Quant II

Lab 1: Introduction: R Markdown, reproducibility, DAGs

Giacomo Lemoli

January 26, 2023

Ciao!

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- Substantive answers should be presented in the written paragraphs
- Ultimately, the goal is to learn how to **do** and **communicate** empirical research

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- Software: R (primary) and Stata (secondary)
  - Focus on R, but Stata may be useful for homeworks, so resources will be available in both languages

Today's plan

- R Markdown
- Doing reproducible work
- DAGs: conditioning, collider bias

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- If you are Python/Data science people, you can also download and run RStudio from Anaconda

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- Stata - https://www.statalist.org/

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- A search engine for replication data: https://datasetsearch.research.google.com/

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- Output documents can be PDFs, Word Documents, HTML pages, and other formats

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- Besides Quant 2 homeworks, I recommend to use it for all class projects that involve replications or data analyses

What if I prefer Stata?

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- Up-to-date Stata software is available on NYU desk machines

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- If you want to generate PDF output, you also need a LaTex system (e.g. MiKTeX)

Getting started with R Markdown

Once you have done all that,

1. Open RStudio
2. Select File > New File > R Markdown
3. Enter Title, Author, Output Format (which can easily be changed later)
4. You are good to go! You will see that there is some example text that you can delete.

Markdown document

The documents typically have four different pieces: the **YAML**, the **formatted text**, **code chunks**, and **inline code**.

YAML

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- **NB**: rules in the header section will alter the whole document

YAML

You will always insert something like this at the top of your new .Rmd script:

```
---
title: "Quant II"
subtitle: "Lab 1: Introduction: R Markdown, reproducibility, I
author: "Giacomo Lemoli"
date: "January 26, 2023"
---
```

Code chunks

- The real payoff of R Markdown
- The code you enter is executed and the results are displayed in the document
- Syntax for code chunks:

````
```{r}
R code here
```
````

Code chunks

- Note that “‘ are backticks, not quotes or apostrophes. Everything that goes between these backticks should have R syntax

```
set.seed(1)

x <- runif(10)
y <- rnorm(10, x, 1)
df <- data.frame(x, y)
df
```

```
##             x           y
## 1  0.26550866 -0.55495972
## 2  0.37212390  0.85955295
## 3  0.57285336  1.31117807
## 4  0.90820779  1.48398914
## 5  0.20168193 -0.10370646
## 6  0.89838968  2.41017085
## 7  0.94467527  1.33451851
## 8  0.66079779  0.03955721
## 9  0.62911404 -1.58558584
## 10 0.06178627  1.18671719
```

Code chunk options

- You can specify options for each code chunk

```
' ' ' {r name, echo = TRUE, eval=TRUE, warning=FALSE, message=
R code here
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- message - Whether to display code messages in the document

Output visualization

```
iris <- read.csv("iris.csv", sep = ",")

head(iris)
```

```
##   X Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1 1          5.1         3.5          1.4         0.2  setosa
## 2 2          4.9         3.0          1.4         0.2  setosa
## 3 3          4.7         3.2          1.3         0.2  setosa
## 4 4          4.6         3.1          1.5         0.2  setosa
## 5 5          5.0         3.6          1.4         0.2  setosa
## 6 6          5.4         3.9          1.7         0.4  setosa
```

Output visualization

```r
fit <- lm(Sepal.Length ~ Sepal.Width, iris)

