a[1] <- mean(dat_fra[[vari]])
  a[2] <- median(dat_fra[[vari]])
  a[3] <- ifelse(a[1]>a[2], "Yes", "No")
  return(a)
  }
```

```
rand_samp(5, "DISTRICT_TYPE_CODE")
```

```
## [1] "1.4" "2"   "No"
```

6.5 Binomial

A basketball player claims he makes 70% of his free throws. During a recent game he made only 4 of 10. Does this cast doubt on his 70% claim or could making only 4 of 10 happen to a 70% shooter?

```
free_throws <- rbinom(300, 10, .7)
free_throws
```

```
##   [1]  7  8  5  7  6 10  7  8  7  7  8  7  8  7  5  7  3  7  6  8  7  5  7
##  [24]  7  7  8  8  9  6  6  6  9  8  7  8  8  8  8  9  8  7  6  8  6  7  8
##  [47]  6  8  6  7  7  8  6  5  8  8  6  6  7  6  7  9  7  5  9  7  8  7  6
##  [70]  7  4  8  7  6  9  5  2  6  6  7  7  7  6  8  7  8  7  7  7  9  6  7
##  [93]  5  5  9  7  8  6  8  9  8  7  9  5  8  8  7  5  7  6  6  9  7  7  3
## [116]  5  7  7  8  7  4  7  9  8  5  9  4  9  6  6  9  5 10  6  6  7  5  8
## [139]  7  7  8  5  7  8  6  8  8 10  8  8  9  6  8  7  8  8  7  7  6  4  8
## [162]  9  8  6  5  6  7  7  7  4  8  6  5  8  6  5  9  7  7  6  8  6  9  7
## [185]  9  8  7  5  4  8  8  8  7  8  5  8 10  8  9  8  7  3  6  7  4  7  5
## [208]  7  8  6  7  8  8  6  7  7  7  9  9  9  7  7  4  5  9  7  3  6  9  6
## [231]  7  6  7  8  4  5 10  8  6  7  7  7  9  3  7  7  7  9 10  5  8  8 10
## [254]  8  7  7  9  9  7  7  7  6  9  5  7  7  8  6  6  8  6  9  8  7  6  7
## [277]  7  6 10  6  5 10  7  6  8  7  9  8  6  7  5  4  7  8  8  6  6  8  6
## [300]  9
```

```
sort(free_throws)
```

```
##   [1]  2  3  3  3  3  3  4  4  4  4  4  4  4  4  4  4  5  5  5  5  5  5  5
##  [24]  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  5  6  6  6
##  [47]  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
##  [70]  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6  6
##  [93]  6  6  6  6  6  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7
## [116]  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7
## [139]  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7
## [162]  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7  7
## [185]  7  7  7  7  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8
## [208]  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8
## [231]  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8  8
## [254]  8  8  8  8  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9
## [277]  9  9  9  9  9  9  9  9  9  9  9  9  9  9  9 10 10 10 10 10 10 10 10
## [300] 10
```

```
table(free_throws)
```

```
## free_throws
##  2  3  4  5  6  7  8  9 10
##  1  5 10 27 54 91 69 34  9
```