# COMPARISON

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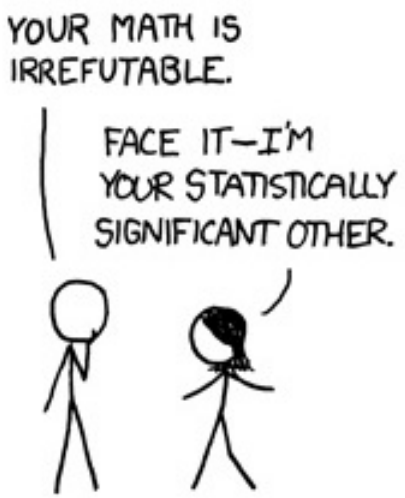


# Statistical hypotheses

From the Reason "free minds and free markets" Foundation:

> *"A number of theorists assume that drinking has harmful economic effects, but data show that* ***drinking and earnings are positively correlated****.* ***We hypothesize that drinking leads to higher earnings by increasing social capital.*** *If drinkers have larger social networks, their earnings should increase. Examining the General Social Survey, we find that self-reported drinkers earn 10-14 percent more than abstainers, which replicates results from other data sets."*
>
> *(B. L. Peters, E. Stringham, "No Booze? You May Lose", 2006.)*

$H_1$: "An increase in social drinking leads to an increase in earnings."

# Statistical hypotheses

## Substantive, directional hypotheses

$H_1$ : ±social drinking ($\rightarrow$ ±social capital) $\rightarrow$ ±earnings
$H_2$ : ±earnings ($\rightarrow$ ±disposable income) $\rightarrow$ ±social drinking

## Rejecting the null hypothesis $H_0$

$H_0$: no relationship between social drinking and earnings
$H_a$: any relationship between social drinking and earnings

## Proof by contradiction

1. Get approximate upper bound of ***p*-value** $p \sim Pr(H_0)$
2. Reject or retain $H_0$ at **level of confidence** $\alpha \sim 0.05$ (or 0.01)