summary(fit)
```

```
##
## Call:
## lm(formula = Sepal.Length ~ Sepal.Width, data = iris)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.5561 -0.6333 -0.1120  0.5579  2.2226
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   6.5262     0.4789   13.63   <2e-16 ***
## Sepal.Width  -0.2234     0.1551   -1.44    0.152
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8251 on 148 degrees of freedom
## Multiple R-squared:  0.01382,    Adjusted R-squared:  0.007159
## F-statistic: 2.074 on 1 and 148 DF,  p-value: 0.1519
```

Output visualization

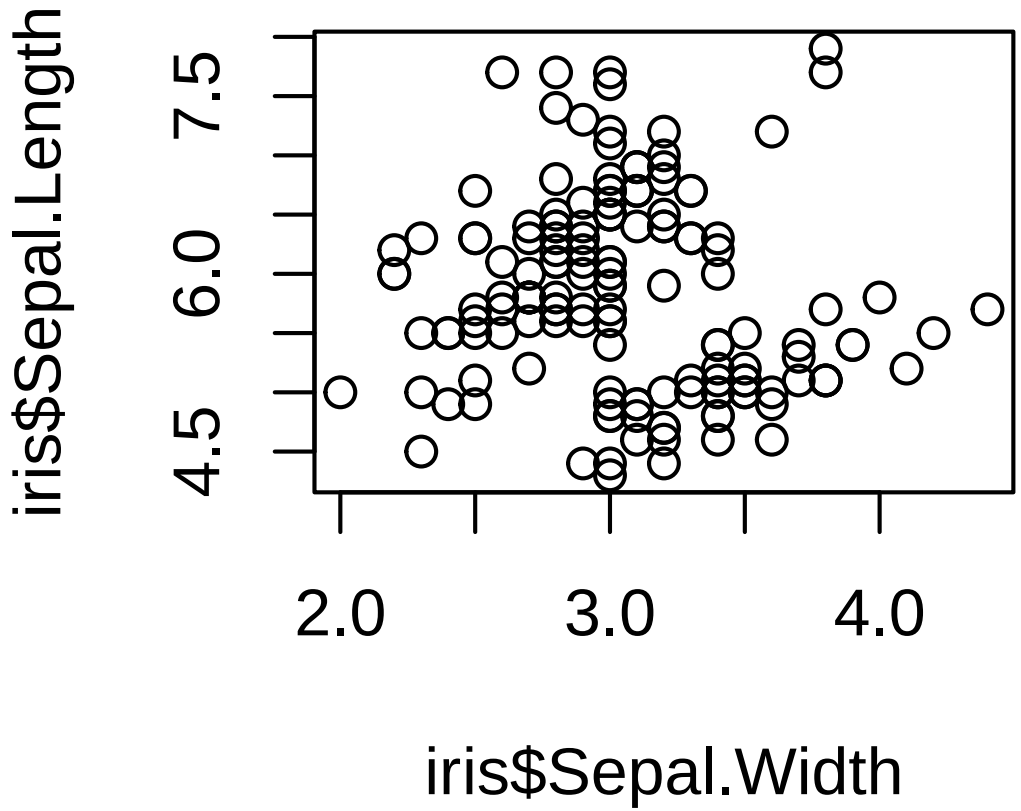
```
library(stargazer)

stargazer(fit, type = "text")
```

```
##
## ================================================
##                          Dependent variable:
##                      ---------------------------
##                              Sepal.Length
## ------------------------------------------------
## Sepal.Width                    -0.223
##                                (0.155)
##
## Constant                      6.526***
##                                (0.479)
##
## ------------------------------------------------
## Observations                     150
## R2                              0.014
## Adjusted R2                     0.007
## Residual Std. Error       0.825 (df = 148)
## F Statistic              2.074 (df = 1; 148)
## ================================================
## Note:                *p<0.1; **p<0.05; ***p<0.01
```

Output visualization

```
plot(iris$Sepal.Width, iris$Sepal.Length)
```



Output visualization

```
![](screenparts.png)
```

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---
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subtitle: "Lab 1: Intro to R Markdown, reproducibility, DAGs"
author: "Giacomo Lemoli"
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output:
    beamer_presentation:
        theme: "Madrid"
        colortheme: "crane"
urlcolor: blue
---

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- Personal website: [giacomolemoli.com](https://giacomolemoli.com/)
```

Formatted text

It is very easy to format your text in Markdown.

