Lec 10 - ggplot2 ecosystem & designing visualization

Statistical Programming

Sem 1, 2020

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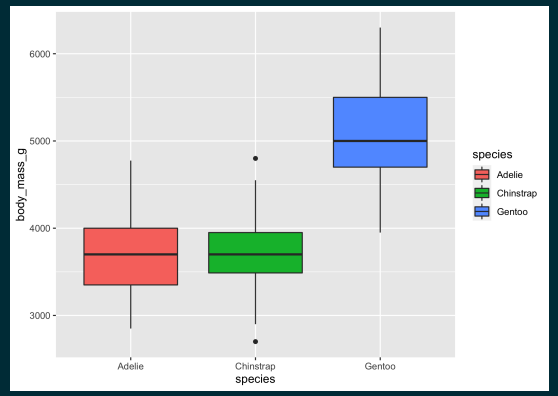
The ggplot2 ecosystem

ggthemes

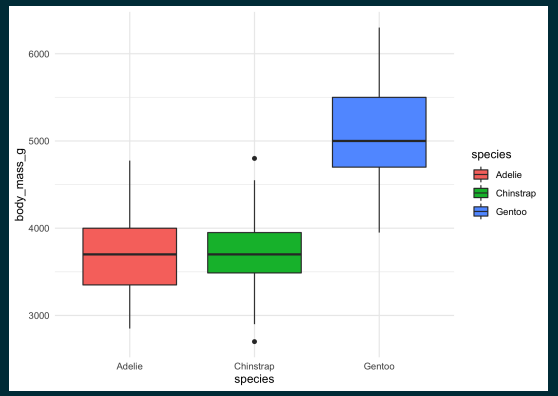
ggplot2 themes

```
g = ggplot(palmerpenguins::penguins, aes(x=species, y=body_mass_g, fill=species)) + geom_boxplot()
```

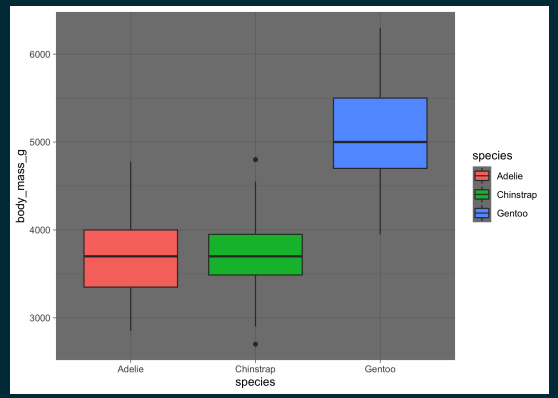
```
g
```



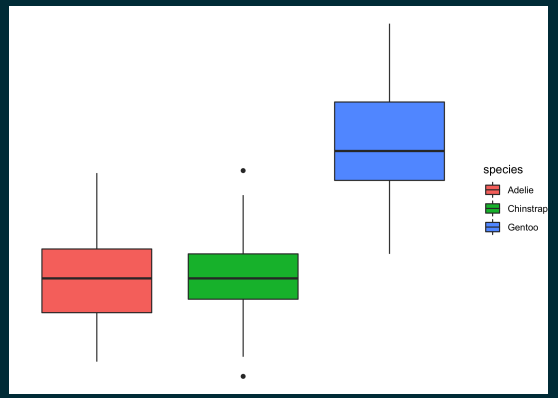

```
g + theme_minimal()
```




```
g + theme_dark()
```

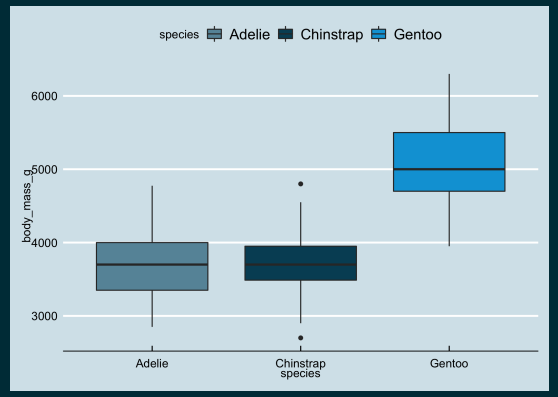



```
g + theme_void()
```

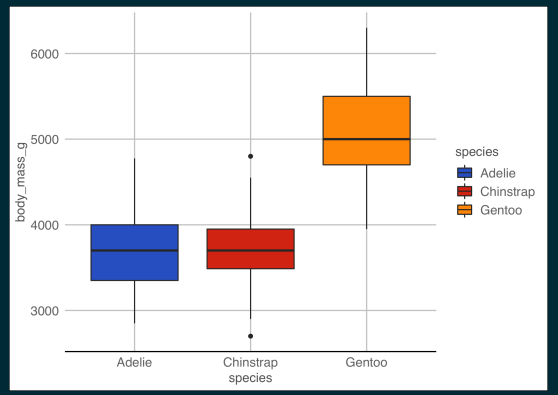


ggthemes

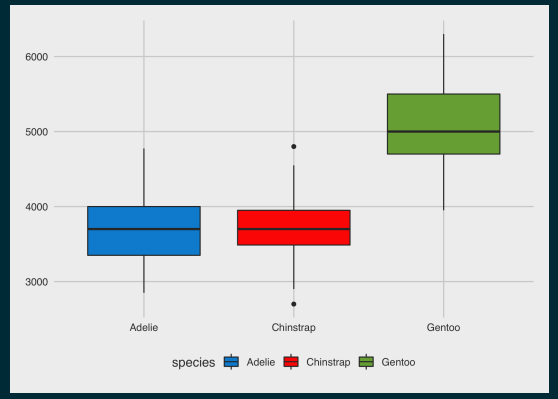
```
g + ggthemes::theme_economist() +
  ggthemes::scale_fill_economist()
```



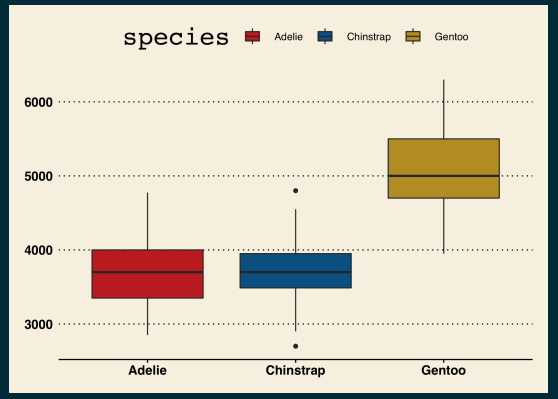

```
g + ggthemes::theme_gdocs() +
  ggthemes::scale_fill_gdocs()
```




```
g + ggthemes::theme_fivethirtyeight() +
  ggthemes::scale_fill_fivethirtyeight()
```

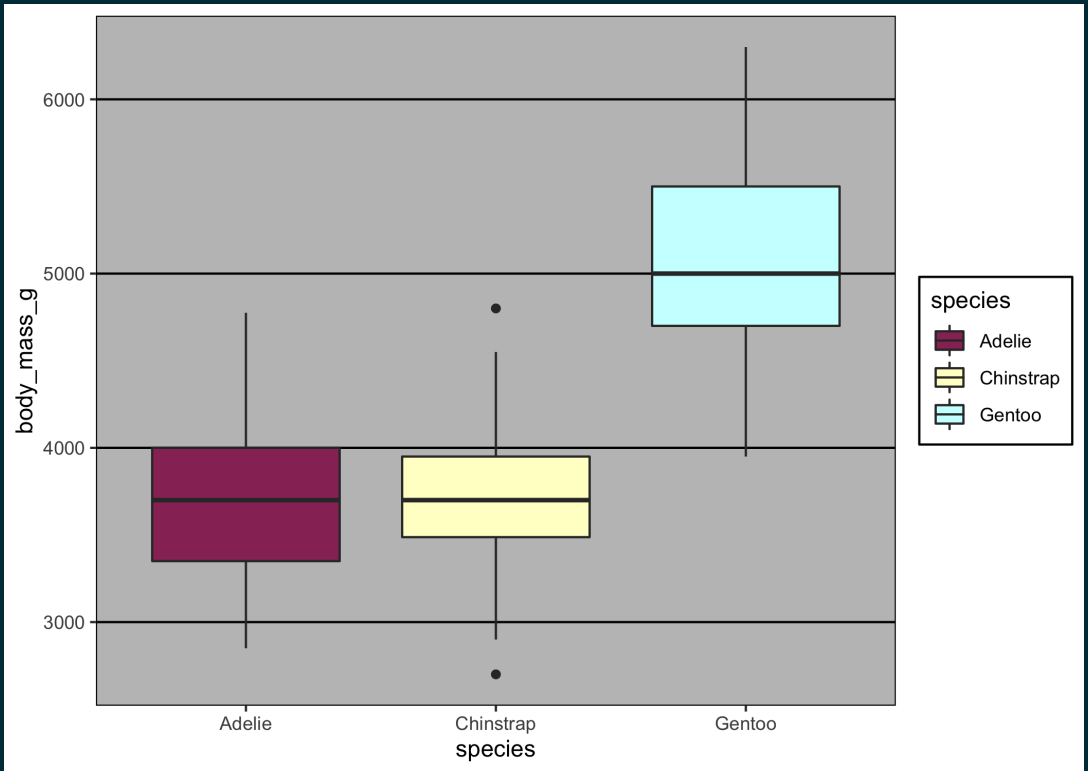



```
g + ggthemes::theme_wsj() +
  ggthemes::scale_fill_wsj()
```

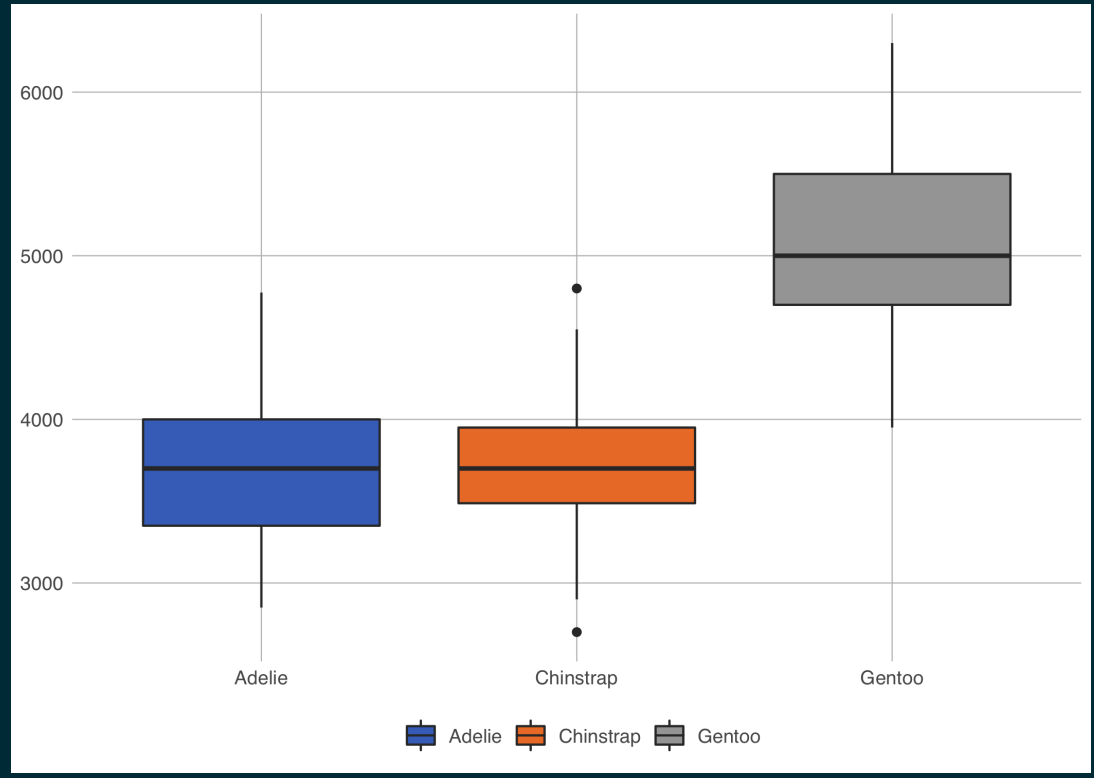


And for those who miss Excel

```
g + ggthemes::theme_excel() +
  ggthemes::scale_fill_excel()
```

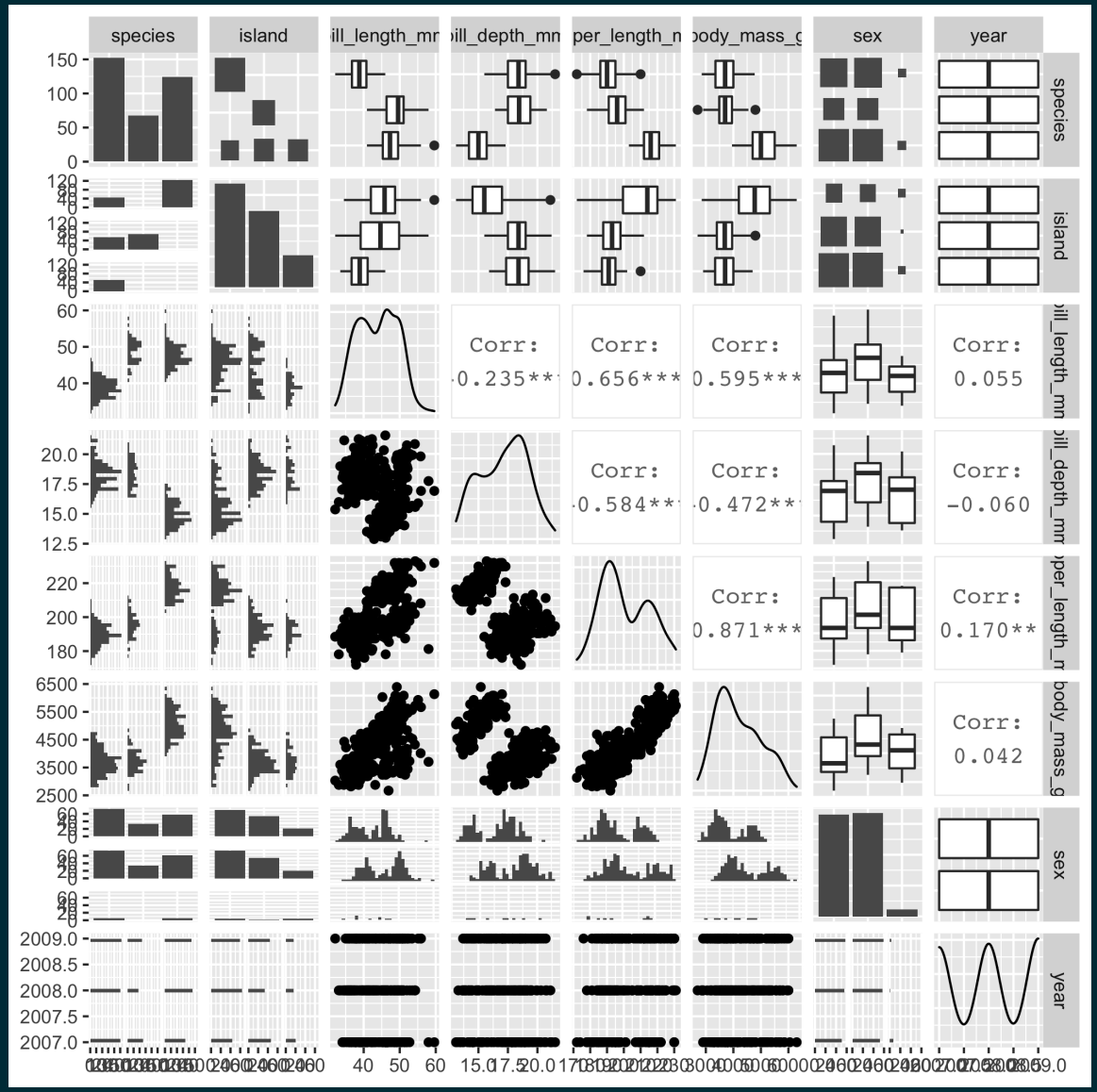


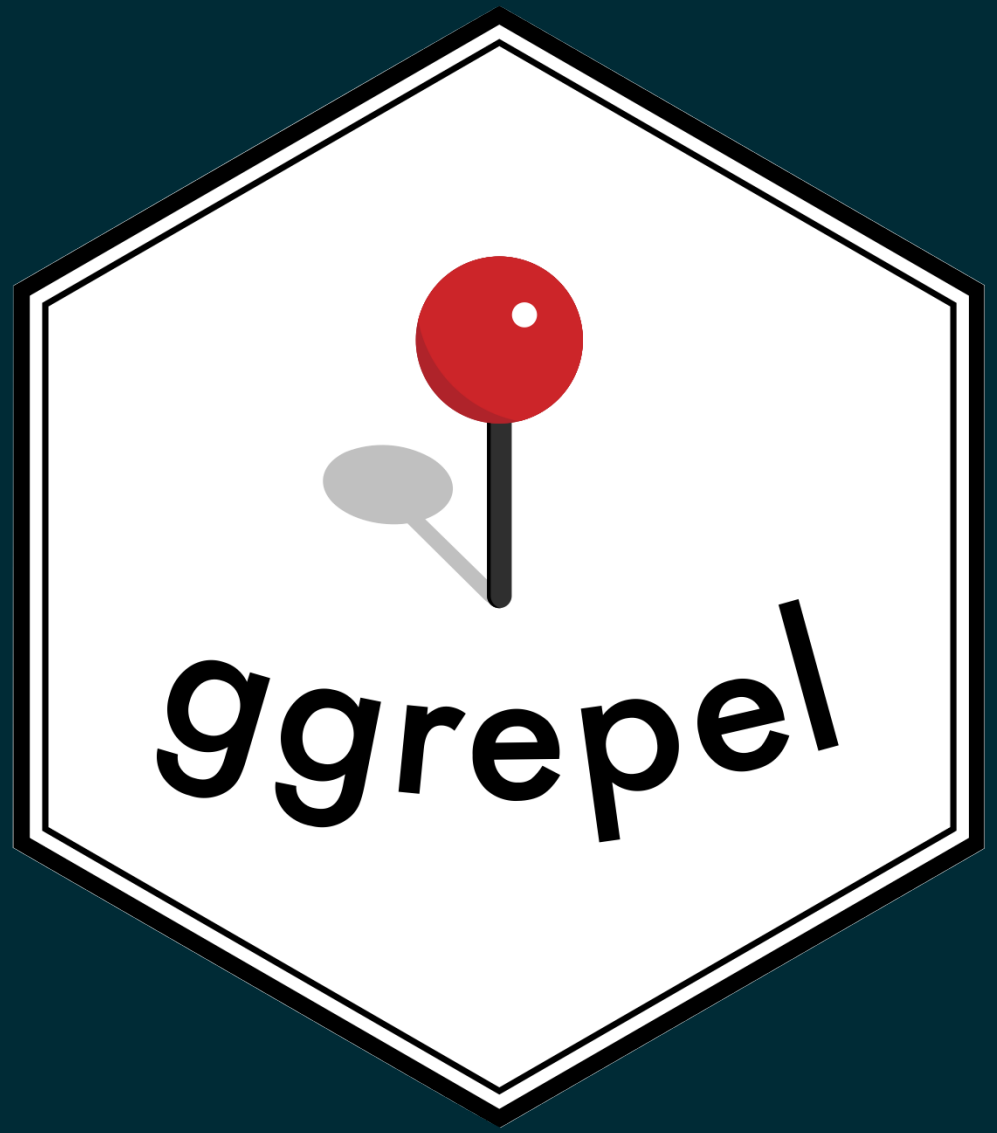

```
g + ggthemes::theme_excel_new() +
  ggthemes::scale_fill_excel_new()
```



