More Data Tricks and Data Workshop

David recently transferred from the Marketing programme to the Management programme. Consequently, the average IQ of students in both the Marketing and Management programmes has increased.

Why?

Simpson's Paradox

You are making a comparison between two hospitals:

- Hospital A: Among each 1,000 patients, 900 survived.
- Hospital B: Among each 1,000 patients, 800 survived.

Which hospital will you choose, and why?

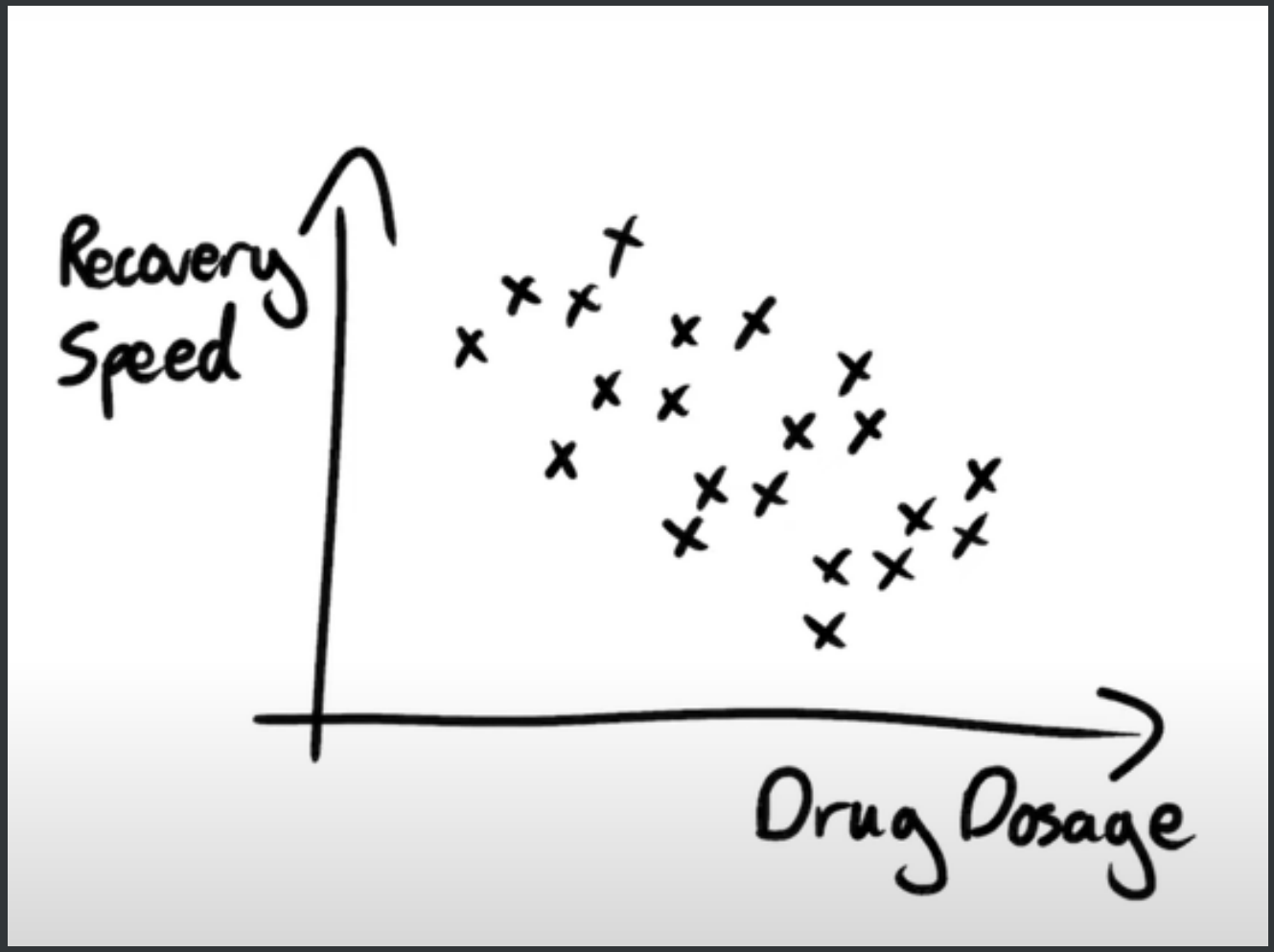
Let us take a closer look at the data...