- `*italics*` *italics*
- `**bold**` **bold**
- `~~strikethrough~~` ~~strikethrough~~
- `[nyu](https://www.nyu.edu/)` nyu
- `superscript^2^` superscript^2

You can find many more (e.g. headers, lists, etc.) here or Googling

Equations

- Use LaTex notation
- Inline equation (single dollar sign) We can use inline equations such as `$y_i = \alpha + \beta x_i + e_i$` which is displayed as $y_i = \alpha + \beta x_i + e_i$.
- Displayed equation (double dollar sign)

```
$$f(x) = \frac{e^{(-x-\mu)^{2}/(2\sigma^{2})}}
{\sigma \sqrt{2\pi}}$$
```

Which give this:

$$f(x) = \frac{e^{(-x-\mu)^2/(2\sigma^2)}}{\sigma\sqrt{2\pi}}$$

Equations

For multiline equations, you need the `aligned` environment:

```
$$
\begin{aligned}
x & = 2*z + 3 \\
y & = 5*z + 6
\end{aligned}
$$
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Inline code

- You can embed R output within text
- Use [r R-object] within the single backticks

```
mean <- mean(x)
```

The mean of x is bt-r mean-bt

The mean of x is 0.5515139

- Text gets updated automatically when code is updated too

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- Implications: structure of data files and folders, coding style

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- Then your code pulls files from and saves files to the specific sub-directories

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- Play around with replication packages to learn coding tricks

Resources

- Great resource: Gentzkow and Shapiro (2014), Code and Data for the Social Sciences: a Practitioner's Guide

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- Important concepts:
  - Backdoor path: non-causal dependency between D and Y
  - Collider: variable caused by different variables

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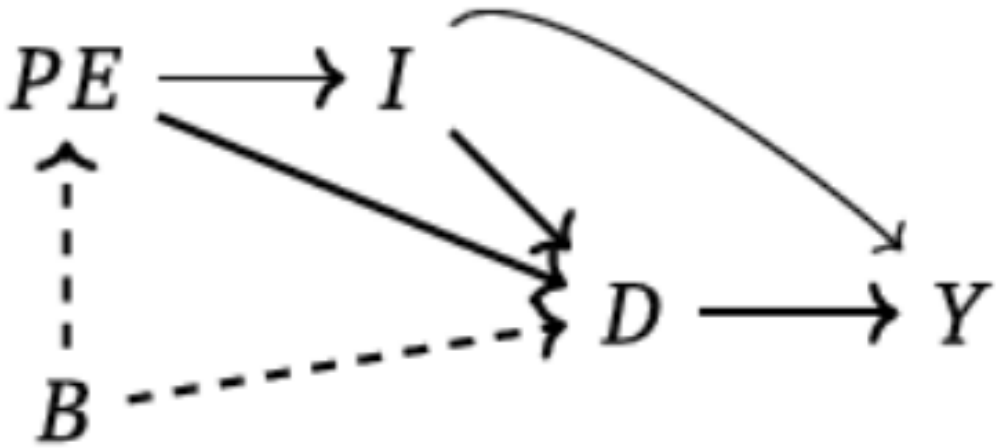
- If w is a collider, link all pairs of parents of w by drawing an undirected edge between them
- For any ancestor of w, if this ancestor is itself a collider, link all pairs of parents of this ancestor with undirected edges to connote induced dependencies
- Erase w from the graph and all the edges connected with w

DAGs

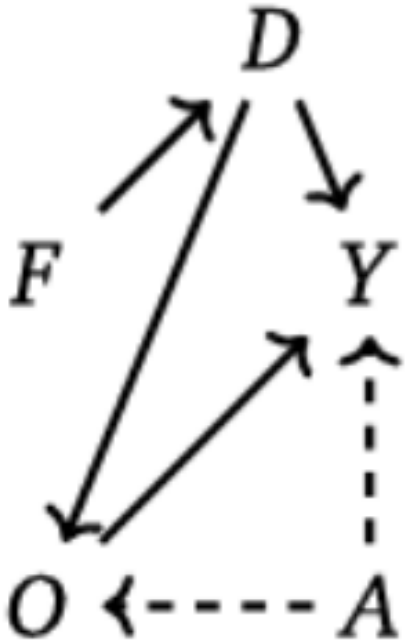
An example from the Mixtape



Collider bias

- Let's see these properties at work, with some simulations
- Examples and code from The Mixtape, (pp. 108-113)

Case 1: the effect of gender discrimination on women income



Collider bias

```
library(tidyverse)
library(stargazer)