# Significance tests

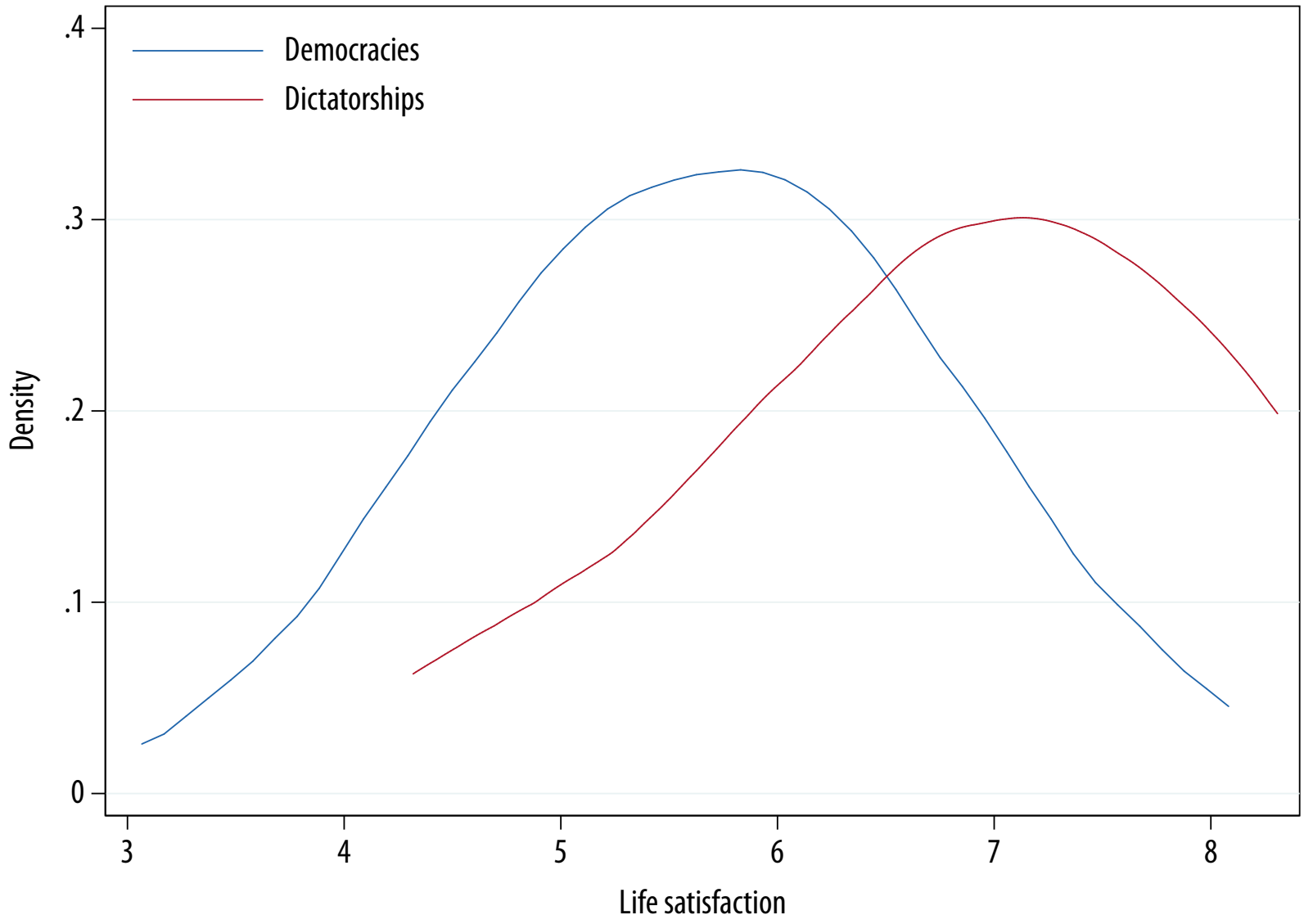
## Comparing differences

- Comparing means: $H_0$: $\Delta = \bar{X} - \bar{Y} = 0$ `ttest`
- Comparing proportions: $H_0$: $\Delta = Pr(X) - Pr(Y) = 0$ `prtest`

## Comparing distributions

- $\chi^2$-test: observed vs. expected percentages `tab_chi`
- Odds ratios: success vs. failure rates `tabodds`

# *t*-test


Democracies
Dictatorships
Density
.4
.3
.2
.1
0
3
4
5
6
7
8
Life satisfaction

# *t*-test

Measuring association as the difference in means between two groups of i.i.d. observations:

- Population notation: $\delta = \mu_1 - \mu_2$
- Sample notation: $D = \bar{X}_1 - \bar{X}_2$

The *t*-test computes a 95% CI around the difference of their means and returns its *p*-value against the *t*-distribution.

- Null hypothesis $H_0$: $\mu_1 - \mu_2 = 0$
- Test statistic: $t = \frac{D}{SE_D}$

