Tidy data, data viz, and summaries

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> “Tidy data is particularly important for ggplot2 because the job of ggplot2 is to map variables to visual properties: if your data isn’t tidy, you’ll have a hard time visualising it.”

- Wickham, ggplot2 book, Chapter 9

Aesthetics

- Aesthetics map a variable to a visual clue called a glyph
- When mapping a variable to a glyph, use `aes()`. Calls outside of `aes()` will affect all elements equally.
- Tidy data are *glyph-ready* data.

Example

- Using the data below, how could you show the relation between math scores and classroom size?

```
library(tidyverse)
star <- read_csv("./data/star.csv")
head(star)
```

```
## # A tibble: 6 × 12
##   schidkn   sex   frl reg_size reg_size_aid small_size white black other
##     <int> <chr> <chr>    <int>        <int>      <int> <int> <int> <int>
## 1      63  girl    no        0            0          1     1     0     0
## 2      20  girl    no        0            0          1     0     1     0
## 3      19   boy   yes        0            1          0     0     1     0
## 4      69   boy    no        1            0          0     1     0     0
## 5      79   boy   yes        0            0          1     1     0     0
## 6       5   boy   yes        1            0          0     1     0     0
## # ... with 3 more variables: totexp <int>, tmathss <int>, treadss <int>
```

Answer: We can't

at least not without making some manipulations first.

Let's tidy!

- In this case, I think it's easiest to again add a prefix to each variable prior to the gather, then separate and spread on that prefix.
    - Notice I'm using a space as a delimiter given that some already have underscores.

```
names(star)[4:6] <- paste("size", names(star)[4:6])
names(star)[7:9] <- paste("eth", names(star)[7:9])
head(star)
```

```
## # A tibble: 6 × 12
##   schidkn   sex   frl `size reg_size` `size reg_size_aid`
##     <int> <chr> <chr>           <int>                <int>
## 1      63  girl    no               0                    0
## 2      20  girl    no               0                    0
## 3      19   boy   yes               0                    1
## 4      69   boy    no               1                    0
## 5      79   boy   yes               0                    0
```

Quick aside

If you are using indexing to extract variables, as I did on the previous slide, a better output (I think) is to wrap the names of the data frame in a call to as.data.frame

```
as.data.frame(names(star))
```

```
##          names(star)
## 1            schidkn
## 2                sex
## 3                frl
## 4       size reg_size
## 5  size reg_size_aid
## 6    size small_size
## 7          eth white
## 8          eth black
## 9          eth other
## 10            totexp
## 11           tmathss
## 12           treadss
```

Let's go through this step by step

- Note - we're essentially un-dummy-coding these variables

```
library(tidyverse)
star_tidy <- star %>%
  mutate(sid = row_number()) %>%
  gather(var, val, c(4:9)) %>%
  separate(var, c("var", "val2"), sep = " ") %>%
  filter(val == 1) %>%
  select(-val) %>%
  spread(var, val2)  %>%
  arrange(sid)
star_tidy
```

```
## # A tibble: 5,748 × 9
##    schidkn   sex   frl totexp tmathss treadss   sid   eth         size
##      <int> <chr> <chr>  <int>   <int>   <int> <int> <chr>        <chr>
## 1       63  girl    no      7     473     447     1 white   small_size
## 2       20  girl    no     21     536     450     2 black   small_size
## 3       19   boy   yes      0     463     439     3 black reg_size_aid
## 4       69   boy    no     16     559     448     4 white     reg_size
## 5       79   boy   yes      5     489     447     5 white   small_size
```