# Set seed
set.seed(123)

# Simulate our data
tb <- tibble(
  female = ifelse(runif(10000) >= 0.5, 1, 0),
  ability = rnorm(10000),
  discrimination = female,
  occupation = 1 + 2*ability + 0*female - 2*discrimination + rnorm(10000),
  wage = 1-1*discrimination + 1*occupation + 2*ability + rnorm(10000)
)

# Estimate regressions
lm_1 <- lm(wage ~ female, tb)
lm_2 <- lm(wage ~ female + occupation, tb)
lm_3 <- lm(wage ~ female + occupation + ability, tb)
```

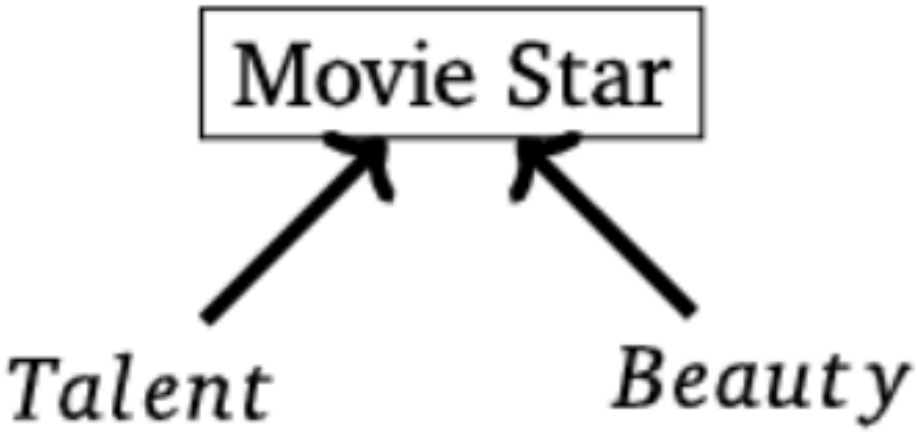
Collider bias

```
# Compare
stargazer(lm_1, lm_2, lm_3, type = "text",
          column.labels = c("Biased unconditional",
                            "Biased",
                            "Unbiased Conditional"))
```