GGally

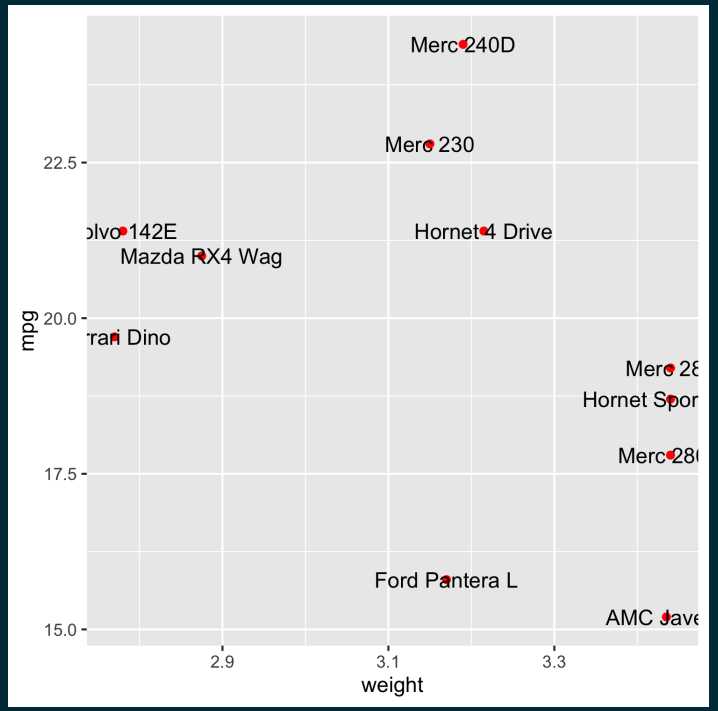
```
GGally::ggpairs(palmerpenguins::penguins)
```



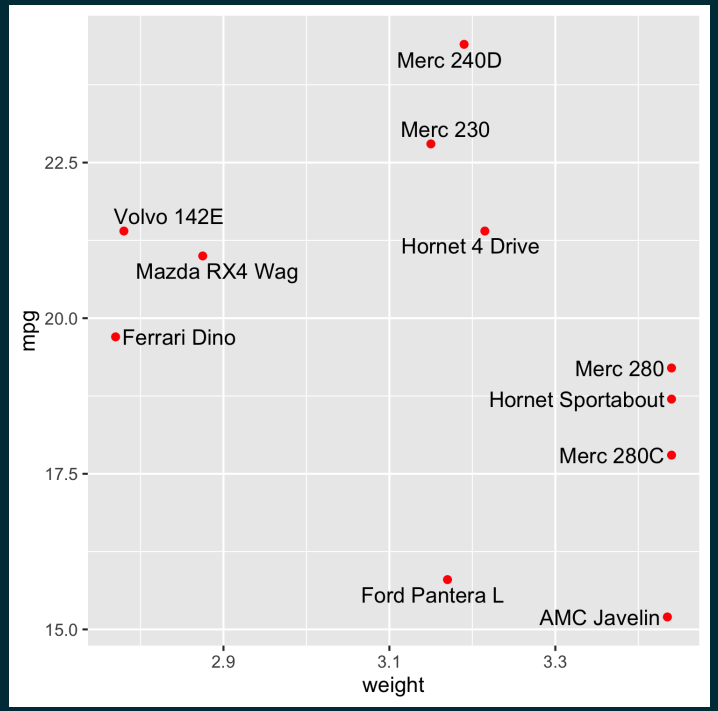

ggrepel

```r
d = tibble(
  car = rownames(mtcars),
  weight = mtcars$wt,
  mpg = mtcars$mpg
) %>%
  filter(weight > 2.75, weight < 3.45)
```

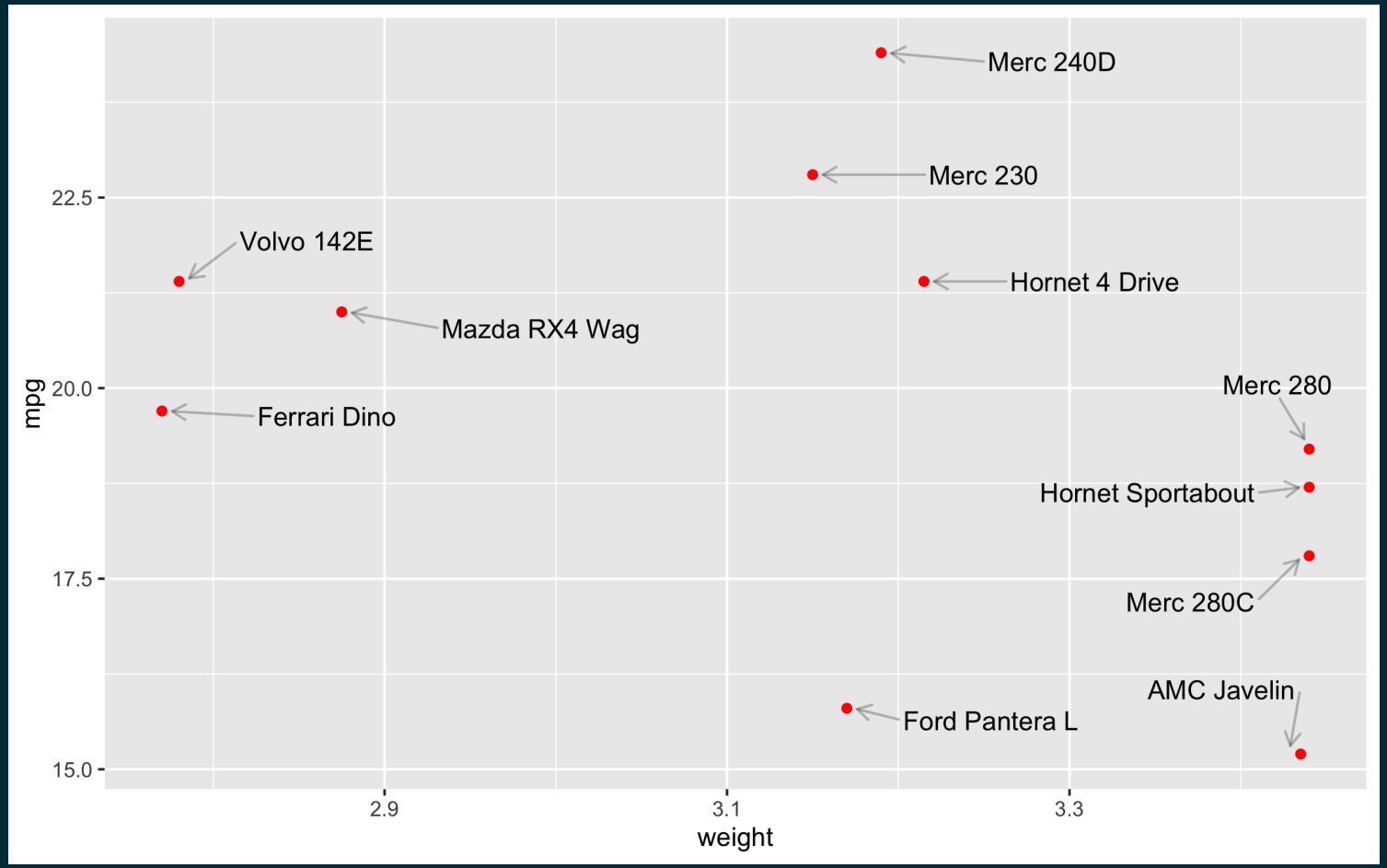
```r
ggplot(d, aes(x=weight, y=mpg)) +
  geom_point(color="red") +
  geom_text(
    aes(label = car)
  )
```




```r
ggplot(d, aes(x=weight, y=mpg)) +
  geom_point(color="red") +
  ggrepel::geom_text_repel(
    aes(label = car)
  )
```



```r
ggplot(d, aes(x=weight, y=mpg)) +
  geom_point(color="red") +
  ggrepel::geom_text_repel(
    aes(label = car),
    nudge_x = .1, box.padding = 1, point.padding = 0.6,
    arrow = arrow(length = unit(0.02, "npc")), segment.alpha = 0.25
  )
```

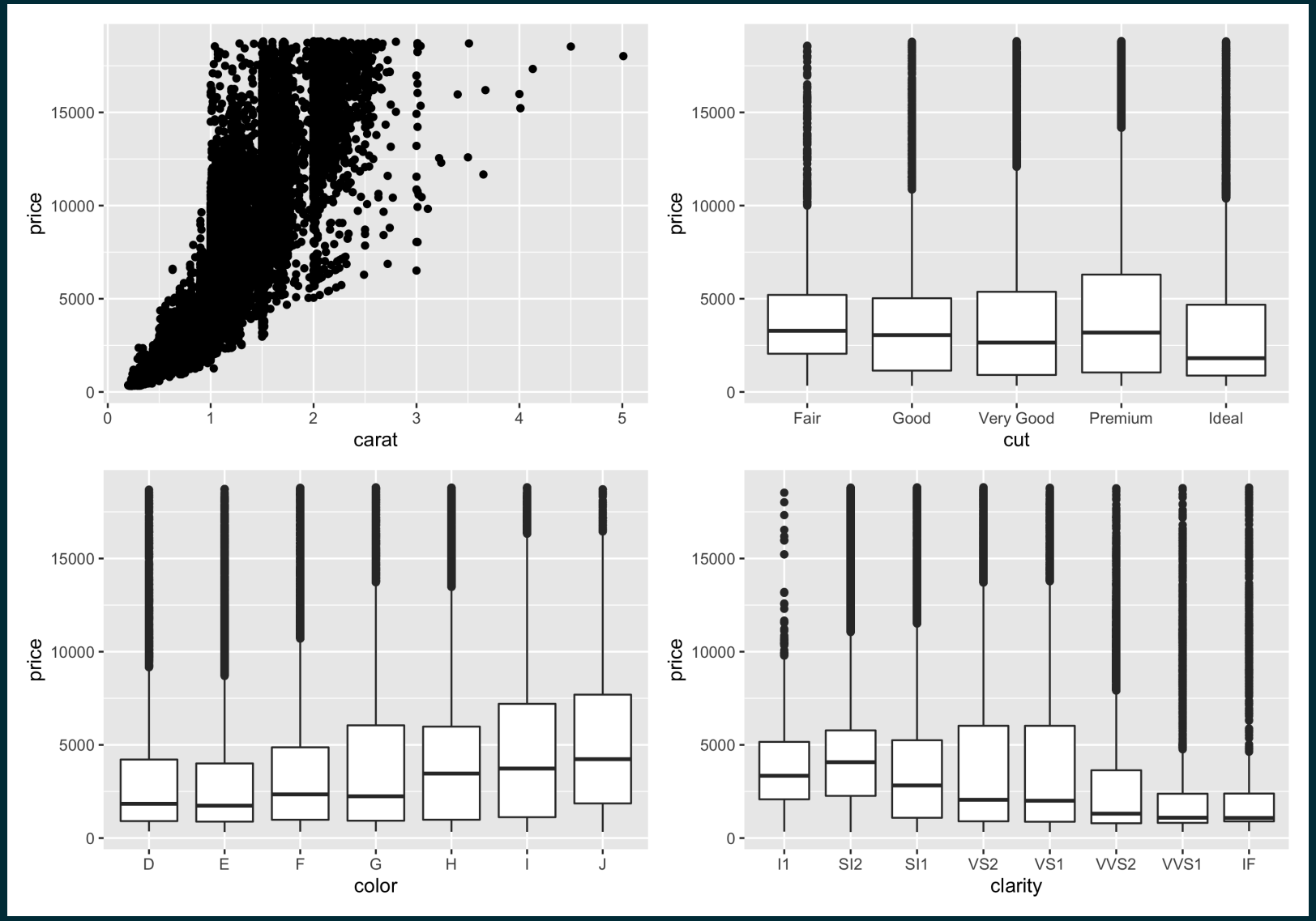



PATCH
WORK

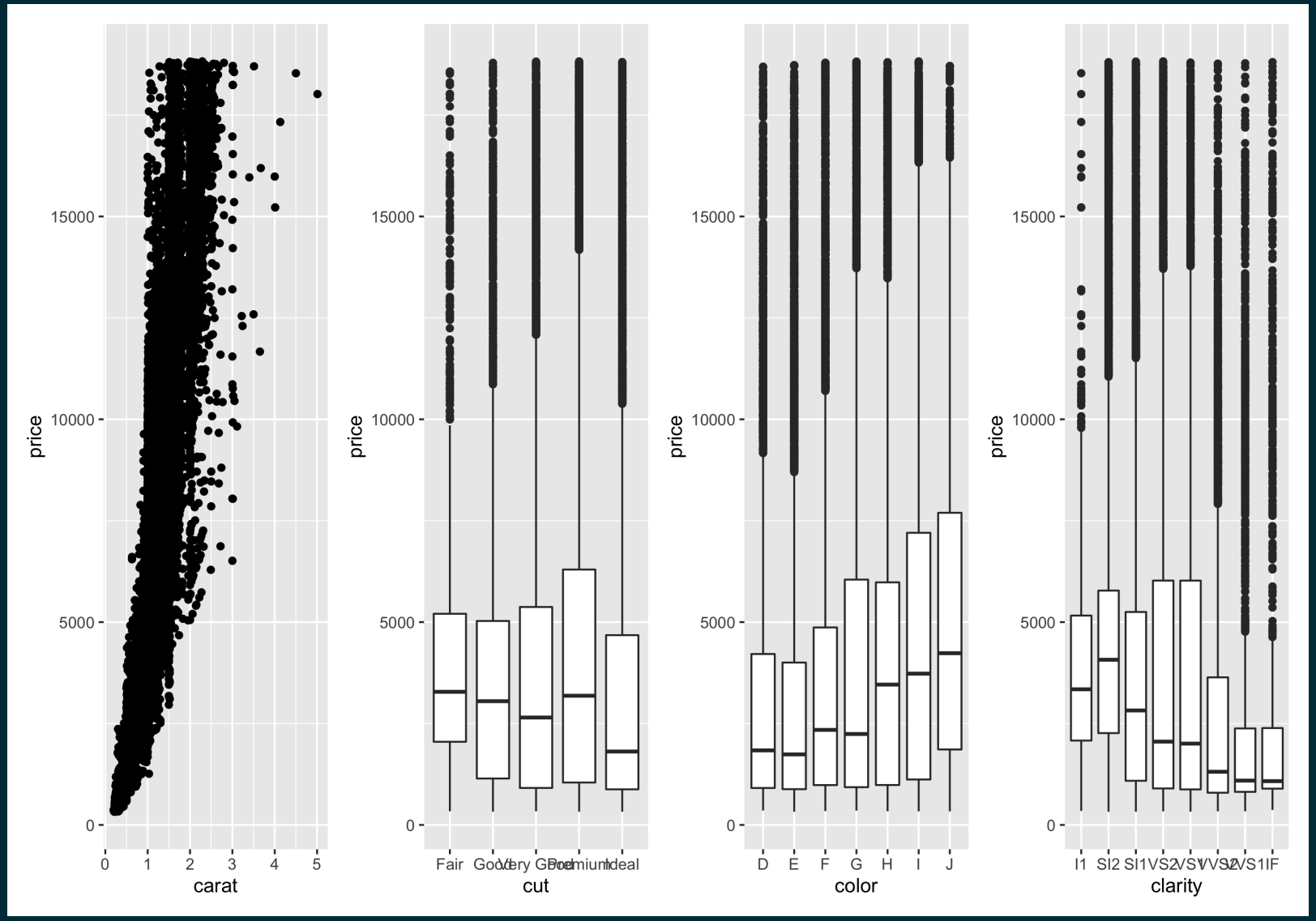
Plot objects

```
library(patchwork)

p1 = ggplot(diamonds) + geom_point(aes(x = carat, y = price))

p2 = ggplot(diamonds) + geom_boxplot(aes(x = cut, y = price))

p3 = ggplot(diamonds) + geom_boxplot(aes(x = color, y = price))

p4 = ggplot(diamonds) + geom_boxplot(aes(x = clarity, y = price))
```