Quick housekeeping

- Let's reorder the variables to make it a little tidy-er

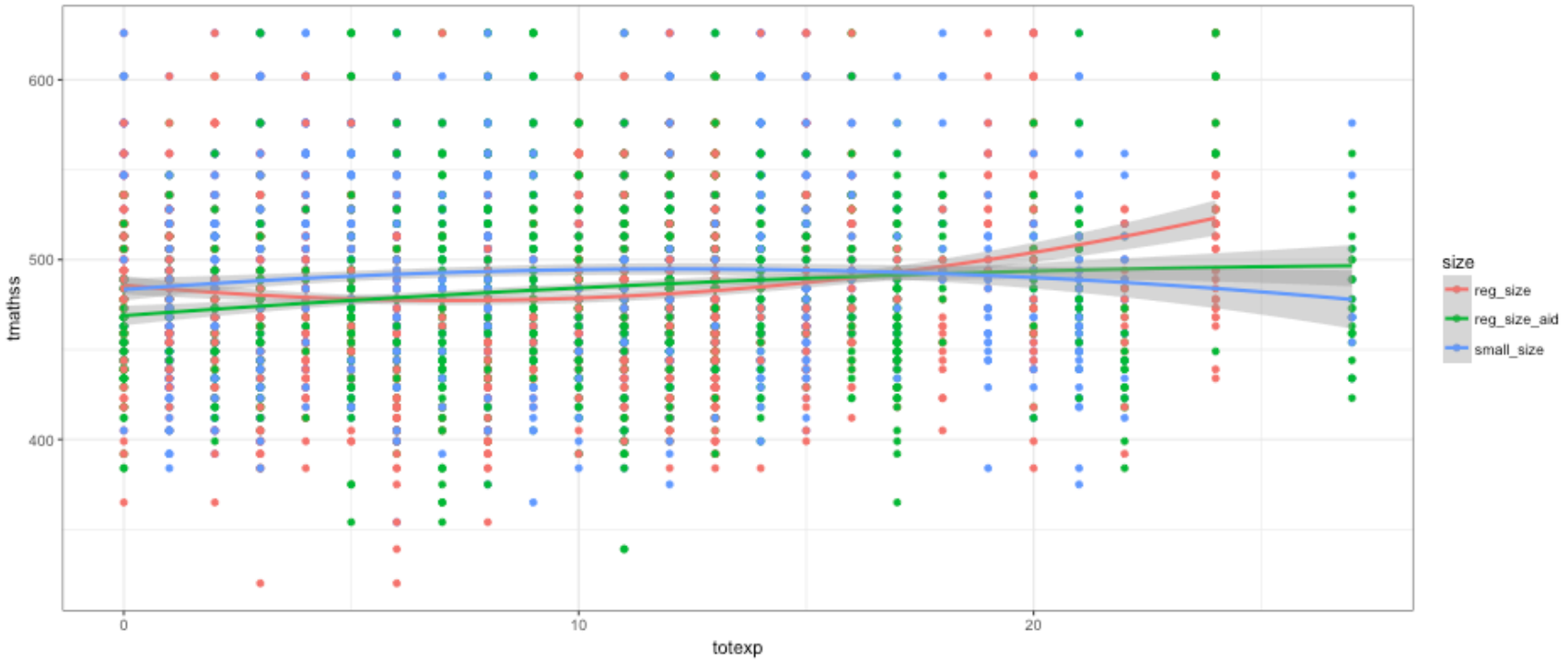
```
star_tidy <- star_tidy %>%
    select(sid, schidkn, sex, frl, eth, totexp, size, 5:6)
star_tidy
```

```
## # A tibble: 5,748 × 9
##      sid schidkn   sex   frl   eth totexp         size tmathss treadss
##    <int>   <int> <chr> <chr> <chr>  <int>        <chr>   <int>   <int>
## 1      1      63  girl    no white      7   small_size     473     447
## 2      2      20  girl    no black     21   small_size     536     450
## 3      3      19   boy   yes black      0 reg_size_aid     463     439
## 4      4      69   boy    no white     16     reg_size     559     448
## 5      5      79   boy   yes white      5   small_size     489     447
## 6      6       5   boy   yes white      8     reg_size     454     431
## 7      7      16  girl   yes black     17 reg_size_aid     423     395
## 8      8      56  girl    no white      3     reg_size     500     451
## 9      9      11  girl    no black     11   small_size     439     478
## 10    10      66  girl    no white     10   small_size     528     455
## # ... with 5,738 more rows
```

Now can we produce it?