```
##
## ================================================================================================
##                                                Dependent variable:
##                    ------------------------------------------------------------------------------
##                                                       wage
##                          Biased unconditional          Biased              Unbiased Conditional
##                                   (1)                  (2)                        (3)
## ------------------------------------------------------------------------------------------------
## female                          -3.066***            0.587***                   -1.050***
##                                  (0.085)             (0.030)                    (0.028)
##
## occupation                                           1.796***                   0.987***
##                                                      (0.006)                    (0.010)
##
## ability                                                                         2.033***
##                                                                                 (0.022)
##
## Constant                         2.023***            0.222***                   1.025***
##                                  (0.060)             (0.020)                    (0.017)
##
## ------------------------------------------------------------------------------------------------
## Observations                      10,000              10,000                     10,000
## R2                                 0.114               0.912                      0.952
## Adjusted R2                        0.114               0.912                      0.952
## Residual Std. Error          4.265 (df = 9998)   1.347 (df = 9997)          0.994 (df = 9996)
## F Statistic           1,292.306*** (df = 1; 9998) 51,551.530*** (df = 2; 9997) 65,927.470*** (df = 3; 9996)
## ================================================================================================
## Note:                                                                *p<0.1; **p<0.05; ***p<0.01
```

Collider bias

Case 2: Talent and beauty



DAG simulations

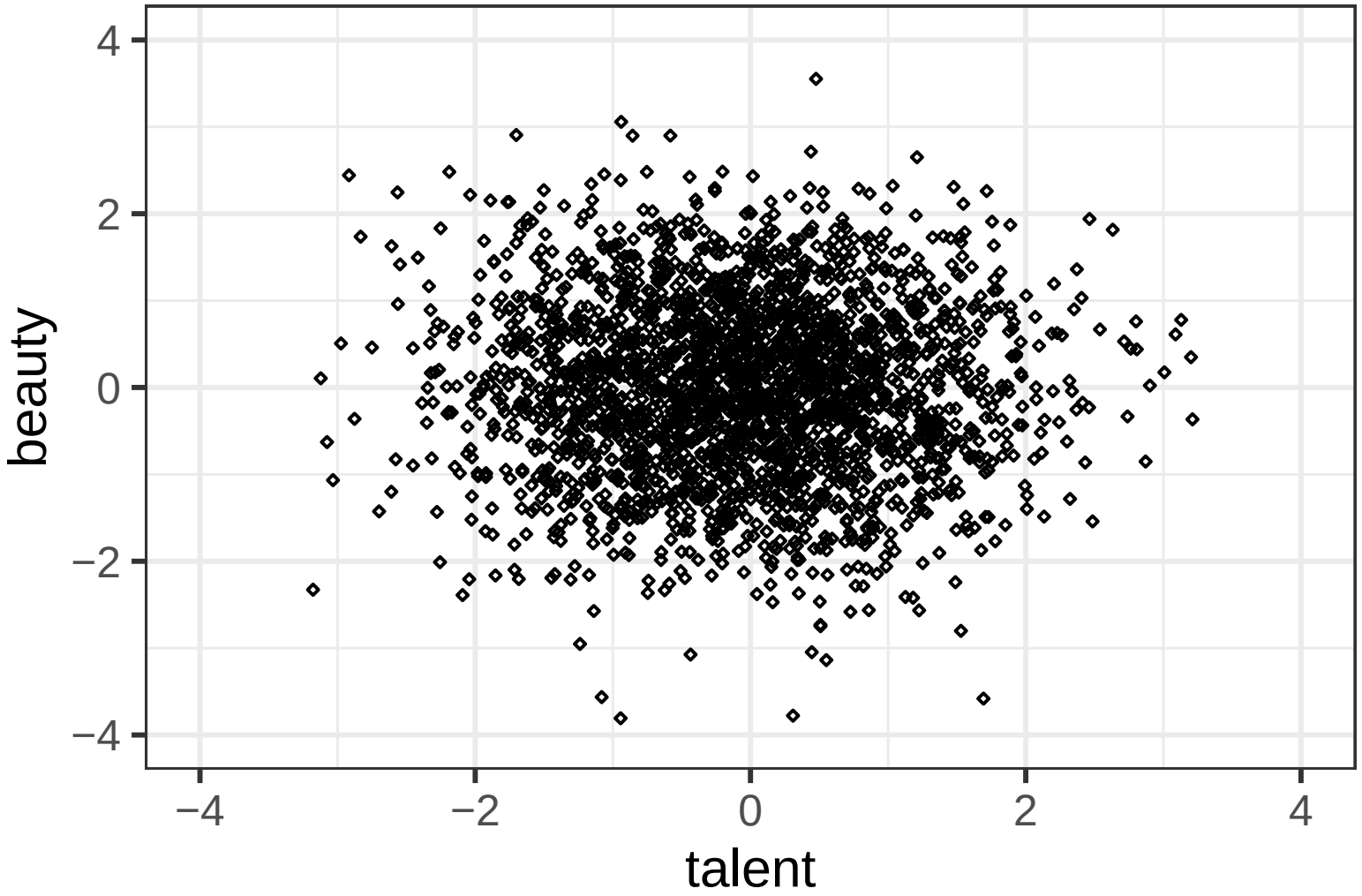
```
library(tidyverse)