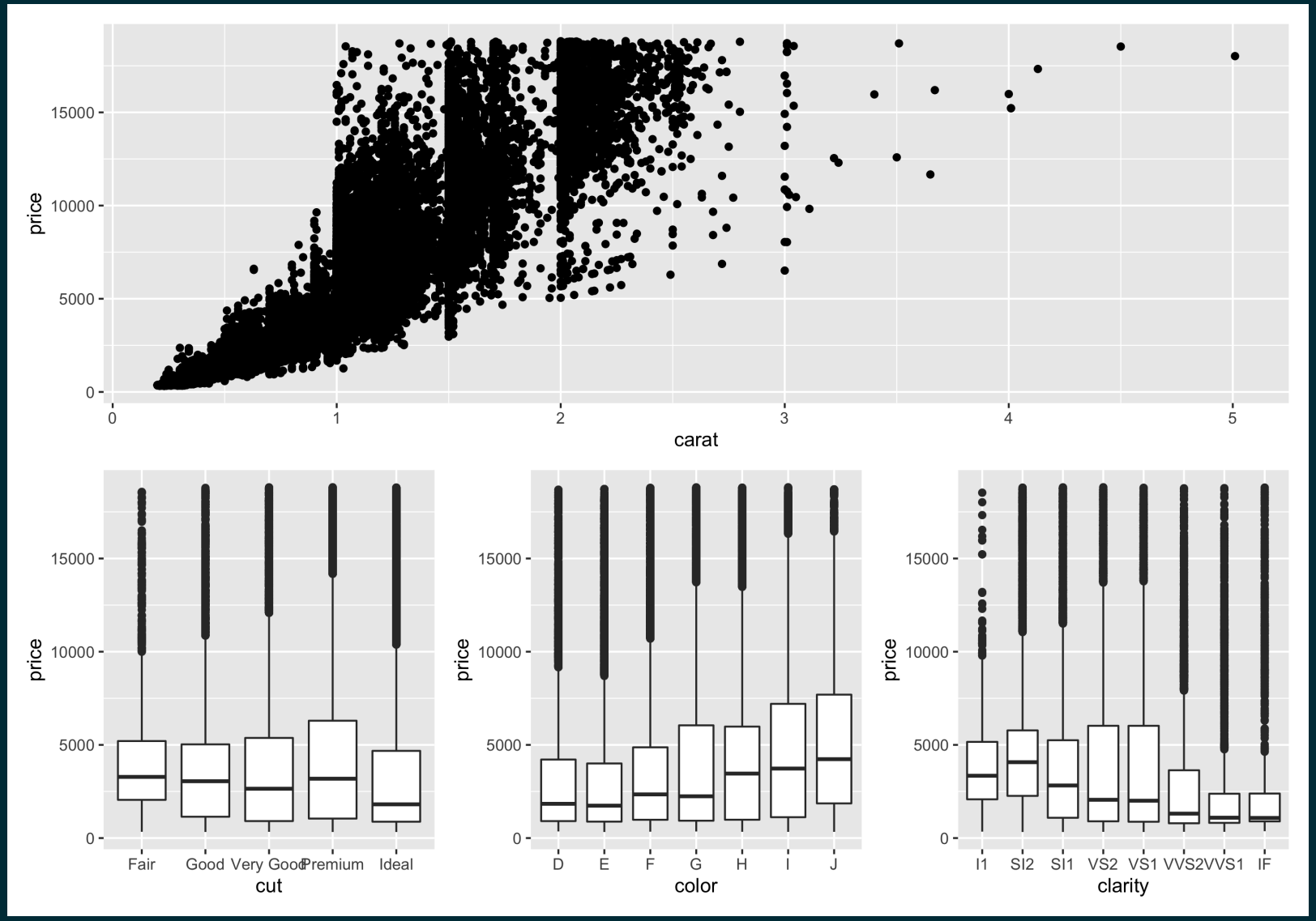
```
p1 + p2 + p3 + p4
```


price
carat
cut
color
clarity
Fair
Good
Very Good
Premium
Ideal
D
E
F
G
H
I
J
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF

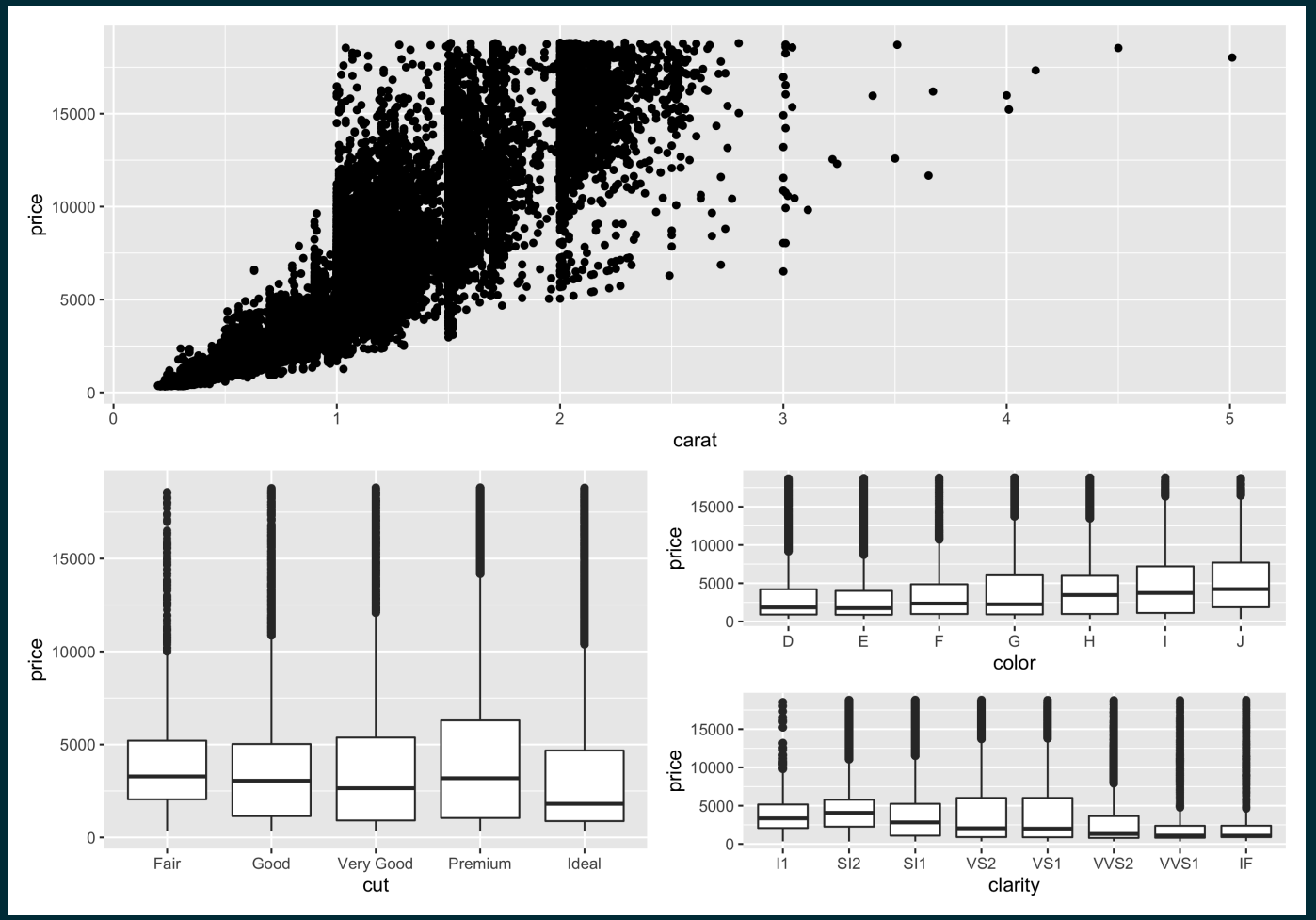
```
p1 + p2 + p3 + p4 + plot_layout(nrow=1)
```



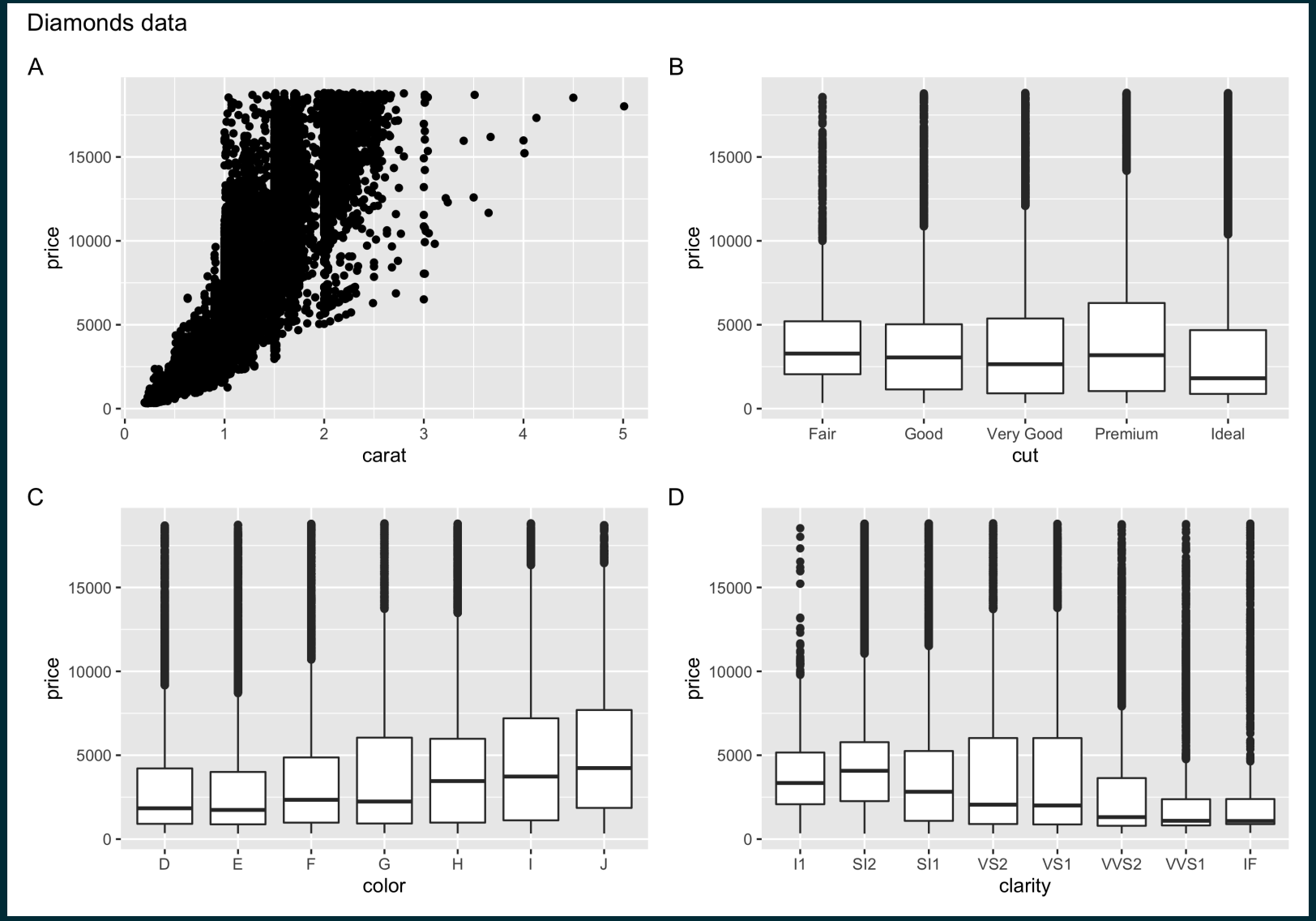
```
p1 / (p2 + p3 + p4)
```

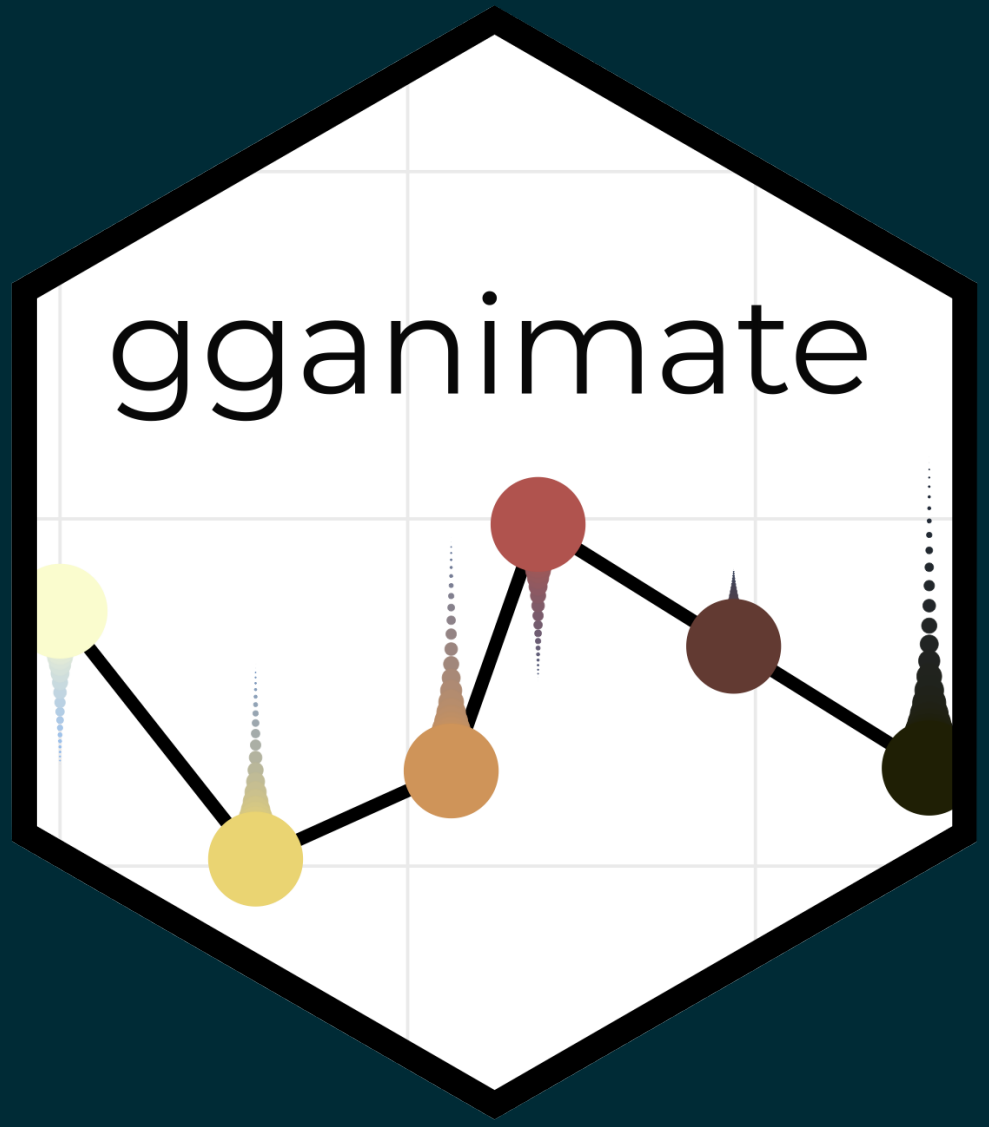

price
15000
10000
5000
0
0
1
2
3
4
5
carat
price
15000
10000
5000
0
Fair
Good
Very Good
Premium
Ideal
cut
price
15000
10000
5000
0
D
E
F
G
H
I
J
color
price
15000
10000
5000
0
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF
clarity

```
p1 + {
  p2 + {
    p3 + p4 + plot_layout(ncol = 1)
  }
} + plot_layout(ncol = 1)
```

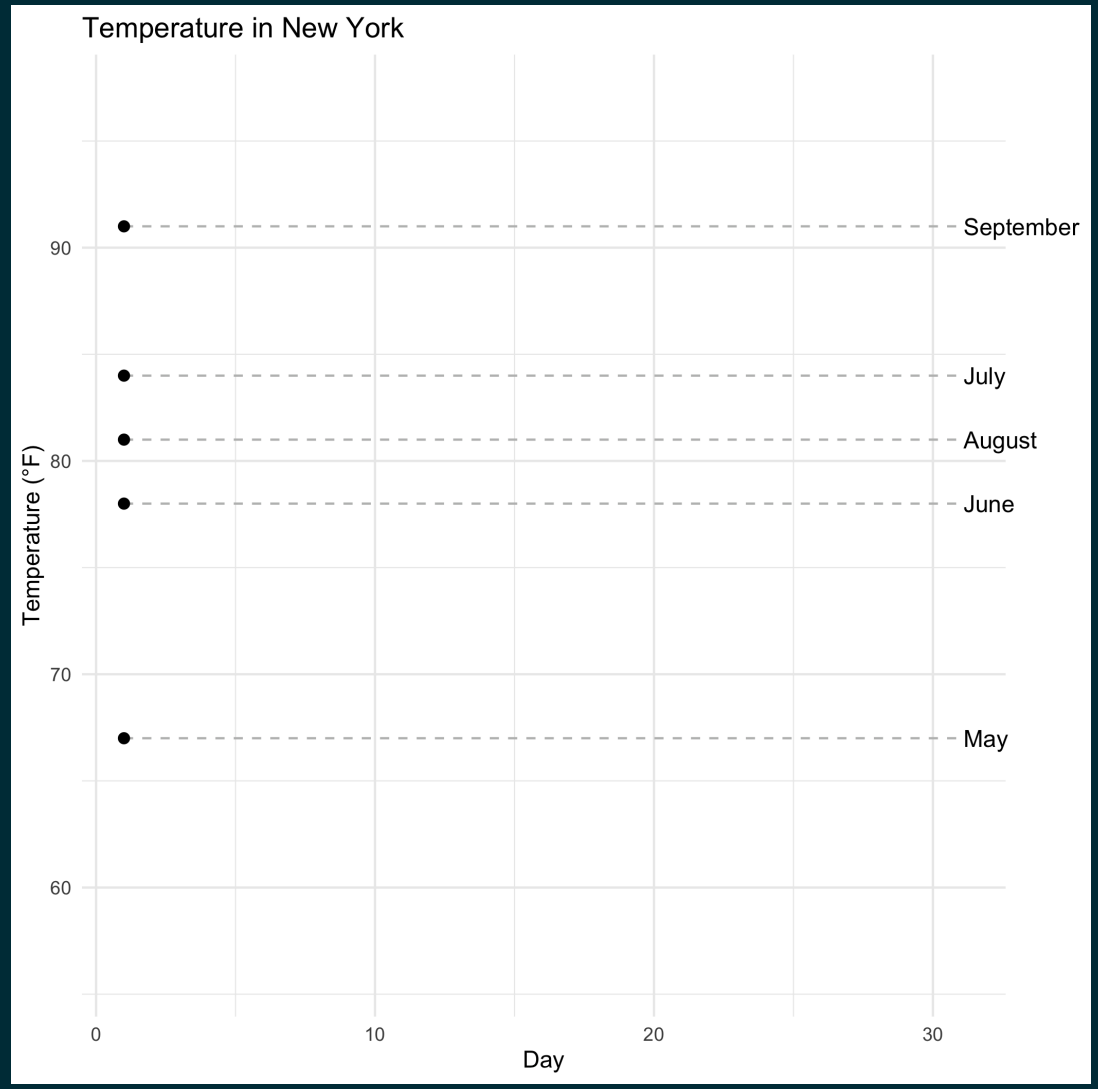


```
p1 + p2 + p3 + p4 + plot_annotation(title = "Diamonds data", tag_levels = c("A","1"))
```




gganimate

```r
airq = airquality
airq$Month = month.name[airq$Month]

ggplot(
  airq,
  aes(Day, Temp, group = Month)
) +
  geom_line() +
  geom_segment(
    aes(xend = 31, yend = Temp),
    linetype = 2,
    colour = 'grey'
  ) +
  geom_point(size = 2) +
  geom_text(
    aes(x = 31.1, label = Month),
    hjust = 0
  ) +
  gganimate::transition_reveal(Day) +
  coord_cartesian(clip = 'off') +
  labs(
    title = 'Temperature in New York',
    y = 'Temperature (°F)'
  ) +
  theme_minimal() +
  theme(plot.margin = margin(5.5, 40, 5.5, 5.5))
```



https://github.com/thomasp85/gganimate

Why do we visualize?

