Gov 51: Descriptive Statistics

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Lots of data

- Data from study of the effect of minimum wage:

```
##        chain location wageBefore wageAfter
## 1     wendys       PA       5.00      5.25
## 2     wendys       PA       5.50      4.75
## 3 burgerking       PA       5.00      4.75
## 4 burgerking       PA       5.00      5.00
## 5        kfc       PA       5.25      5.00
## 6        kfc       PA       5.00      5.00
```

Lots and lots of data

```r
head(minwage$wageAfter, n = 200)
```

```
##   [1] 5.25 4.75 4.75 5.00 5.00 5.00 4.75 5.00 4.50 4.75
##  [11] 4.50 5.00 4.75 4.75 4.75 4.25 5.00 4.90 5.00 4.75
##  [21] 5.00 4.25 4.75 4.25 4.25 4.25 4.25 4.25 4.25 4.38
##  [31] 4.75 4.25 4.50 4.50 4.25 4.25 4.25 4.25 5.05 4.25
##  [41] 4.25 4.25 4.25 4.35 4.50 4.50 5.00 4.75 5.00 4.35
##  [51] 4.25 4.90 4.50 4.50 4.75 6.25 4.35 4.50 4.50 5.00
##  [61] 4.75 4.50 4.75 4.25 4.91 4.40 4.25 5.05 5.05 5.05
##  [71] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
##  [81] 5.50 5.05 5.05 5.05 5.05 5.05 5.05 5.28 5.25 5.05
##  [91] 5.05 5.50 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
## [101] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.25
## [111] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.67
## [121] 5.05 5.05 5.05 5.05 5.25 5.25 5.05 5.50 5.05 5.05
## [131] 5.05 5.50 5.50 5.05 5.05 5.25 5.05 5.05 5.15 5.05
## [141] 5.05 5.05 5.05 5.00 5.05 5.05 5.05 5.05 5.05 5.05
## [151] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
## [161] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
## [171] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
## [181] 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
## [191] 5.05 5.25 5.05 5.05 5.05 5.05 5.05 5.05 5.05 5.05
```

How to summarize data

- How should we summarize the wages data? Many possibilities!
  - Up to now: focus on **averages** or means of variables.
- Two salient features of a variable that we want to know:
  - **Central tendency**: where is the middle/typical/average value.
  - **Spread** around the center: are all values to the center or spread out?

Center of the data

- "Center" of the data: typical/average value.
- **Mean**: sum of the values divided by the number of observations

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

- **Median**:

$$\text{median} = \begin{cases} \text{middle value} & \text{if number of entries is odd} \\ \frac{\text{sum of two middle values}}{2} & \text{if number of entries is even} \end{cases}$$

- In **R**: `mean()` and `median()`.

Mean vs median

- Median more robust to **outliers**:
    - Example 1: data = $\{0, 1, 2, 3, 5\}$. Mean? Median?
    - Example 2: data = $\{0, 1, 2, 3, 100\}$. Mean? Median?
- What does Mark Zuckerberg do to the mean vs median income?

Spread of the data

- Are the values of the variable close to the center?
- **Range**: $[\min(X),\ \max(X)]$
- **Quantile** (quartile, percentile, etc): divide data into equal sized groups.
  - 25th percentile = lower quartile (25% of the data below this value)
  - 50th percentile = median (50% of the data below this value)
  - 75th percentile = upper quartile (75% of the data below this value)
- **Interquartile range** (IQR): a measure of variability
  - How spread out is the middle half of the data?
  - Is most of the data really close to the median or are the values spread out?
- **R** function: `range()`, `summary()`, `IQR()`

Standard deviation

- **Standard deviation**: On average, how far away are data points from the mean?

$$\text{standard deviation} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

- Steps:

  1. Subtract each data point by the mean.
  2. Square each resulting difference.
  3. Take the sum of these values
  4. Divide by $n - 1$ (or n, doesn't matter much)
  5. Take the square root.

- **Variance** = standard deviation^2

- Why not just take the average deviations from mean without squaring?

How large is large?

- Is a wage of 5.30 an hour large?
- Better question: is 5.30 large relative to the distribution of the data?
    - Big in one dataset might be small in another!
    - Different units, different spreads of the data, etc.
- Need a way to put any variable on **common units**.
- **z-score**:

$$\text{z-score of } x_i = \frac{x_i - \text{mean of } x}{\text{standard deviation of } x}$$

- Interpretation:
    - Positive values above the mean, negative values below the mean
    - Units now on the scale of **standard deviations away from the mean**
    - Intuition: data more than 3 SDs away from mean are rare.

z-score example

- Jane works at Hi Rise Bakery, where there's a tip jar.
- She's been keeping track of her daily tips:
    - Average tip of $1.56 with a standard deviation of 20 cents.
- Yesterday, Jane got $1.86 in tips. How big is this?
- Today she got $0.56, what about that?