Yes!

```
theme_set(theme_bw())
ggplot(star_tidy, aes(totexp, tmathss, color = size)) +
  geom_point() +
  geom_smooth(method = "loess", span = 15)
```



What if...

- We wanted to have a plot faceted by subject? What would we need to do?

`gather` once more

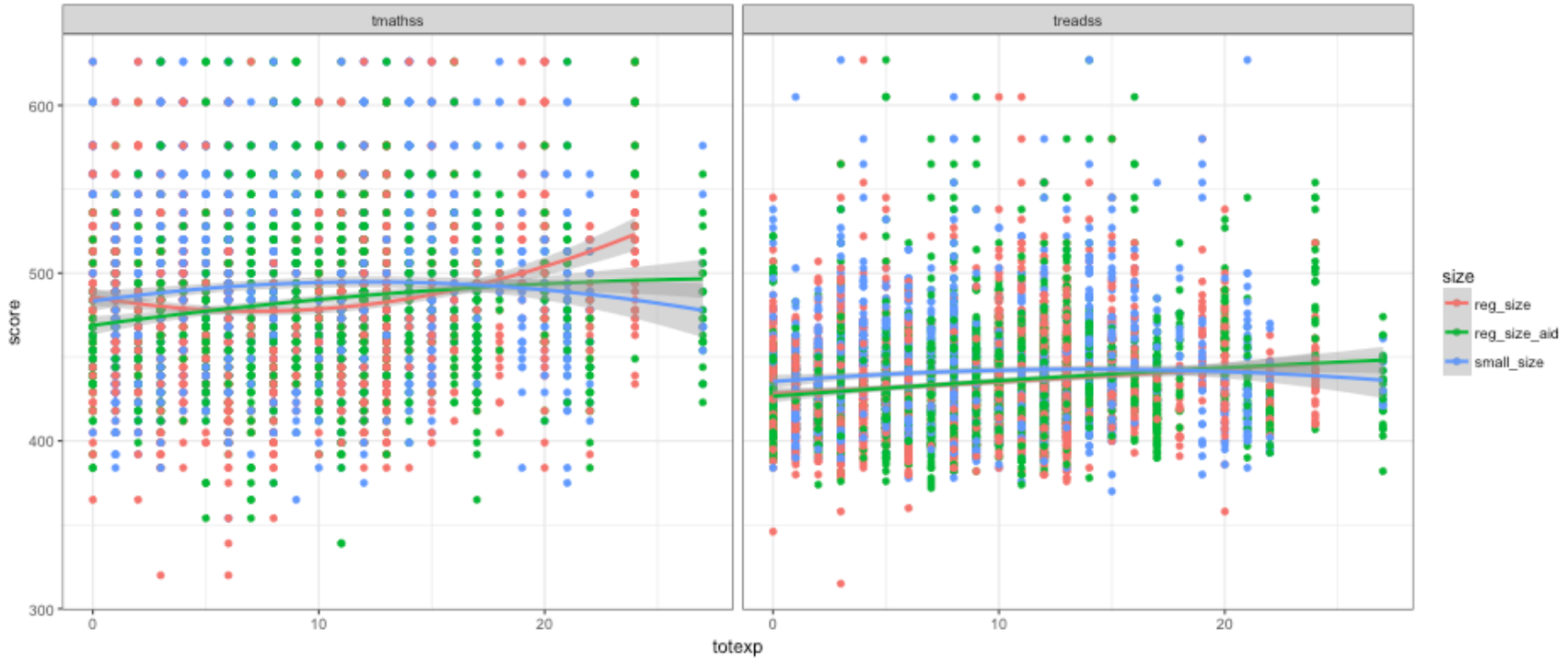
- Note, this is still tidy, but the level of analysis has changed. In other words, before, each case (row) represented a student. Now, each case represents a student within a content area.

```
gathered_star_tidy <- star_tidy %>%
    gather(subject, score, tmathss:treadss)
gathered_star_tidy
```

```
## # A tibble: 11,496 × 9
##      sid schidkn   sex   frl   eth totexp         size subject score
##    <int>   <int> <chr> <chr> <chr>  <int>        <chr>   <chr> <int>
## 1      1      63  girl    no white      7   small_size tmathss   473
## 2      2      20  girl    no black     21   small_size tmathss   536
## 3      3      19   boy   yes black      0 reg_size_aid tmathss   463
## 4      4      69   boy    no white     16     reg_size tmathss   559
## 5      5      79   boy   yes white      5   small_size tmathss   489
## 6      6       5   boy   yes white      8     reg_size tmathss   454
## 7      7      16  girl   yes black     17 reg_size_aid tmathss   423
## 8      8      56  girl    no white      3     reg_size tmathss   500
## 9      9      11  girl    no black     11   small_size tmathss   439
## 10    10      66  girl    no white     10   small_size tmathss   528
## # ... with 11,486 more rows
```