Asncombe's Quartet

```
datasets::anscombe %>% as_tibble()
```

```
## # A tibble: 11 x 8
##       x1    x2    x3    x4    y1    y2    y3    y4
##    <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
##  1    10    10    10     8  8.04  9.14  7.46  6.58
##  2     8     8     8     8  6.95  8.14  6.77  5.76
##  3    13    13    13     8  7.58  8.74 12.7   7.71
##  4     9     9     9     8  8.81  8.77  7.11  8.84
##  5    11    11    11     8  8.33  9.26  7.81  8.47
##  6    14    14    14     8  9.96  8.1   8.84  7.04
##  7     6     6     6     8  7.24  6.13  6.08  5.25
##  8     4     4     4    19  4.26  3.1   5.39 12.5
##  9    12    12    12     8 10.8   9.13  8.15  5.56
## 10     7     7     7     8  4.82  7.26  6.42  7.91
## 11     5     5     5     8  5.68  4.74  5.73  6.89
```

Tidy anscombe

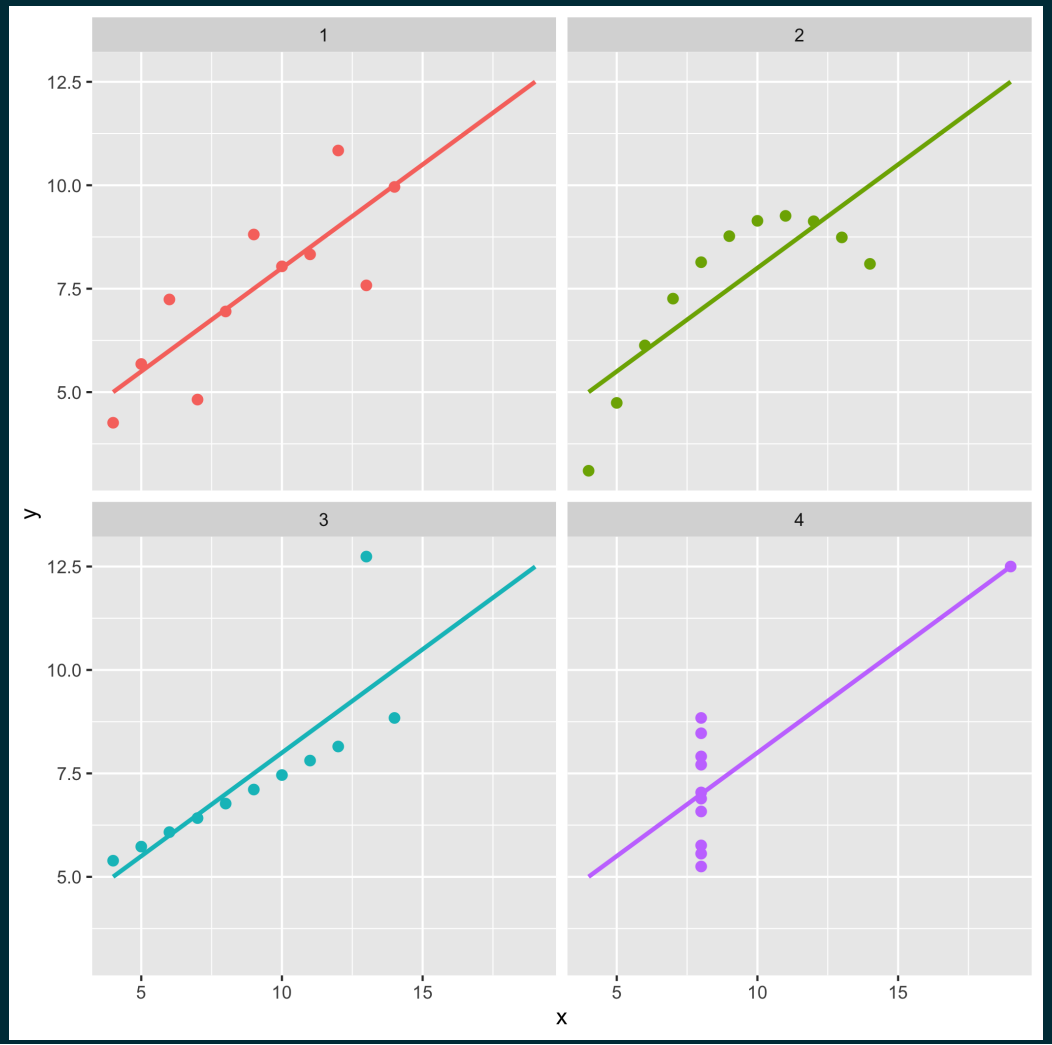
```
(tidy_anscombe = datasets::anscombe %>%
  pivot_longer(everything(), names_sep = 1, names_to = c("var", "group")) %>%
  pivot_wider(id_cols = group, names_from = var,
              values_from = value, values_fn = list(value = list)) %>%
  unnest(cols = c(x,y)))
```

```
## # A tibble: 44 x 3
##    group     x     y
##    <chr> <dbl> <dbl>
##  1 1        10  8.04
##  2 1         8  6.95
##  3 1        13  7.58
##  4 1         9  8.81
##  5 1        11  8.33
##  6 1        14  9.96
##  7 1         6  7.24
##  8 1         4  4.26
##  9 1        12 10.8
## 10 1         7  4.82
## # … with 34 more rows
```

```r
tidy_anscombe %>%
  group_by(group) %>%
  summarize(
    mean_x = mean(x), mean_y = mean(y),
    sd_x = sd(x), sd_y = sd(y),
    cor = cor(x,y), .groups = "drop"
  )
```

```
## # A tibble: 4 x 6
##   group mean_x mean_y  sd_x  sd_y   cor
##   <chr>  <dbl>  <dbl> <dbl> <dbl> <dbl>
## 1 1          9   7.50  3.32  2.03 0.816
## 2 2          9   7.50  3.32  2.03 0.816
## 3 3          9   7.5   3.32  2.03 0.816
## 4 4          9   7.50  3.32  2.03 0.817
```

```
ggplot(tidy_anscombe, aes(x = x, y = y, color = as.factor(group))) +
  geom_point(size=2) +
  facet_wrap(~group) +
  geom_smooth(method="lm", se=FALSE, fullrange=TRUE, formula = y~x) +
  guides(color=FALSE)
```

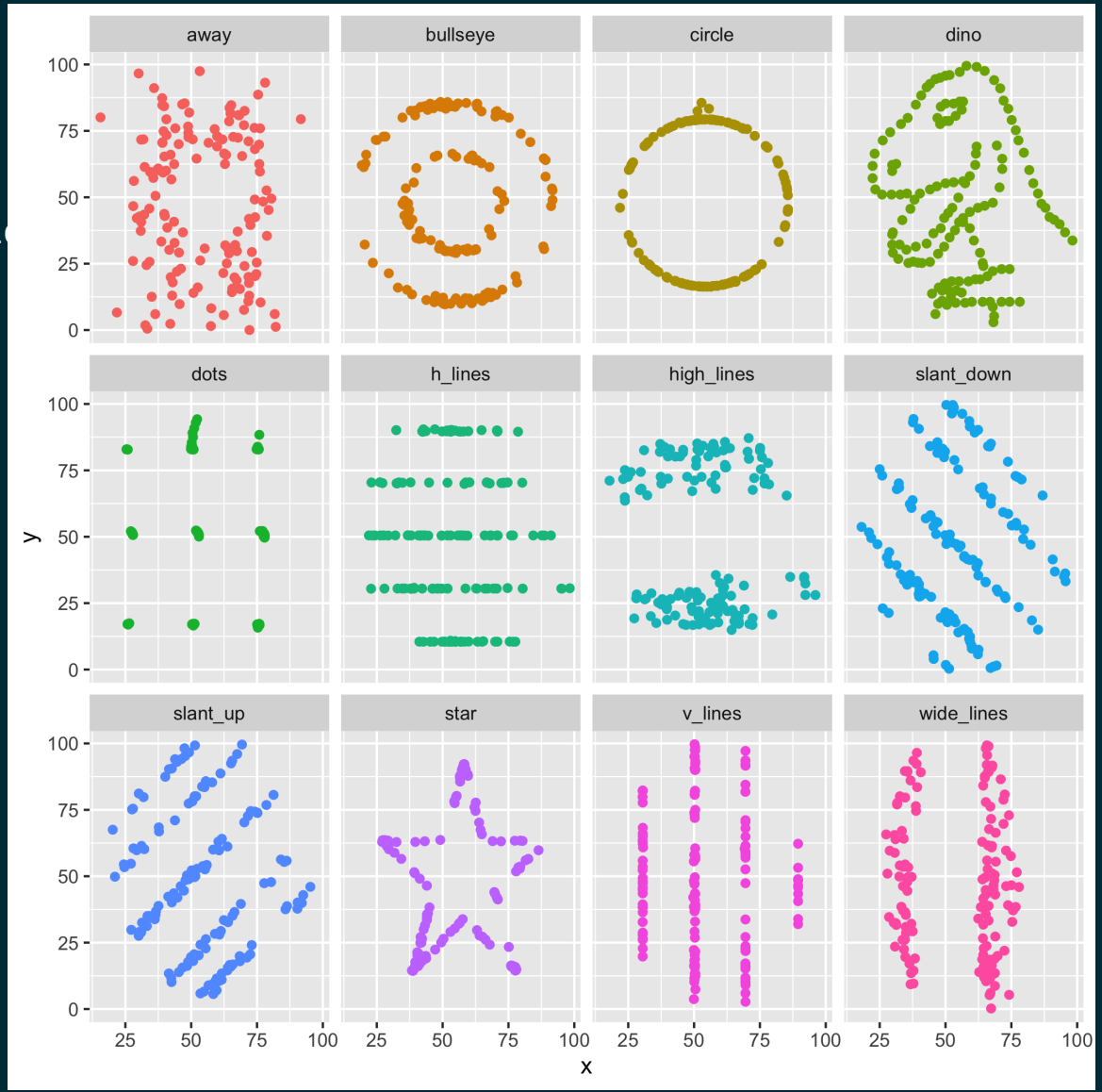


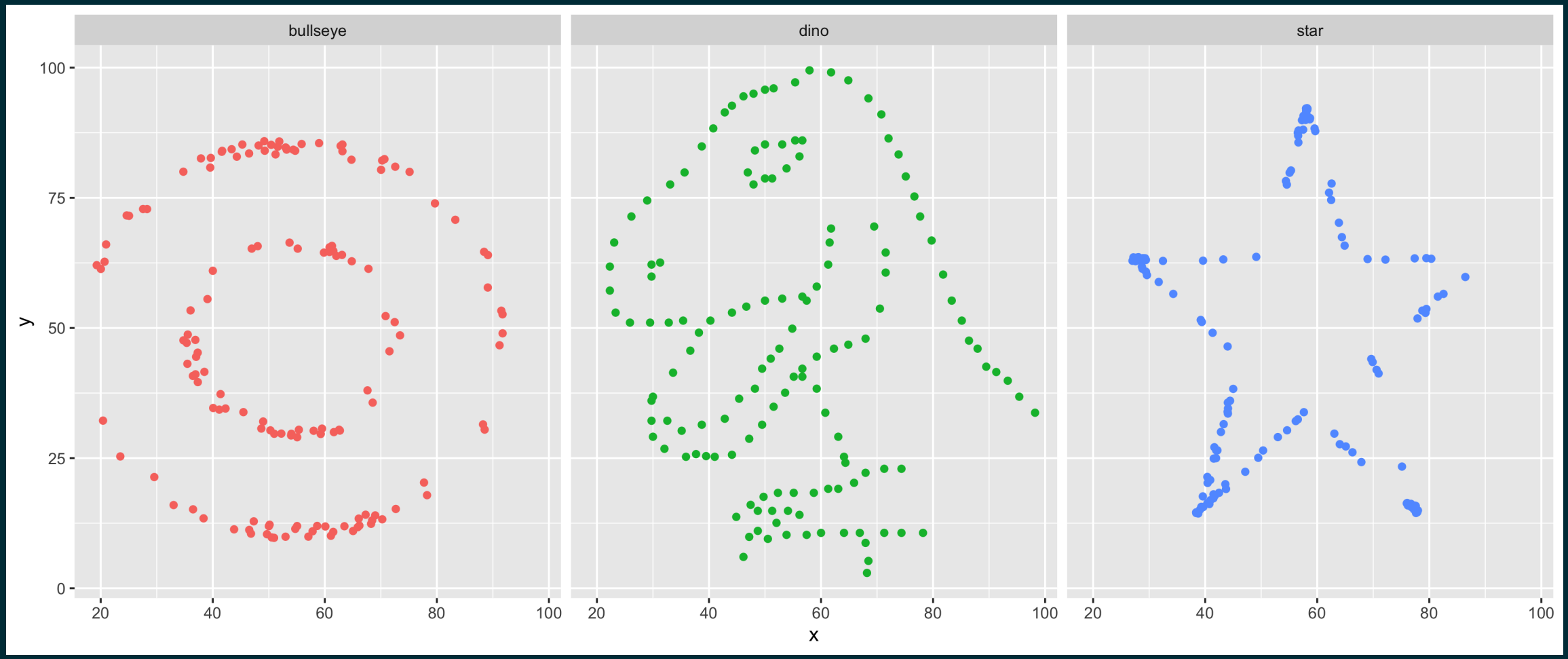
DatasauRus

```
library(datasauRus)
```

```
##
## Attaching package: 'datasauRus'
## The following object is masked _by_ '.Gl
##
##     datasaurus_dozen
```

```
ggplot(
  datasaurus_dozen,
  aes(
    x = x, y = y,
    color = dataset
  )
) +
  geom_point() +
  facet_wrap(~dataset) +
  guides(color=FALSE)
```




bullseye
dino
star
100
75
50
25
0
y
20
40
60
80
100
x

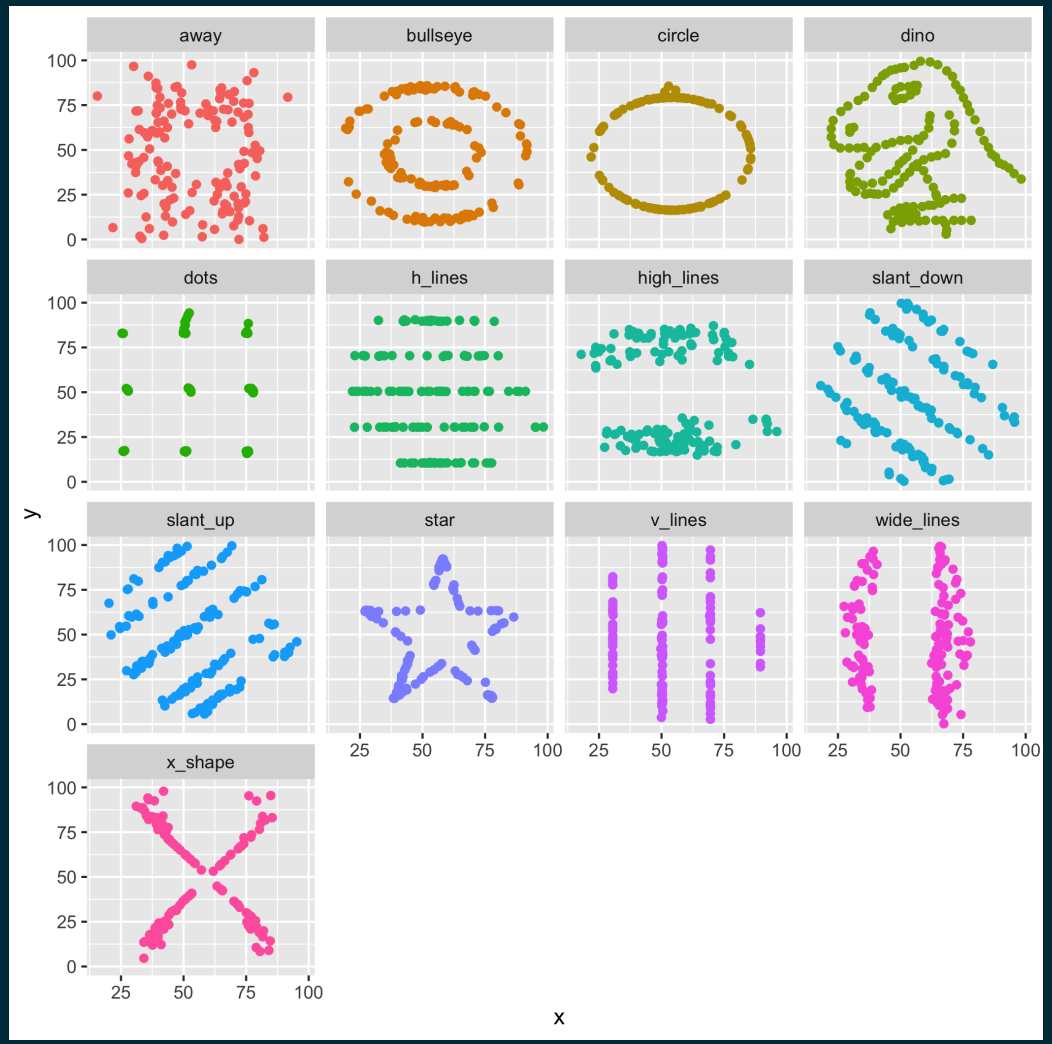
```
datasauRus::datasaurus_dozen
```

```
## # A tibble: 1,846 x 3
##    dataset     x     y
##    <chr>   <dbl> <dbl>
##  1 dino     55.4  97.2
##  2 dino     51.5  96.0
##  3 dino     46.2  94.5
##  4 dino     42.8  91.4
##  5 dino     40.8  88.3
##  6 dino     38.7  84.9
##  7 dino     35.6  79.9
##  8 dino     33.1  77.6
##  9 dino     29.0  74.5
## 10 dino     26.2  71.4
## # … with 1,836 more rows
```