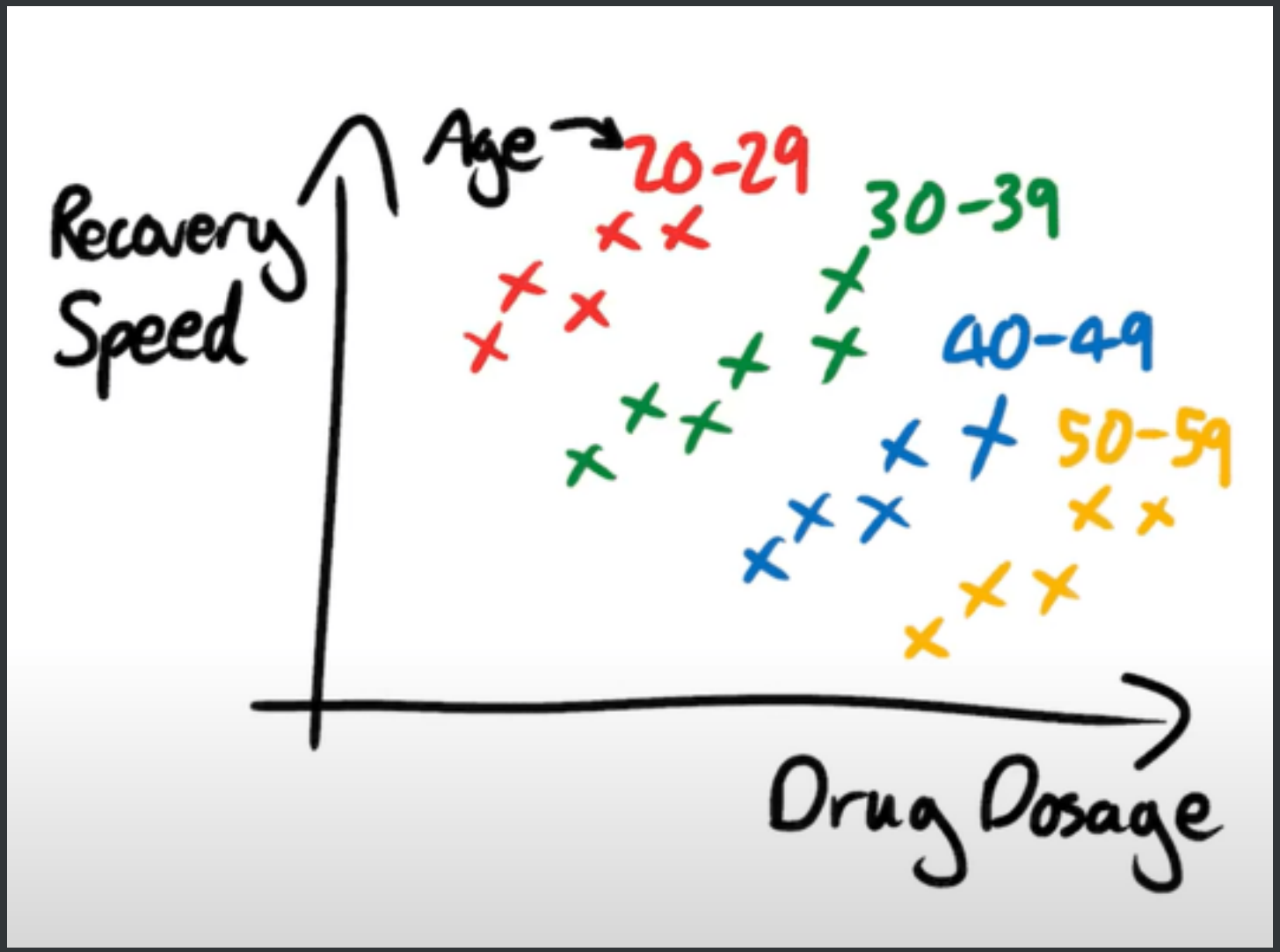
- Hospital A has 100 severe patients, among them 30 survived. It has 900 mild patients, among them 870 survived.
- Hospital B has 400 severe patients, among them 210 survived. It has 600 mild patients, among them 590 survived.