faceted by subject

```
ggplot(gathered_star_tidy, aes(totexp, score, color = size)) +
  geom_point() +
  geom_smooth(method = "loess", span = 15) +
  facet_wrap(~subject)
```



Plotting summaries

Compute first

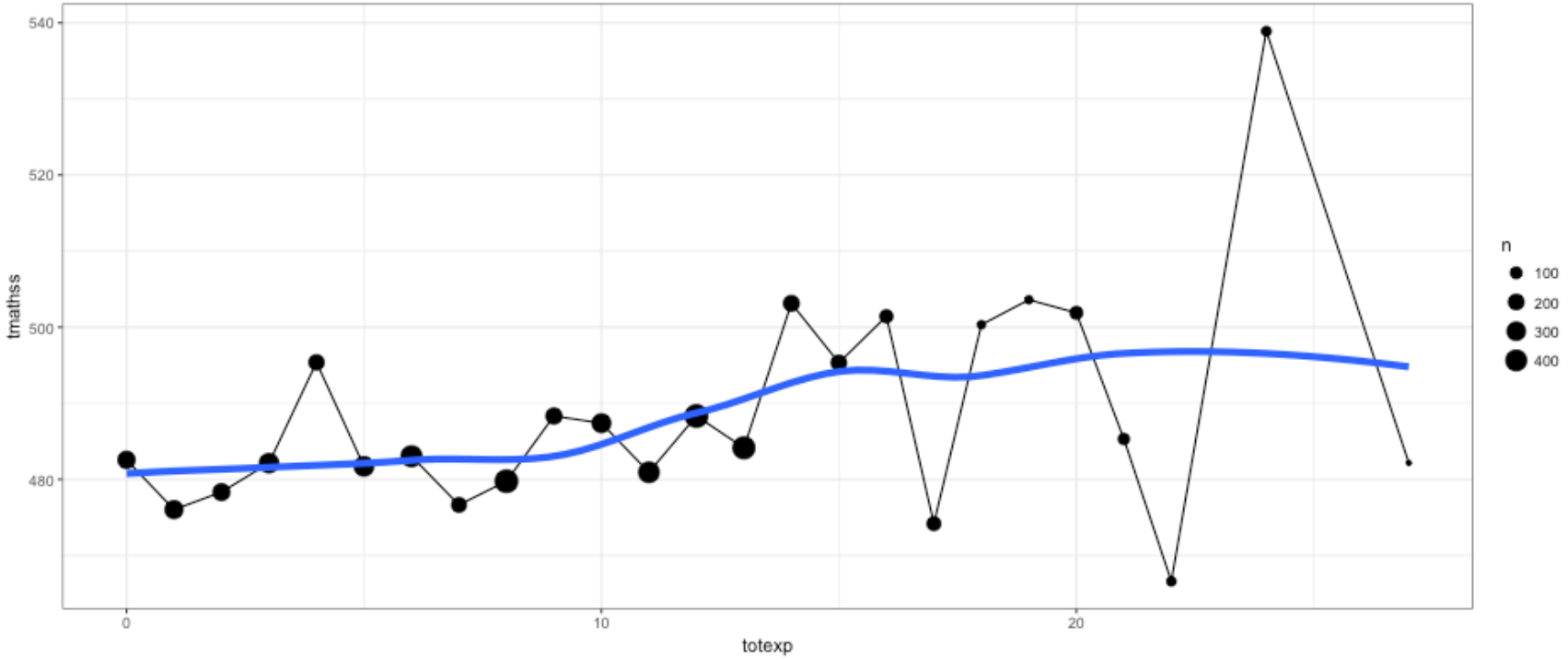
- Produce a summary dataset
- Plot results

```
by_exp <- star_tidy %>%
    group_by(totexp) %>%
    summarize(n = n(),
              tmathss = mean(tmathss))
by_exp
```

```
## # A tibble: 25 × 3
##    totexp     n  tmathss
##     <int> <int>    <dbl>
## 1       0   252 482.5714
## 2       1   284 476.0317
## 3       2   242 478.3306
## 4       3   339 482.1327
## 5       4   191 495.3770
## 6       5   348 481.7155
## 7       6   406 483.0419
## 8       7   175 476.6457
## 9       8   488 479.7582
```