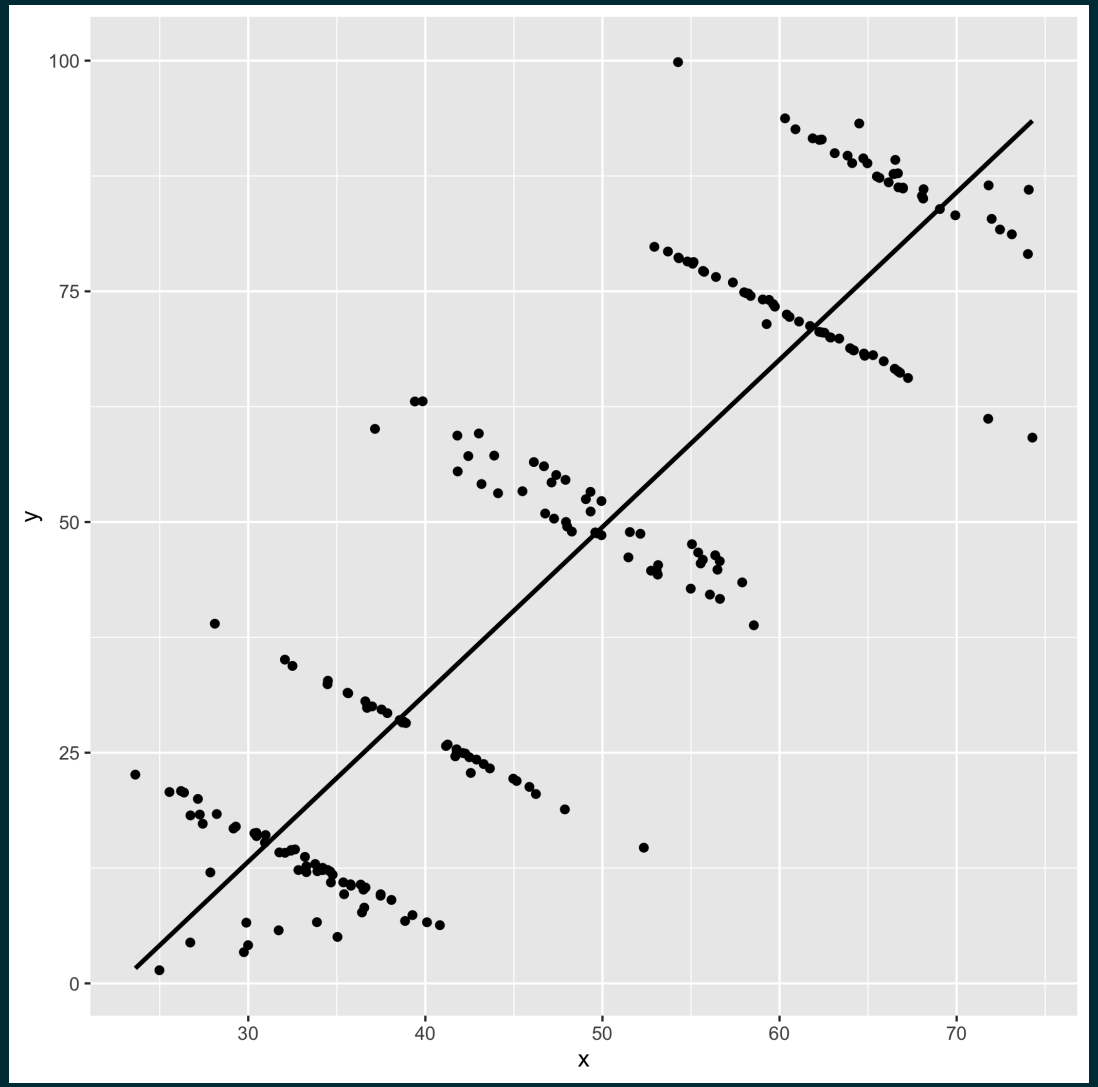
```
datasaurus_dozen %>%
  group_by(dataset) %>%
  summarize(mean_x = mean(x), mean_y = mean(y),
            sd_x = sd(x), sd_y = sd(y),
            cor = cor(x,y), .groups = "drop")
```

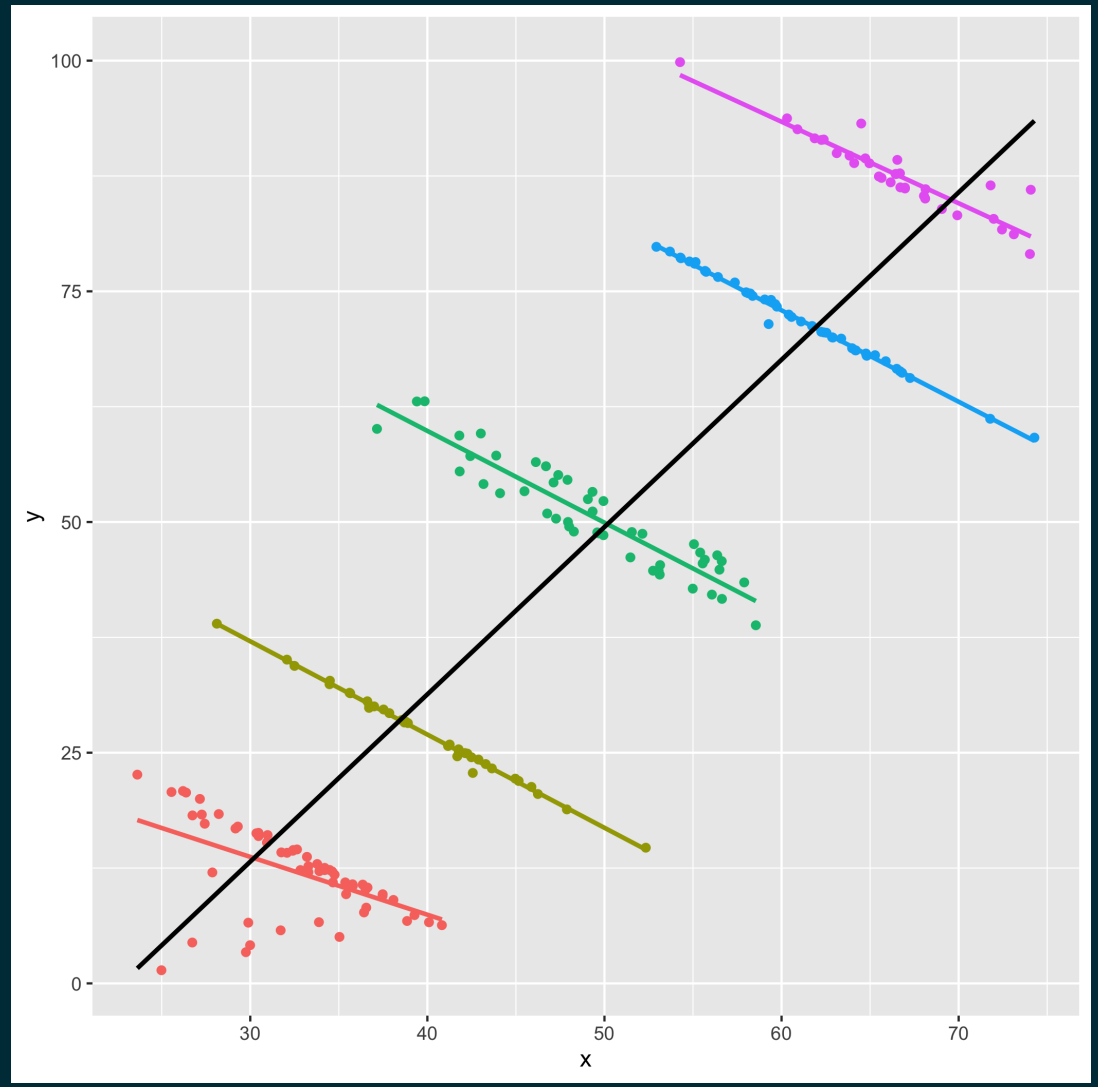
```
## # A tibble: 12 x 6
##    dataset    mean_x mean_y  sd_x  sd_y     cor
##    <chr>       <dbl>  <dbl> <dbl> <dbl>   <dbl>
##  1 away         54.3   47.8  16.8  26.9 -0.0641
##  2 bullseye     54.3   47.8  16.8  26.9 -0.0686
##  3 circle       54.3   47.8  16.8  26.9 -0.0683
##  4 dino         54.3   47.8  16.8  26.9 -0.0645
##  5 dots         54.3   47.8  16.8  26.9 -0.0603
##  6 h_lines      54.3   47.8  16.8  26.9 -0.0617
##  7 high_lines   54.3   47.8  16.8  26.9 -0.0685
##  8 slant_down   54.3   47.8  16.8  26.9 -0.0690
##  9 slant_up     54.3   47.8  16.8  26.9 -0.0686
## 10 star         54.3   47.8  16.8  26.9 -0.0630
## 11 v_lines      54.3   47.8  16.8  26.9 -0.0694
## 12 wide_lines   54.3   47.8  16.8  26.9 -0.0666
```

```
ggplot(datasauRus::datasaurus_dozen, aes(x = x, y = y, color = dataset)) +
  geom_point() +
  facet_wrap(~dataset) +
  guides(color=FALSE)
```