# *t*-test

## `ttest y, by(x)`

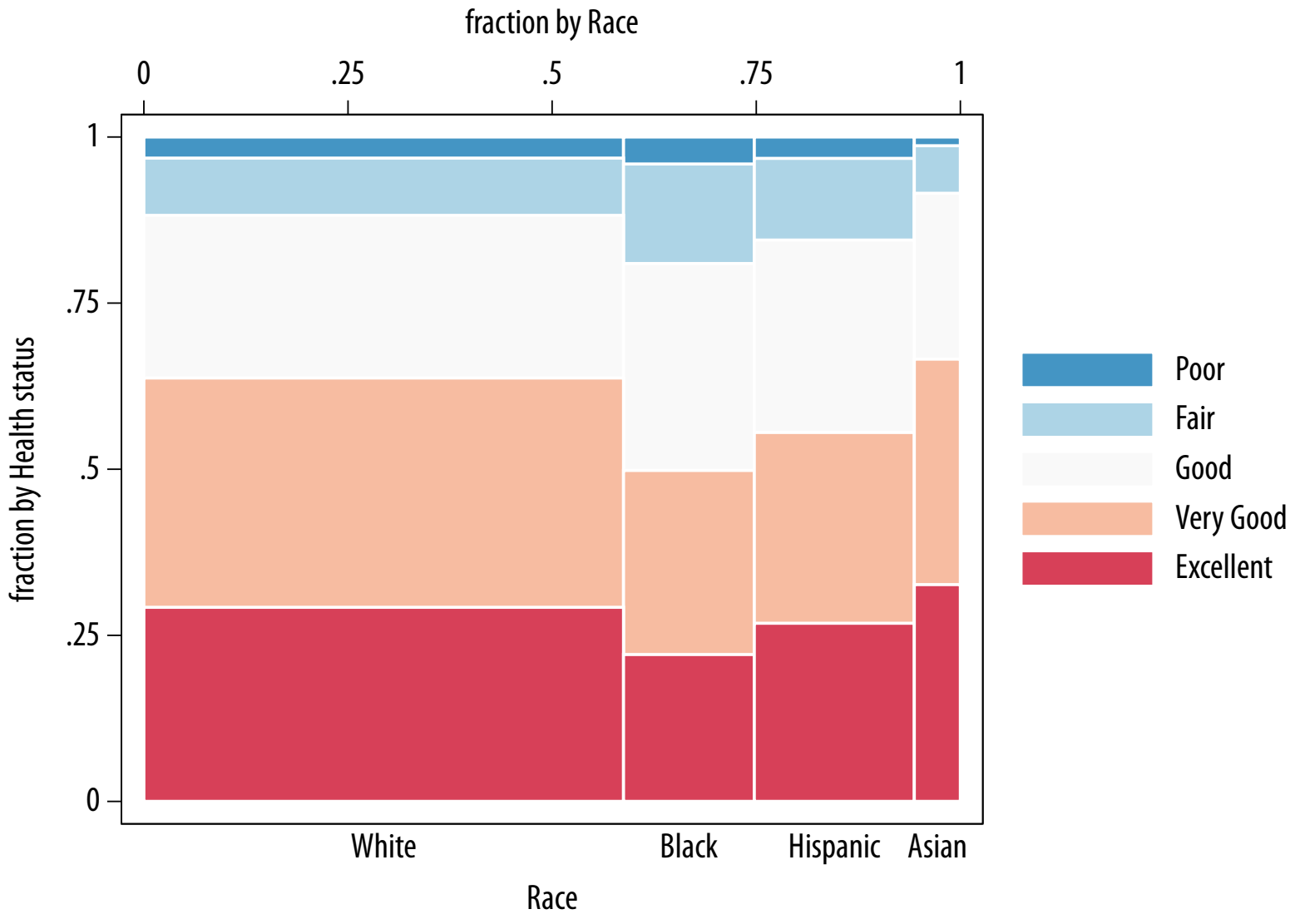
- y is continuous, x is a dummy
- use `prtest` if y is also a dummy (proportions test)
- use `tab, gen()` to create dummies from categorical variables

## use data/qog2011, clear

Interpret the following tests:

- `ttest gol_enep, by(gol_est2)`
- `prtest no_mes, by(gol_polreg)`

# Chi-squared test



# Chi-squared test

The Chi-squared test is a nonparametric test of association that measures the deviation in orthogonality between groups:

- Null hypothesis $H_0$: $\chi^2 = 0$
- Test statistic: $\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$ (deviation between observed frequencies $O_i$ and expected frequencies $E_i$ for each table cell $i$)

```
tab v1 v2, exp chi2 V
```

- add `V` to measure the association with Cramér's $V$ ($0 < V < 1$)
- use `tabchi` to inspect residuals, `tabodds` for odds ratios

# Chi-squared test

## use data/nhis2009, clear

- Variables: `d raceb marstat`
- Analyze the frequencies and residuals with `tabchi`

```
. tab marstat raceb if marstat < 8, chi2 V
```

| Legal marital status | Race | | | | |
|---|---|---|---|---|---|
| | White | Black | Hispanic | Asian | Total |
| Married | 7,151 | 1,059 | 2,231 | 780 | 11,221 |
| Widowed | 1,215 | 352 | 223 | 84 | 1,874 |
| Divorced | 2,367 | 641 | 595 | 93 | 3,696 |
| Separated | 343 | 264 | 274 | 25 | 906 |
| Total | 11,076 | 2,316 | 3,323 | 982 | 17,697 |

```
          Pearson chi2(9) = 733.4437   Pr = 0.000
               Cramér's V =   0.1175
```

# Type I and II Errors

**Type I Error:** rejecting $H_0$ when it is actually true

"Last year executed man proven innocent by DNA evidence."