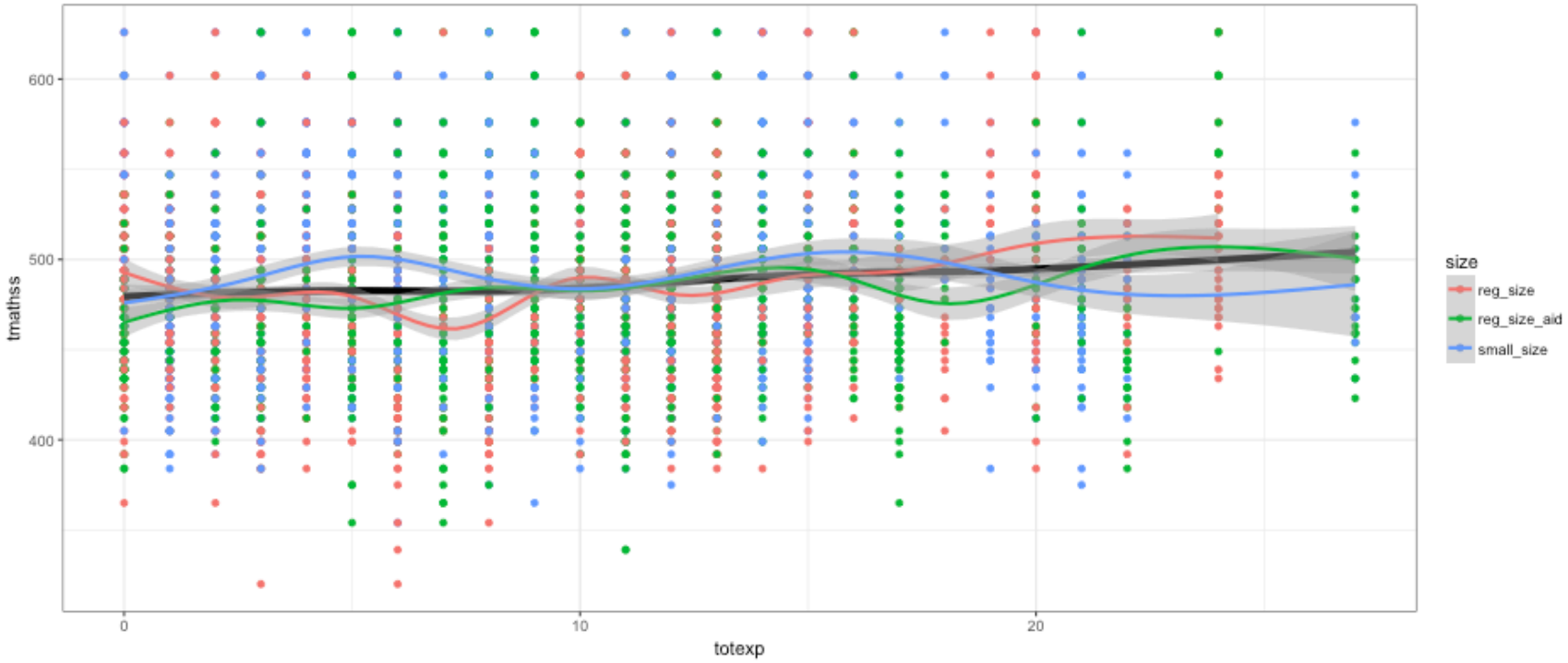
```
ggplot(by_exp, aes(totexp, tmathss)) +
    geom_point(aes(size = n)) +
    geom_line() +
    geom_smooth(se = FALSE, lwd = 2)
```

```
## `geom_smooth()` using method = 'loess'
```