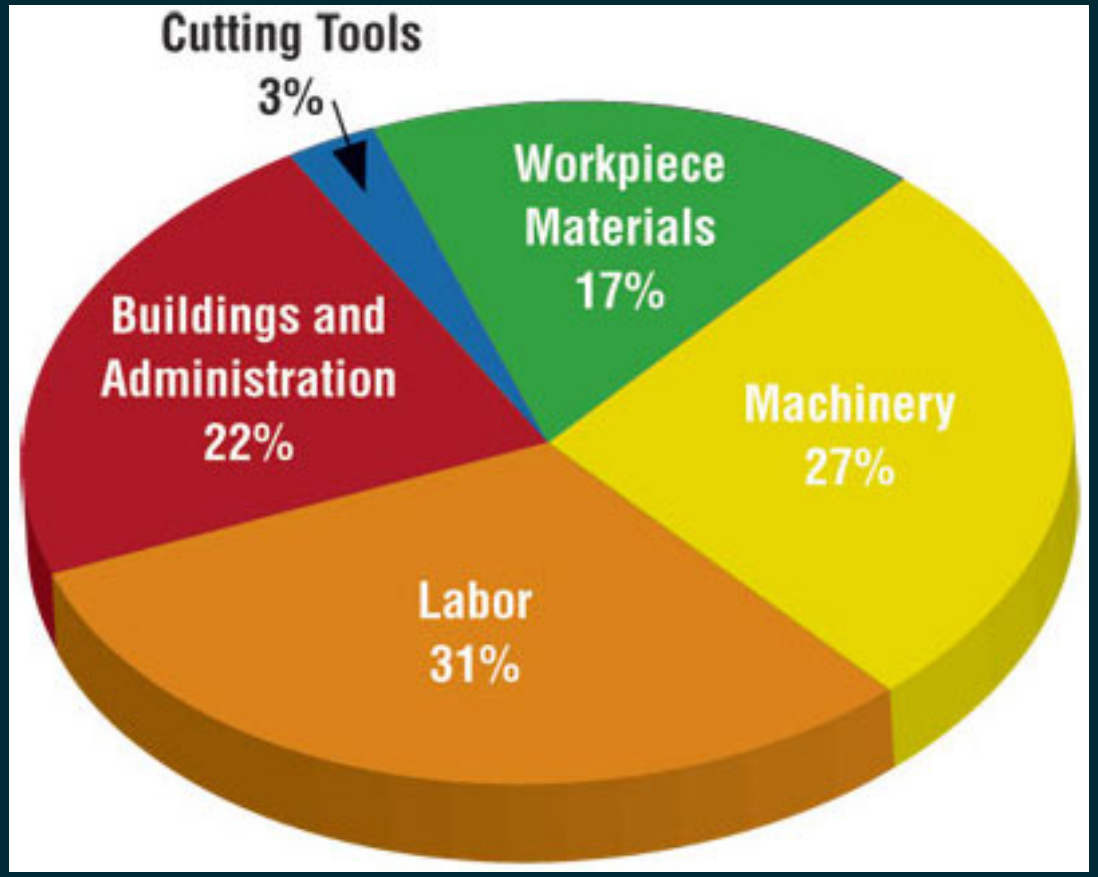
Simpson's Paradox

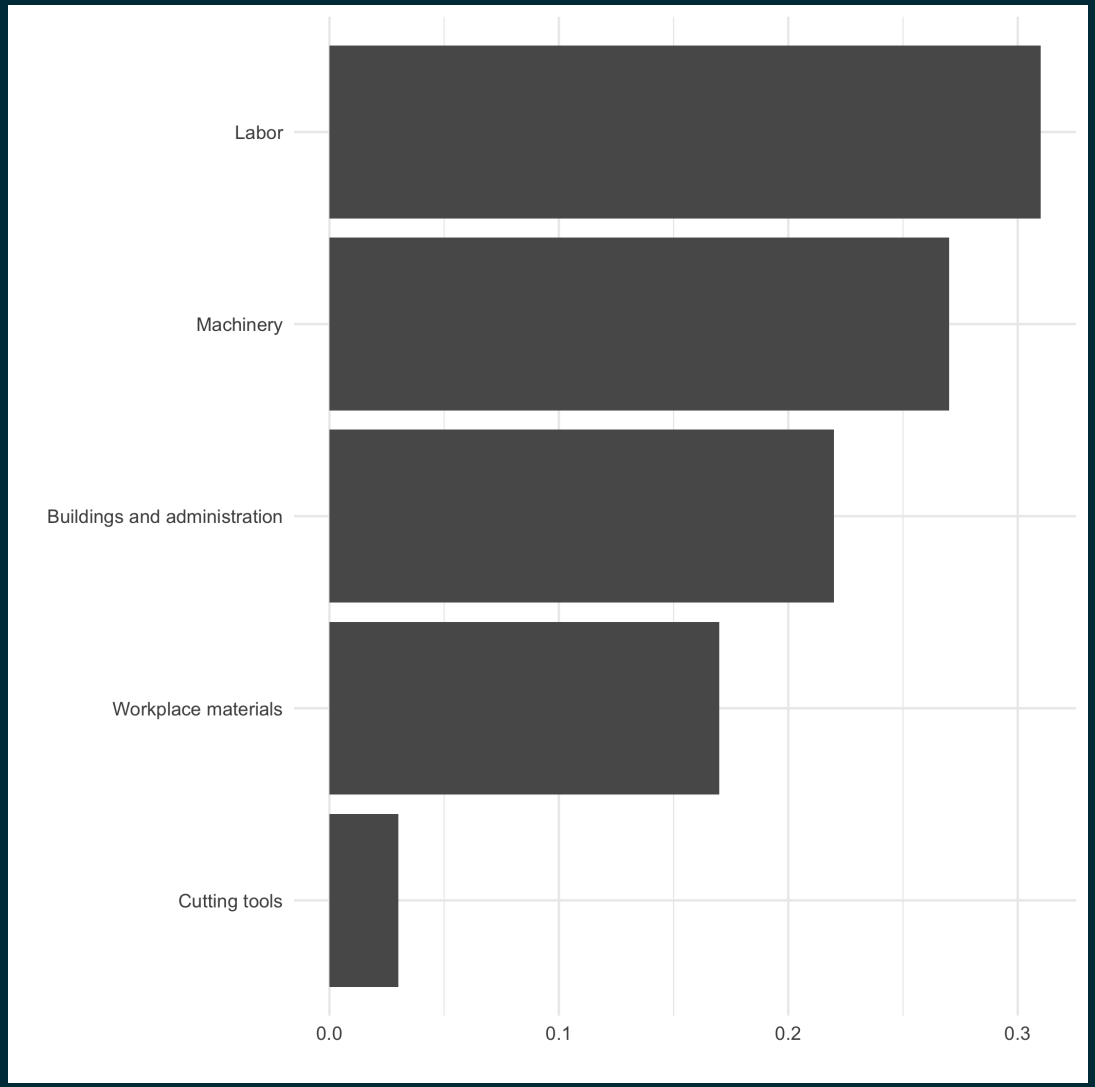




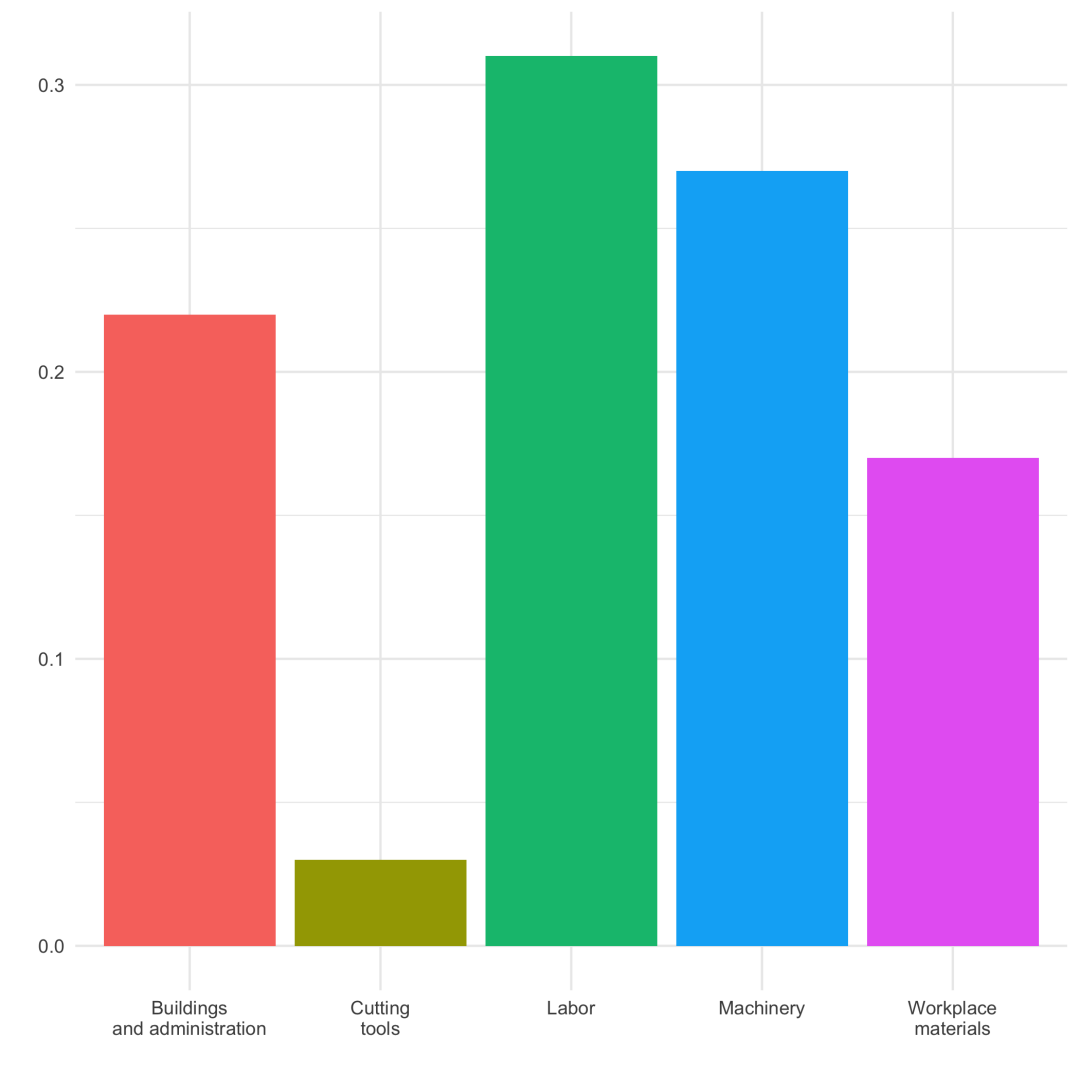
Designing effective visualizations

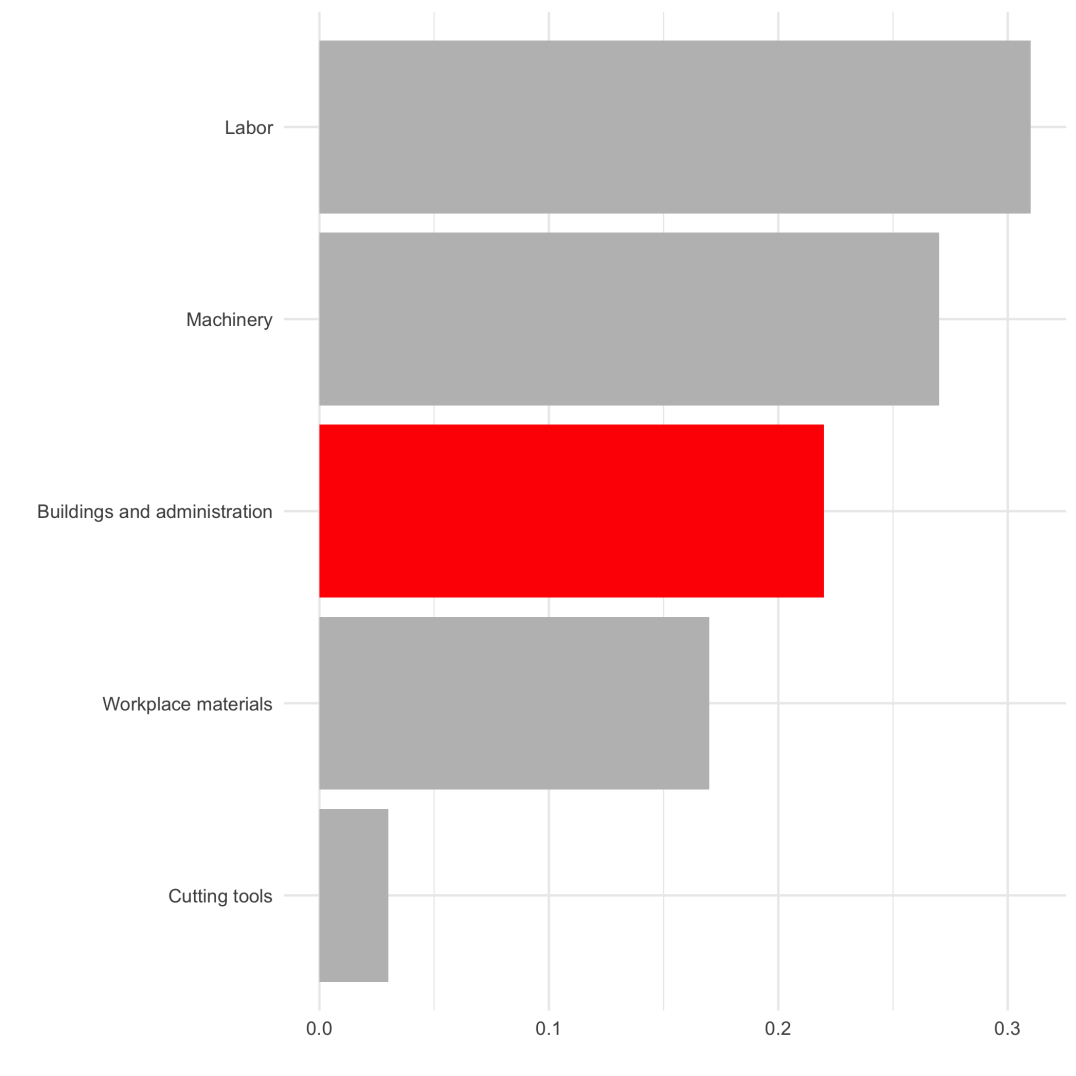
Keep it simple



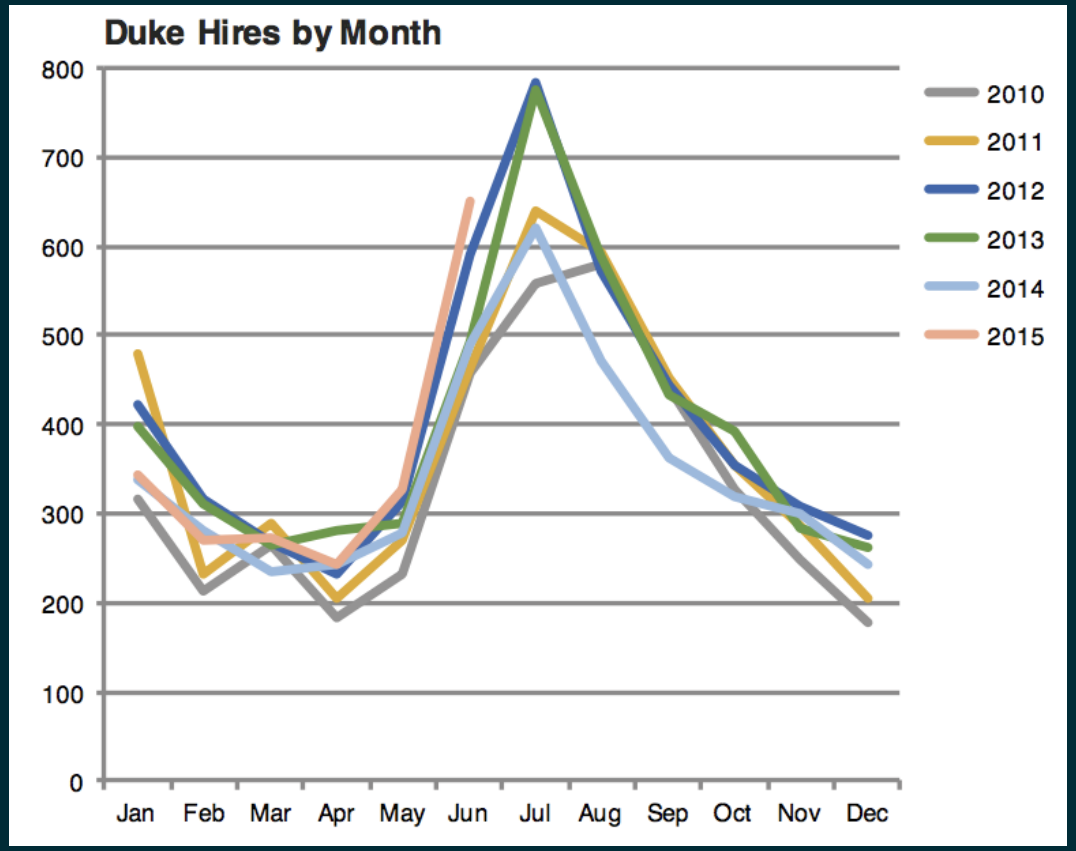


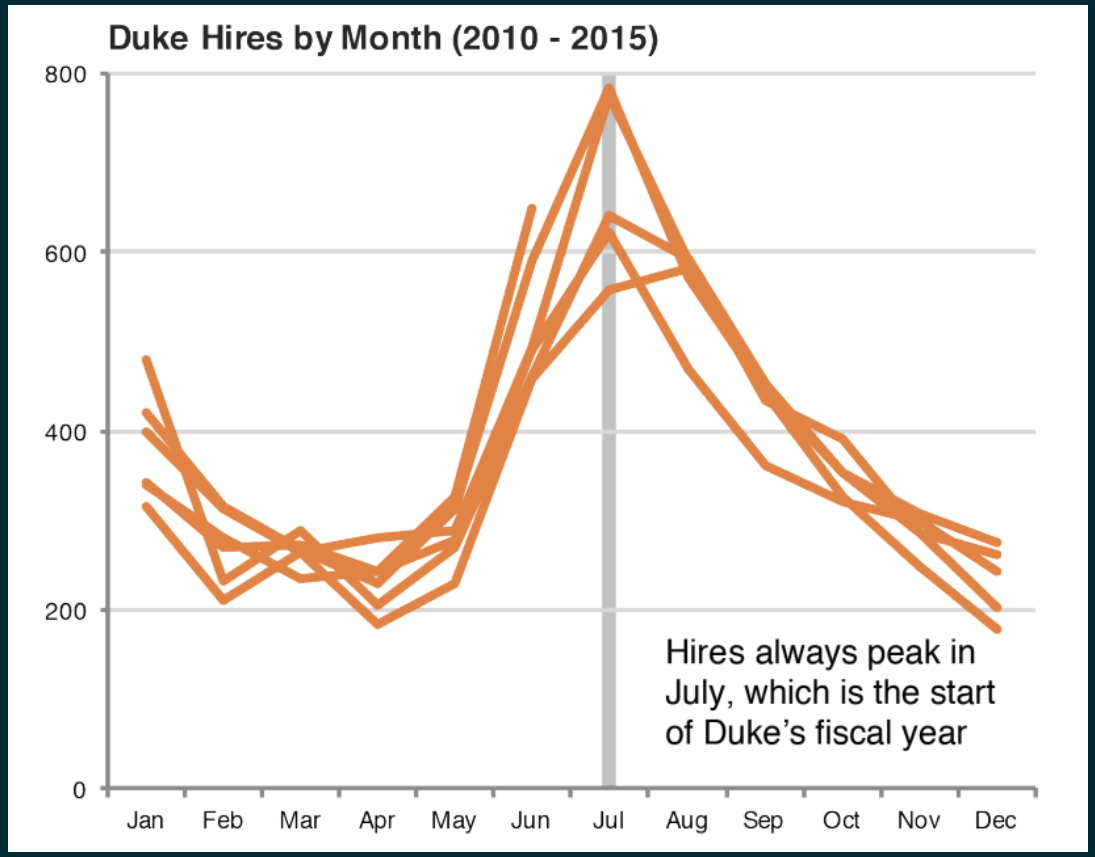
Use color to draw attention





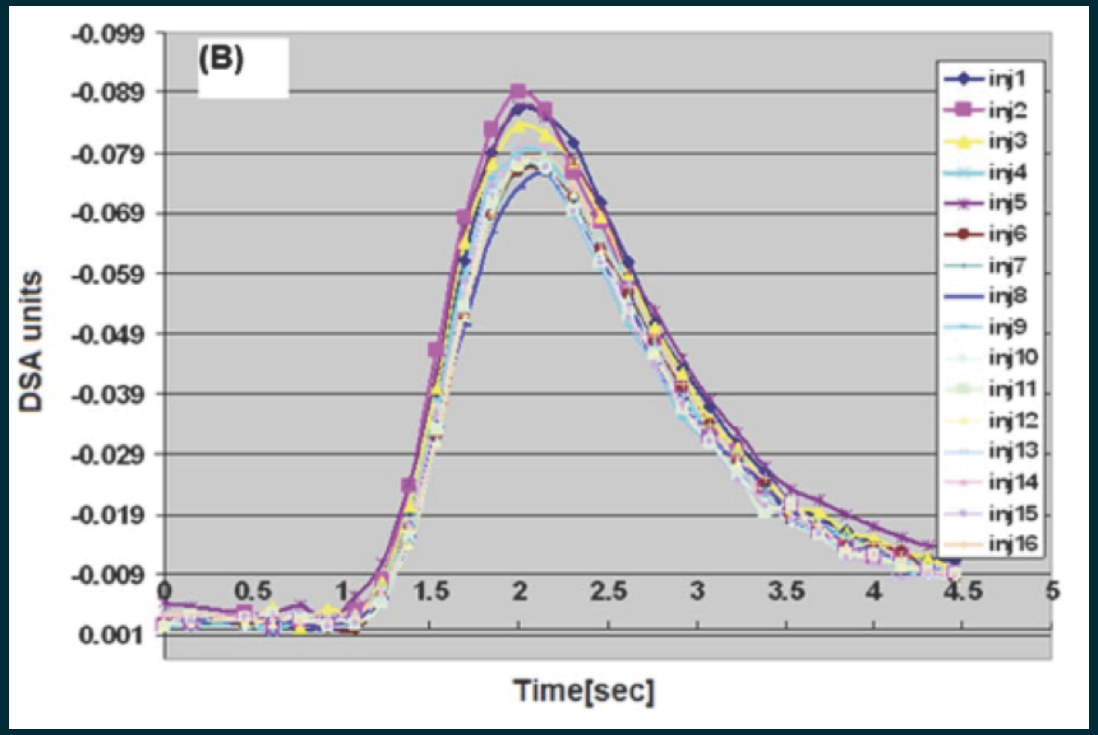
Tell a story

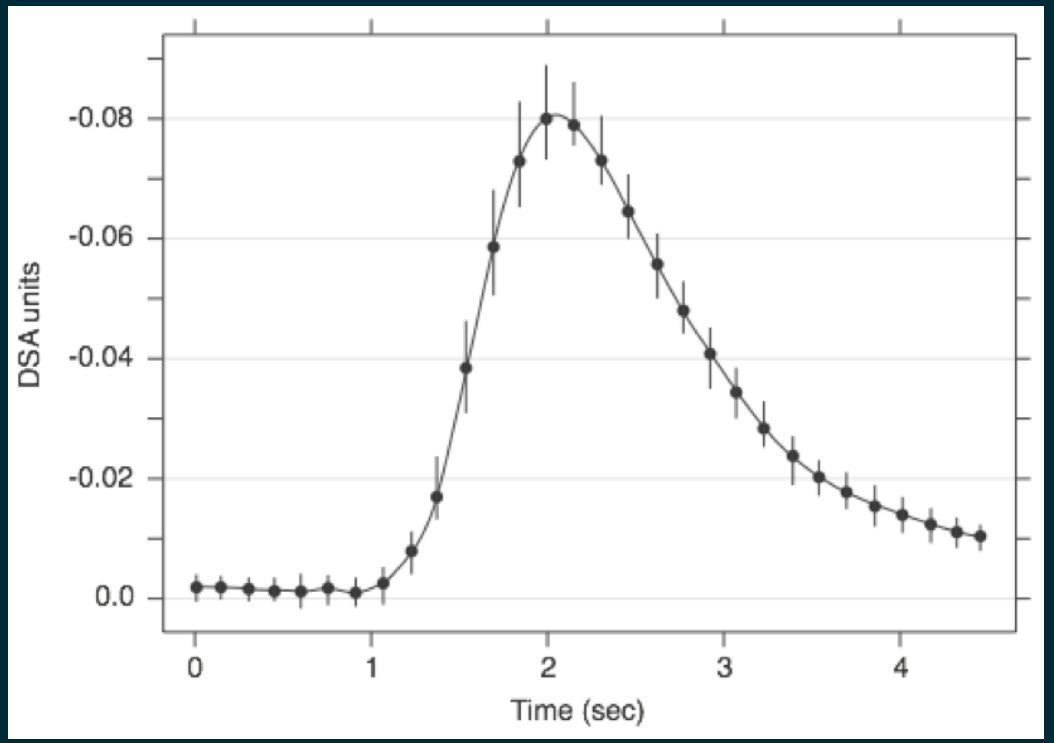




Credit: Angela Zoss and Eric Monson, Duke DVS

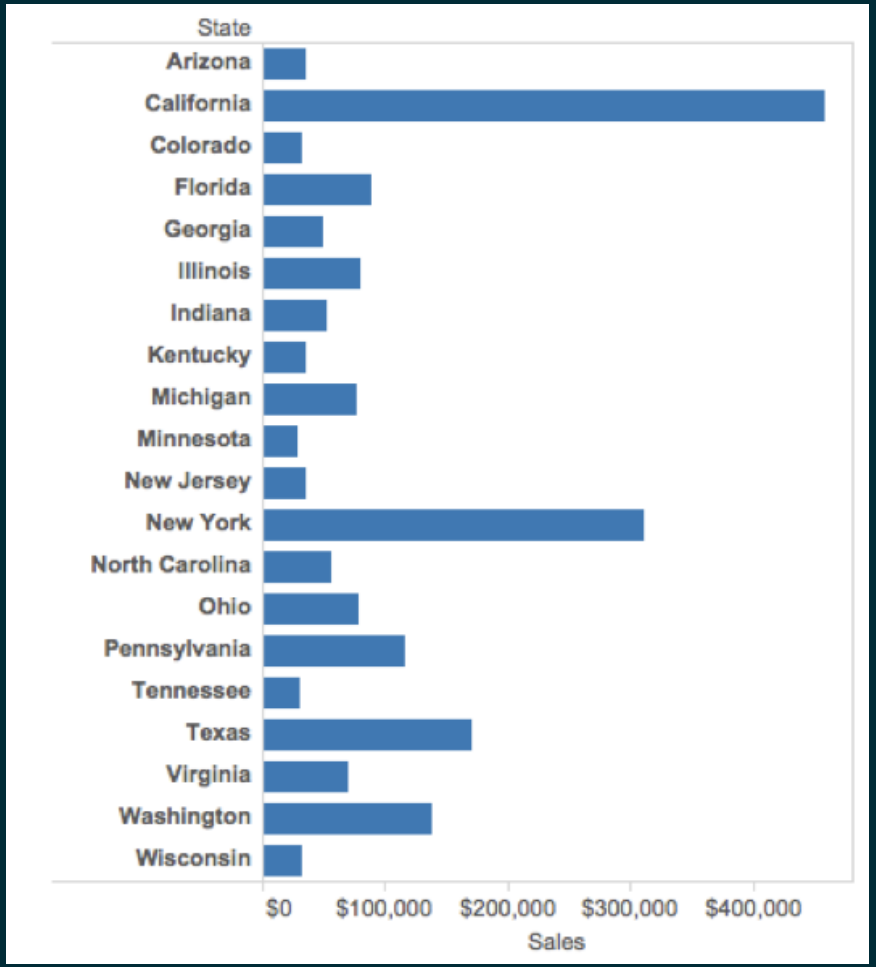
Leave out non-story details

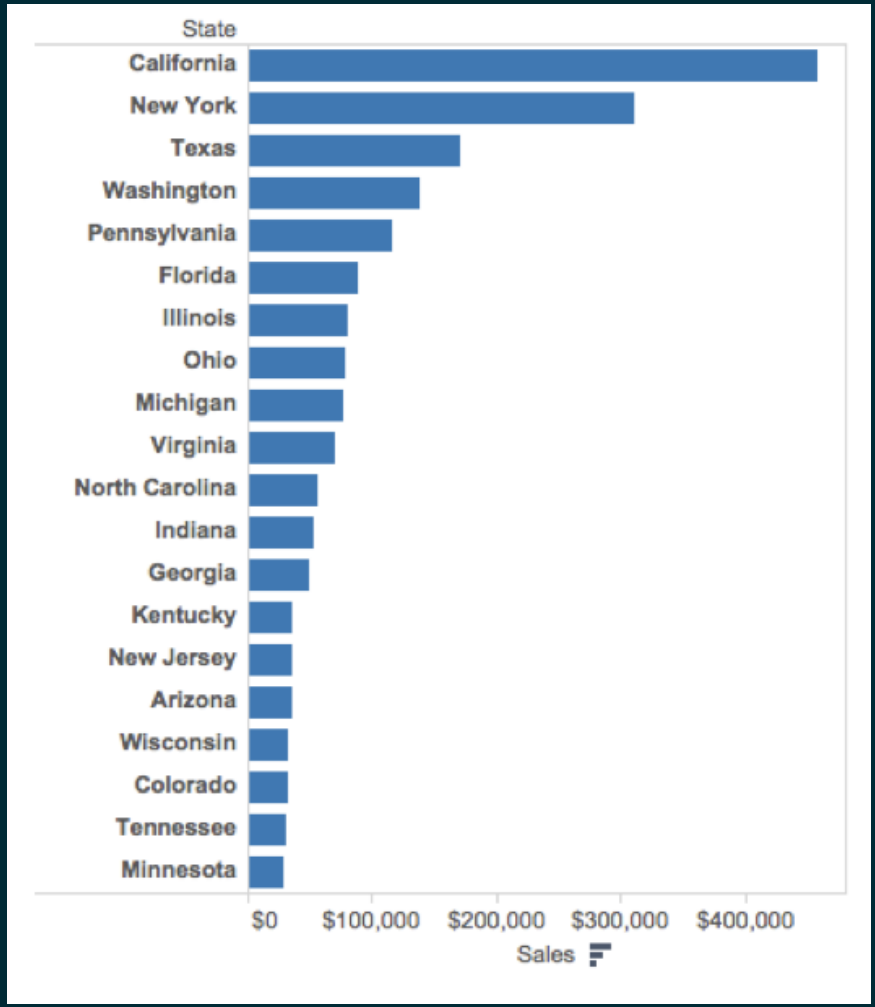




Credit: Angela Zoss and Eric Monson, Duke DVS

Ordering matter





Credit: Angela Zoss and Eric Monson, Duke DVS

Clearly indicate missing data

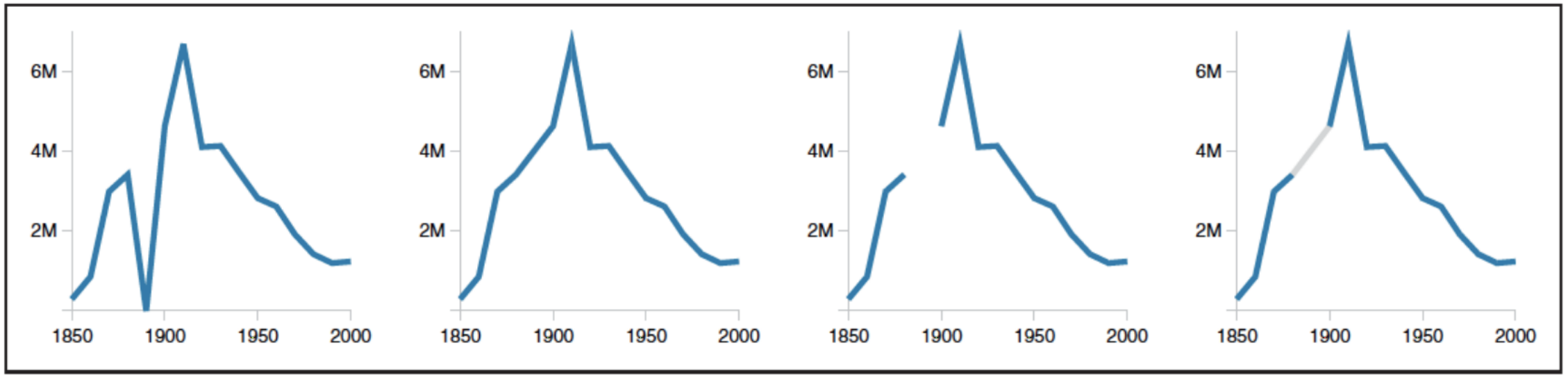