# Set seed
set.seed(3444)

# Simulate data
star_is_born <- tibble(
  beauty = rnorm(2500),
  talent = rnorm(2500),
  score = beauty + talent,
  c85 = quantile(score, .85),
  star = ifelse(score >= c85, 1, 0)
)
```

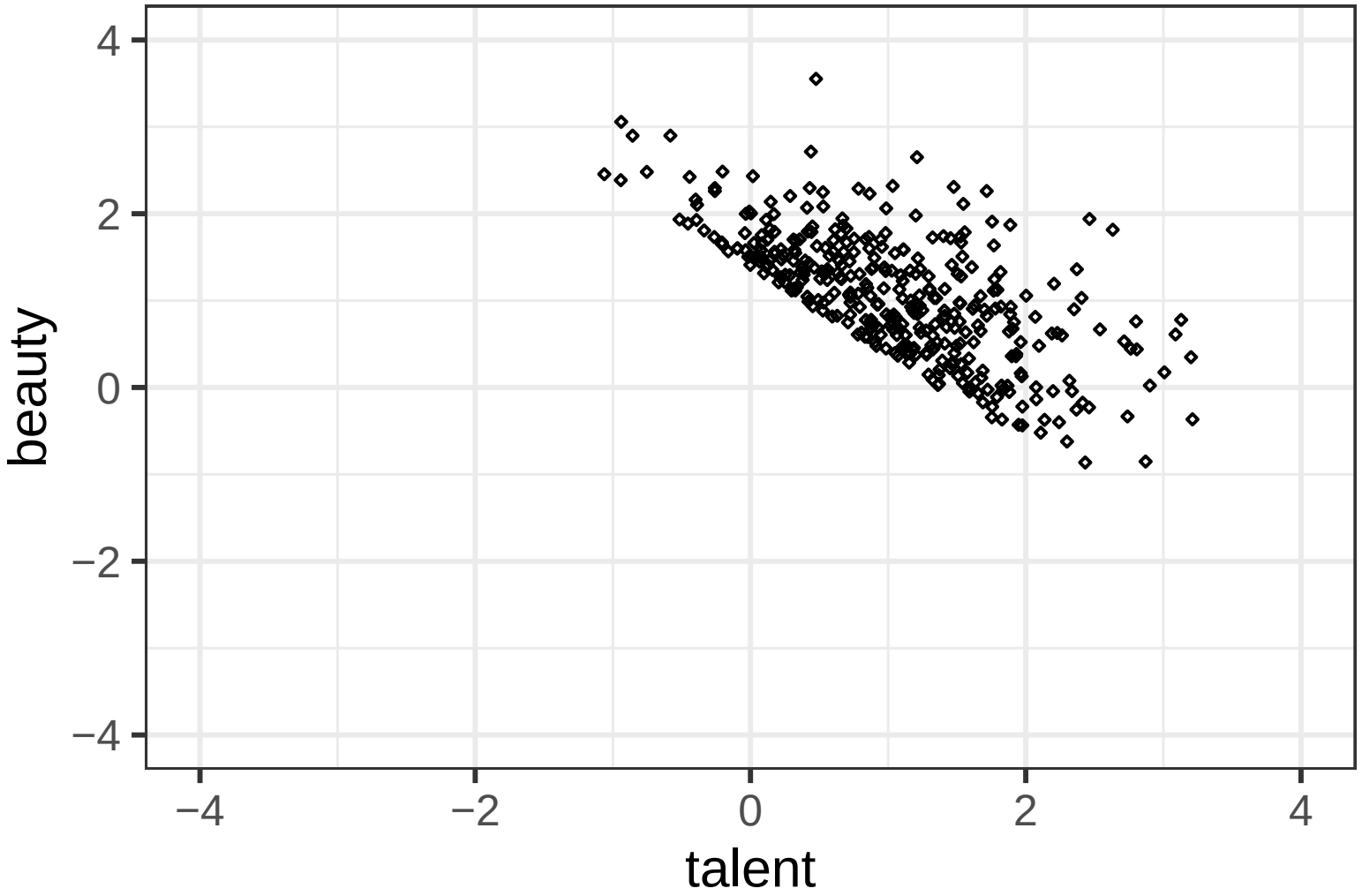
DAG simulations

```
star_is_born %>%
  lm(beauty ~ talent, .) %>%
  ggplot(aes(x = talent, y = beauty)) +
  geom_point(size = 0.5, shape = 23) + xlim(-4, 4) + ylim(-4, 4) +
  theme_bw()
```



DAG simulations

```
star_is_born %>%
  filter(star == 1) %>% lm(beauty ~ talent, .) %>%
  ggplot(aes(x = talent, y = beauty)) +
  geom_point(size = 0.5, shape = 23) + xlim(-4, 4) + ylim(-4, 4) +
  theme_bw()
```



Conclusion

- Don't control for/condition on colliders
  - Endogenous sample selection is a form of collider bias
  - See discussion in Knox et al (2020) on admin data

Additional resources:

- Elwert and Winship (2014), Endogenous selection bias: the problem of conditioning on a collider variable
- Knox, Lucas, and Cho (2022), Testing causal theories with learned proxies
- Schneider (2020), Collider bias in economic history research