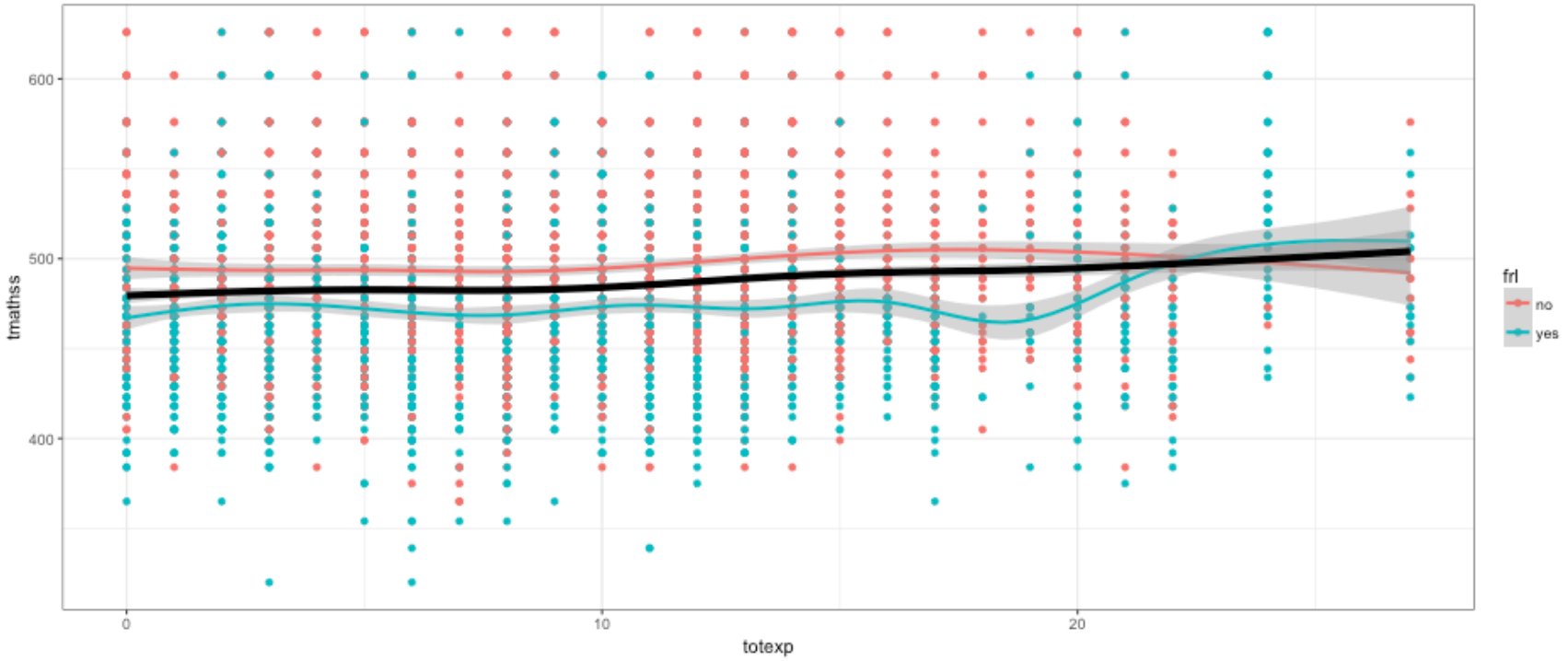
Summaries with raw data

```
ggplot(star_tidy, aes(totexp, tmathss)) +
  geom_point(aes(color = size)) +
  geom_smooth(col = "black", lwd = 2) +
  geom_smooth(aes(color = size))
```



Difference by frl?

