

# Review of Introductory Statistics

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Spring 2021



# Data

An **observation** is a single unit. A **variable** is a measurement made on that unit

- ▶ Record observations as **rows** and variables in **columns**.
- ▶ Variables can be **categorical** or **numerical**.
  - ▶ Categorical variables can be **binary** or not, **ordered** or not.
  - ▶ Numerical variables can be **discrete** or **continuous**.
- ▶ Dates, times and locations merit special consideration.
- ▶ Vocabulary is not universal: Factor, case, treatment ...

```
head(Sitka) # from package MASS
```

```
##   size Time tree treat
## 1 4.51  152    1 ozone
## 2 4.98  174    1 ozone
## 3 5.41  201    1 ozone
## 4 5.90  227    1 ozone
## 5 6.15  258    1 ozone
## 6 4.24  152    2 ozone
```

# Distributions

The **distribution** of a variable is a measure of how often it takes each possible value.

- ▶ The distribution of a categorical variable is a list of the percentage of observations in each category.

```
table(Sitka$treat)/length(Sitka$treat)
```

```
##
```

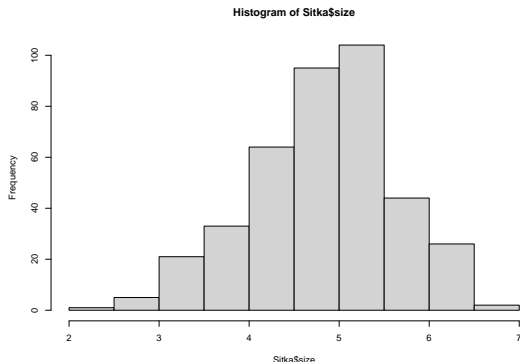
```
##   control      ozone
```

```
## 0.3164557 0.6835443
```

# Distributions

- Picture the distribution of a numerical variable with a histogram, boxplot or density estimate.

```
hist(Sitka$size)
```



- Shape: center, spread, skew, kurtosis

## Numerical summaries

```
summary(Sitka$size)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.230   4.345   4.900   4.841   5.400   6.630
```

```
quantile(Sitka$size, c(0.025,0.975))
```

```
##      2.5%  97.5%
##      3.2370 6.2815
```

```
sd(Sitka$size)
```

```
## [1] 0.7982084
```

```
var(Sitka$size)
```

```
## [1] 0.6371367
```

```
IQR(Sitka$size)
```

```
## [1] 1.055
```

# Common distributions

- ▶ Normal distribution

- ▶ The sum of many independent effects tends to be normal.

- ▶ Formula that you never use:  $N(\mu, \sigma^2)(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$

- ▶ Observations on disparate scales can be standardized with z scores:  $z = \frac{x - \mu}{\sigma}$

- ▶ Other distributions from Intro Stats

- ▶ t - Like the normal distribution, but adjusted for small samples.

- ▶  $\chi^2$  - Sum of squared standard normals.

- ▶ F - Similar to  $\chi^2$ , used in ANOVA.

- ▶ Binomial - How many successes in  $n$  trials?

- ▶ Poisson - Count of discrete events in fixed time or space.

- ▶ ...

# Inference

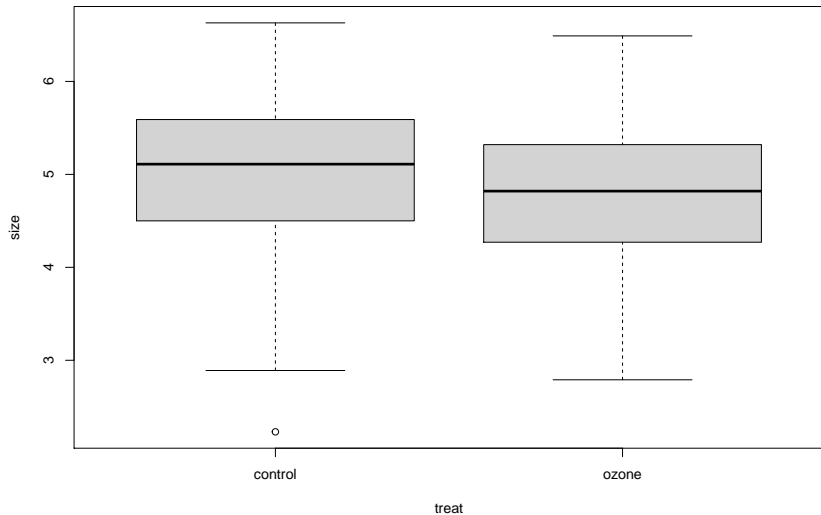
- ▶ Confidence intervals
- ▶ Hypothesis tests
  - ▶ p(robability)-values
  - ▶ Null and alternate hypotheses
  - ▶ t-tests, ANOVA,  $\chi^2$  tests

```
t.test(size~treat, data = Sitka)
```

```
##  
##  Welch Two Sample t-test  
##  
## data:  size by treat  
## t = 2.3163, df = 209.44, p-value = 0.02151  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
##  0.03144833 0.39086574  
## sample estimates:  
## mean in group control    mean in group ozone  
##           4.985120           4.773963
```

# Always plot your data!

```
boxplot(size~treat, data = Sitka)
```





# Linear models

- ▶ Slope and intercept parameters
- ▶ Correlation
- ▶ Residuals
- ▶ Inference

```
summary(lm(size~Time, data = Sitka))
```

```
##
## Call:
## lm(formula = size ~ Time, data = Sitka)
##
## Residuals:
```

	Min	1Q	Median	3Q	Max
	-2.02610	-0.37956	0.06948	0.41669	1.30948

```
##
## Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	2.2732443	0.1768643	12.85	<2e-16 ***
Time	0.0126855	0.0008592	14.77	<2e-16 ***

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.641 on 393 degrees of freedom
## Multiple R-squared:  0.3568, Adjusted R-squared:  0.3551
## F-statistic: 218 on 1 and 393 DF, p-value: < 2.2e-16
```

# Always plot your data!

```
plot(size~Time, data = Sitka)
abline(lm(size~Time, data=Sitka))
```