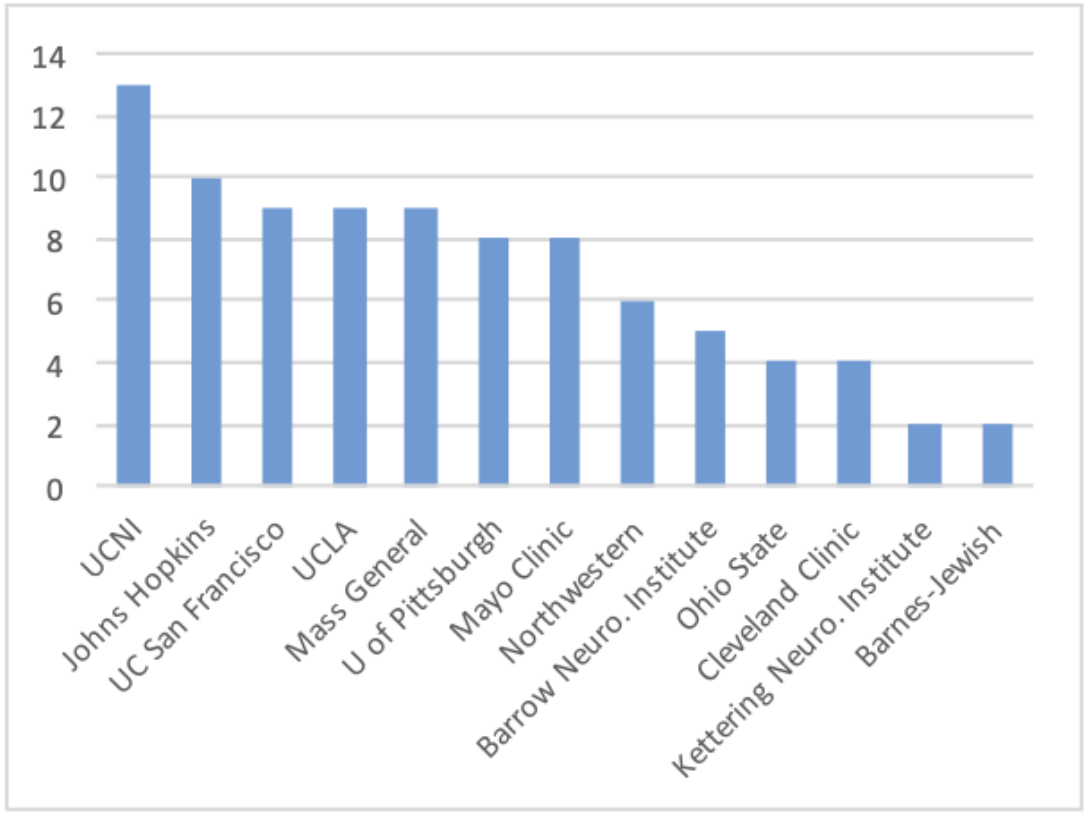
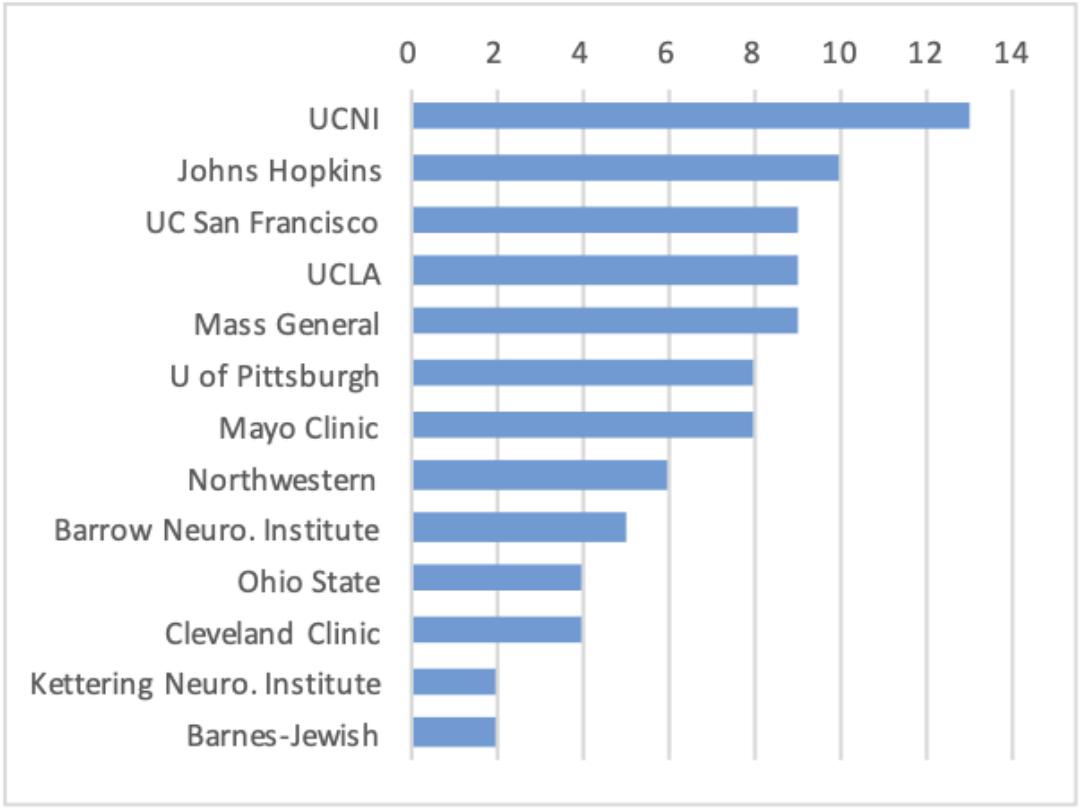


Figure 4. Alternative representations of missing data in a line chart. The data are U.S. census counts of people working as 'Farm Laborers'; values from 1890 are missing due to records being burned in a fire. (a) Missing data is treated as a zero value. (b) Missing data is ignored, resulting in a line segment that interpolates the missing value. (c) Missing data is omitted from the chart. (d) Missing data is explicitly interpolated and rendered in gray.

http://ivi.sagepub.com/content/10/4/271, Angela Zoss and Eric Monson, Duke DVS

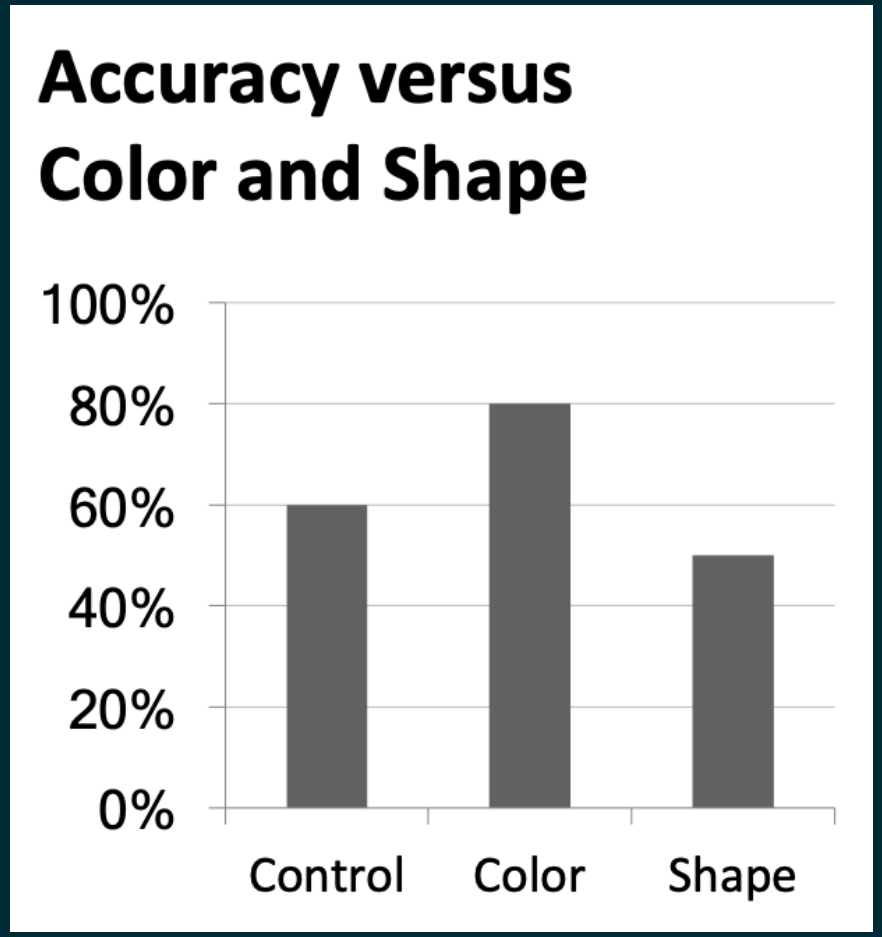
Reduce cognitive load

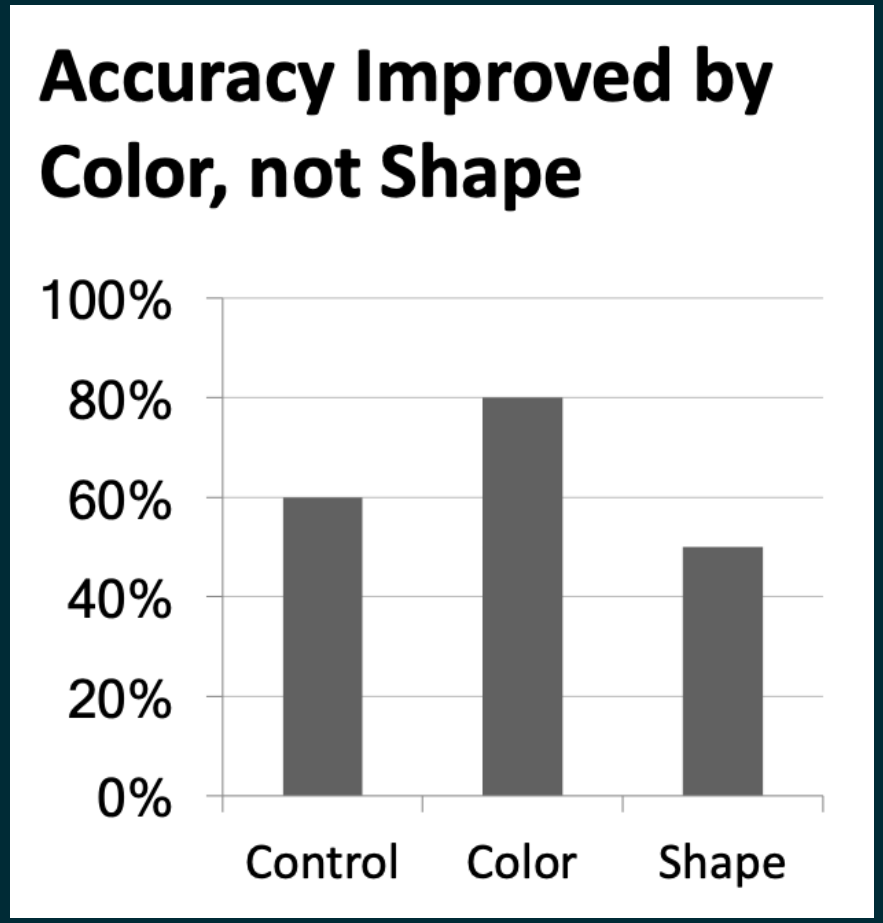




http://www.storytellingwithdata.com/2012/09/some-finer-points-of-data-visualization.html