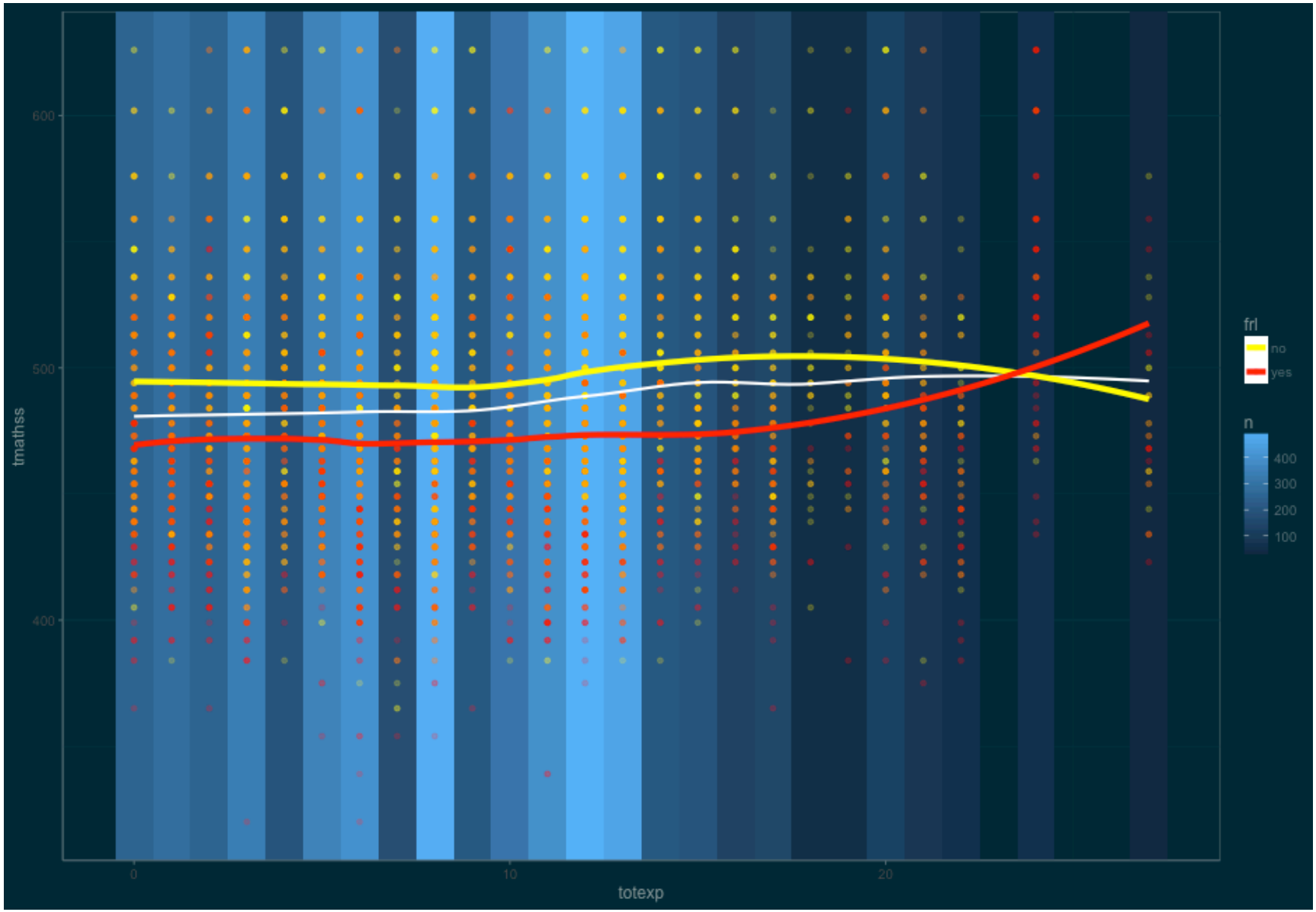
```
ggplot(star_tidy, aes(totexp, tmathss, color = frl)) +
    geom_point() +
    geom_smooth() +
    geom_smooth(data = star_tidy, lwd = 2, col = "black")
```