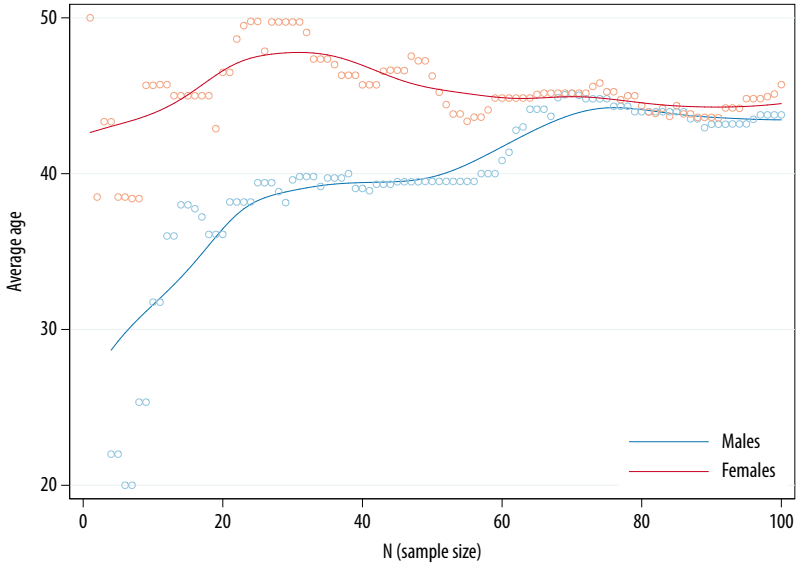
- $H_0$: presumption of innocence...
- $H_a$: ... until proven guilty ($H_0$ wrongly rejected)

**Type II Error:** retaining $H_0$ when it is actually false

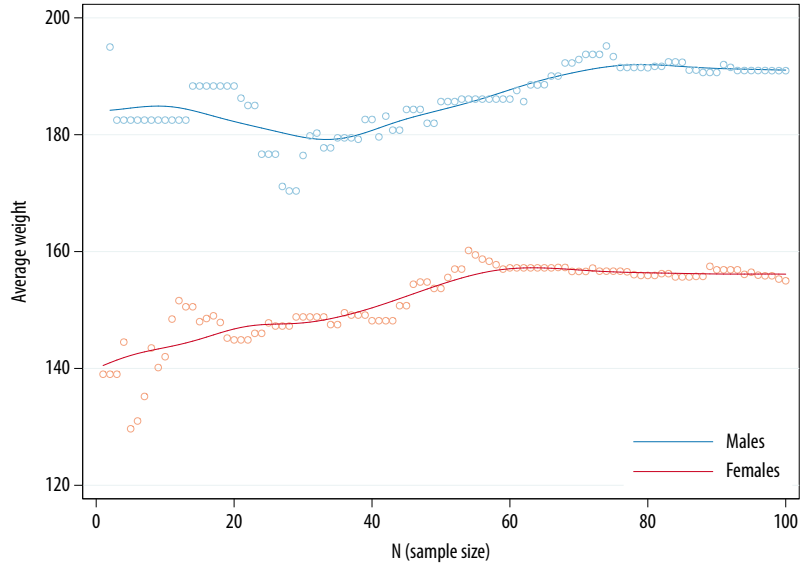
"Violent father beats children after being released from custody."

- $H_0$: parents considered responsible
- $H_a$: ... until proven abusive ($H_0$ wrongly retained)

# Type I and II Errors




Type I error




Type II error

# Estimation is powerful

# Significance is deceptive

# Practice session

## Class

```
* Get the do-file for this week.
srqm fetch week6.do
* Open to read and replicate.
doedit code/week6
```

## Coursework

- Finish the do-file and read all comments at home.
- Catch up on all readings (see course website).
- Revise your code and paper after getting feedback.

# Exercises

## Ex 6.1. European Social Survey 2008

1. Recode `rlgblg` and `dscrgrp` to dummies.
2. Compute a proportions test for `dscrgrp` by `rlgblg`.
3. Interpret the result of the test.

## Ex 6.2. European Social Survey 2008

1. Subset the data to Sweden.
2. Find a measure of support for male/female income equality.
3. Select a test to compare the variable over gender groups.