Use descriptive titles



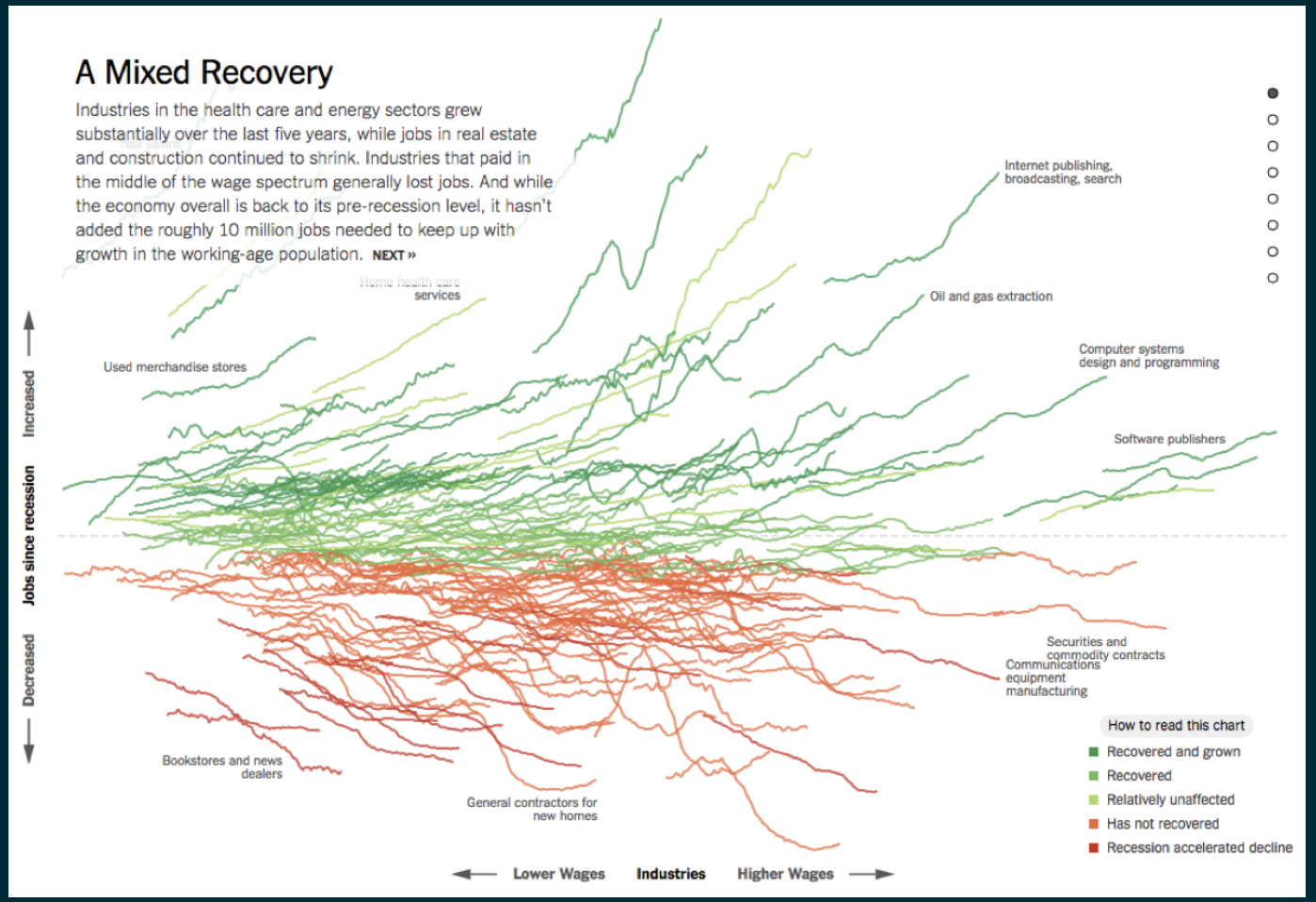


Credit: Angela Zoss and Eric Monson, Duke DVS

Annotate figures directly

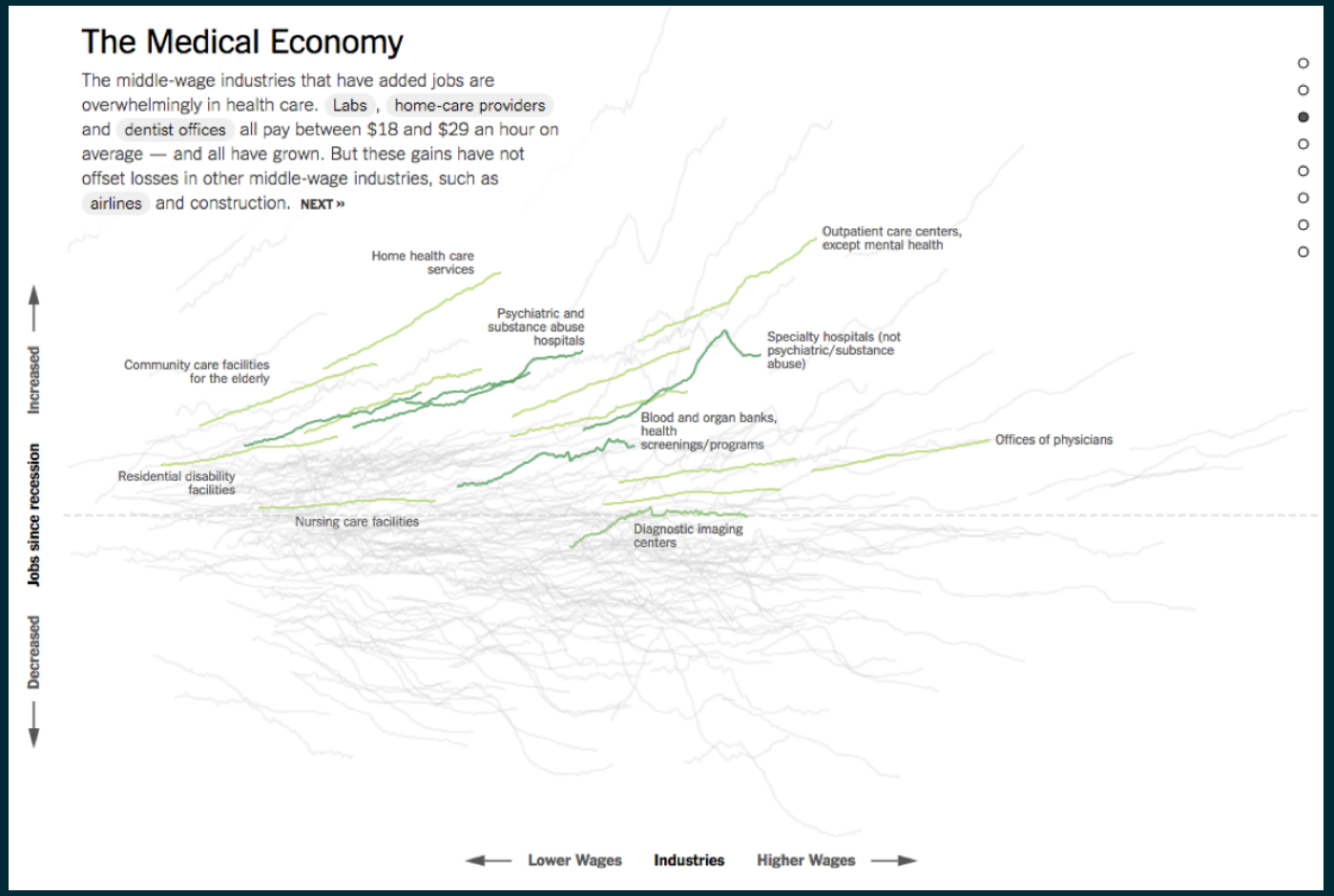
https://bl.ocks.org/susielu/23dc3082669ee026c552b85081d90976

All of the data doesn't tell a story



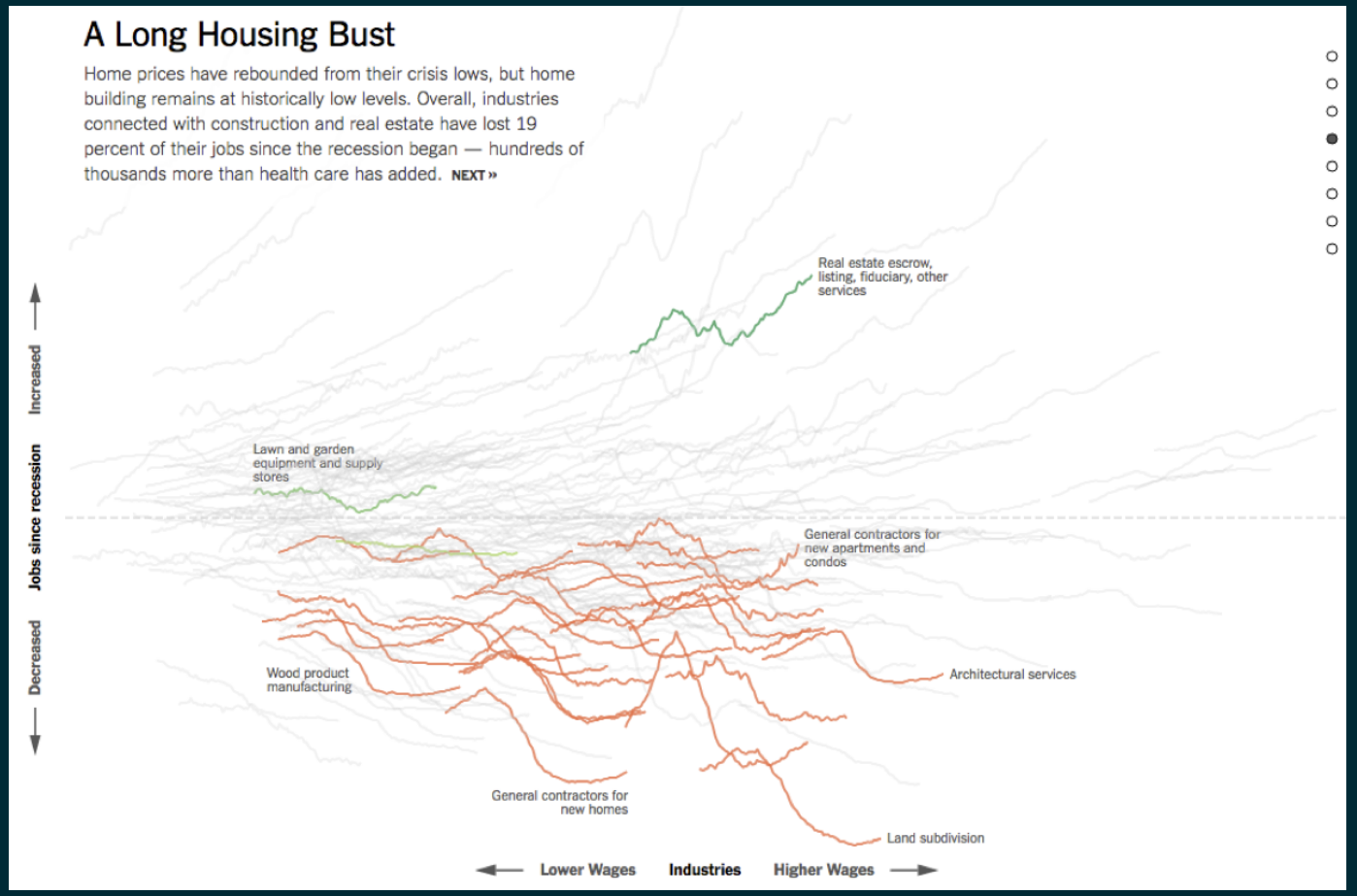
http://www.nytimes.com/interactive/2014/06/05/upshot/how-the-recession-reshaped-the-economy-in-255-charts.html

All of the data doesn't tell a story



http://www.nytimes.com/interactive/2014/06/05/upshot/how-the-recession-reshaped-the-economy-in-255-charts.html

All of the data doesn't tell a story



http://www.nytimes.com/interactive/2014/06/05/upshot/how-the-recession-reshaped-the-economy-in-255-charts.html

Chart Remakes / Makeovers

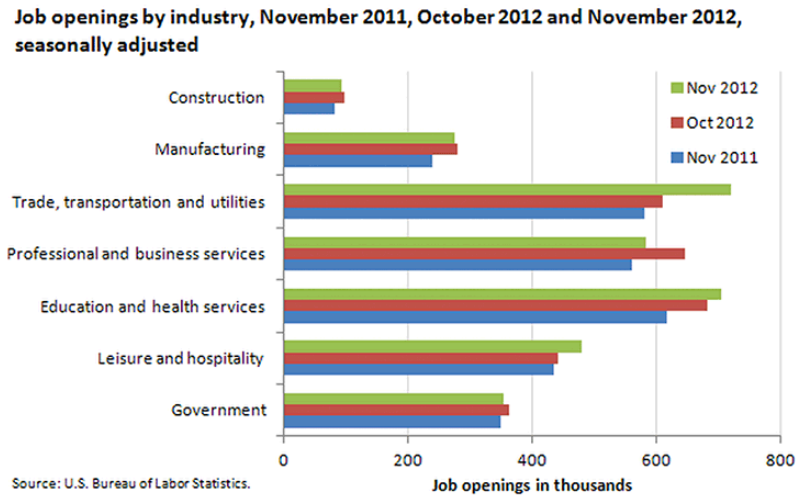
The Why Axis - BLS

Job openings in November 2012

JANUARY 11, 2013

There were 3.7 million job openings on the last business day of November 2012, unchanged from October 2012. In November 2011 there were 3.3 million job openings.

CHART IMAGE | CHART DATA



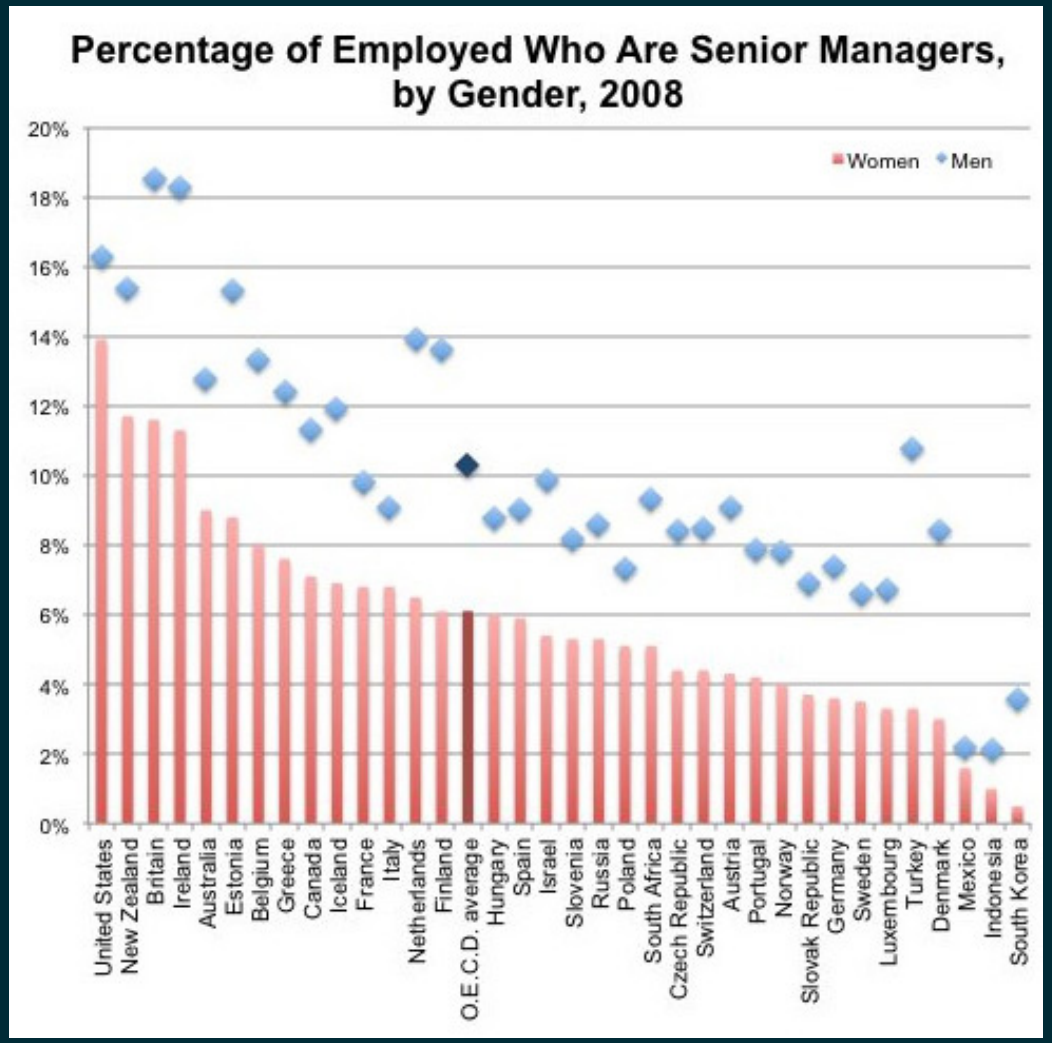
From November 2011 to November 2012, job openings increased most in retail trade (144,000, within the trade, transportation and utilities industry) and health care and social assistance (91,000, within the education and health services industry).

Government job openings increased the least, by 6,000.

These data are from the Job Openings and Labor Turnover Survey. Data for the most recent month are preliminary and subject to revision. For additional information, see Job Openings and Labor Turnover — November 2012" (HTML) (PDF), news release USDL-13-0015. More charts featuring data on job openings, hires, and employment separations can be found in Job Openings and Labor Turnover Survey Highlights: November 2012 (PDF).

http://thewhyaxis.info/defaults/

The Why Axis - Gender Gap



http://thewhyaxis.info/gap-remake/

Acknowledgments

Above materials are derived in part from the following sources:

- Hadley Wickham - R for Data Science & Elegant Graphics for Data Analysis
- ggplot2 website
- Visualization training materials developed by Angela Zoss and Eric Monson, Duke DVS