A complicated example

```
library(ggthemes)
low_y <- min(star_tidy$tmathss, na.rm = TRUE)
high_y <- max(star_tidy$tmathss, na.rm = TRUE)

ggplot(by_exp, aes(totexp, tmathss)) +
    geom_rect(aes(xmin = totexp - 0.5,
                  xmax = totexp + 0.5,
                  fill = n),
              ymin = -Inf,
              ymax = Inf) +
    ylim(low_y, high_y) +
    geom_point(data = star_tidy, aes(color = frl), alpha = .2) +
  geom_smooth(col = "white", lwd = 1, se = FALSE) +
  geom_smooth(data = star_tidy, aes(color = frl),
      lwd = 2,
      se = FALSE,
      method = "loess") +
  scale_color_manual(values = c("yellow", "red")) +
  theme_solarized(light = FALSE)
```

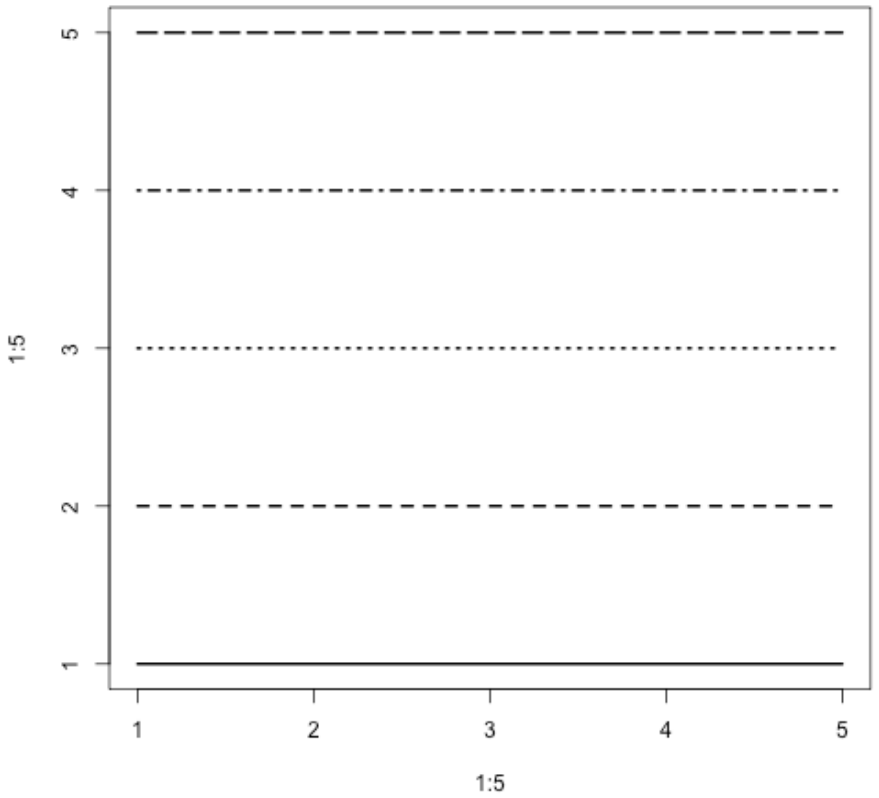

600
500
400
tmathss
0
10
20
totexp
frl
no
yes
n
400
300
200
100

Quick aside

Want to index line type or points by number? Create these references.

```
plot(1:25, 1:25, pch = 1:25)
```


```
plot(1:5, 1:5, type = "n")
for(i in 1:5) lines(x = c(1, 5), y = c(i, i), lty = i, lwd = 2)
```



Challenge