Location	Price (MM)	Units	Average Price (MM)
Suburban	$100	3,500	2.9
Downtown	$1,000	21,000	4.8
Total	$1,100	24,500	4.5

Location	Price (MM)	Units	Average Price (MM)
Suburban	$500	15,000	3.3
Downtown	$1,000	20,000	5.0
Total	$1,500	35,000	4.3

Do patients recovery more slowly when taking more drugs?



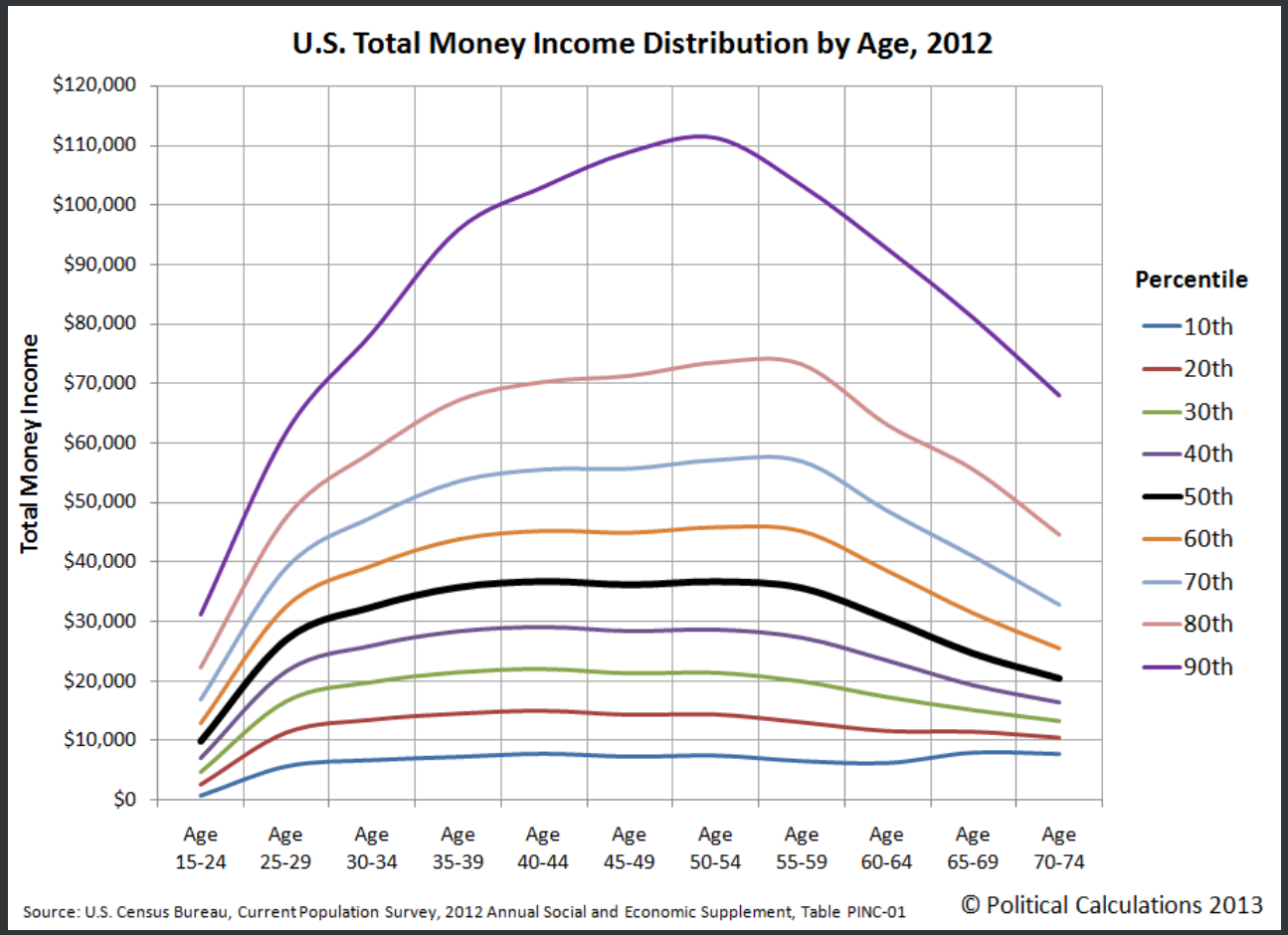


Again, Simpson's Paradox

https://www.youtube.com/embed/ebEkn-BiW5k?enablejsapi=1

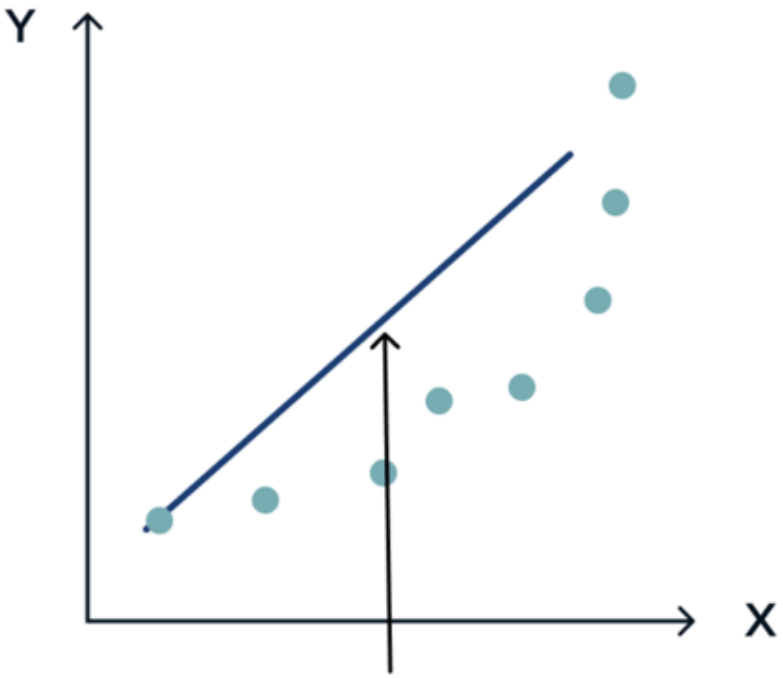
More Data Tricks

How does income change with age?



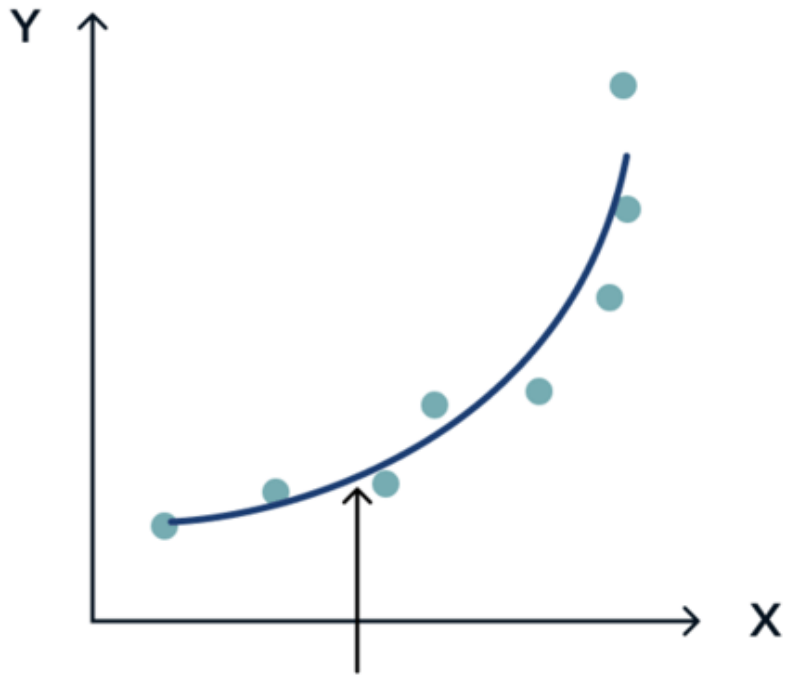
If you run a linear regression, you find that income either increases or decreases with age. But this does not capture the nonlinear relationship between the two variables. What should you do in this scenario?

Simple linear model



$$y=b_0+b_1x$$

Polynomial model



$$y=b_0+b_1x+b_2x_1^2$$

Quadratic Regression

Suppose that we want to see how Y changes nonlinearly with X, we can run the following quadratic regression (as opposed to linear regression):

$$Y = a + b_1 X + b_2 X^2$$

You can further extend the model to include cubic terms etc.

Crowdfunding: An Example

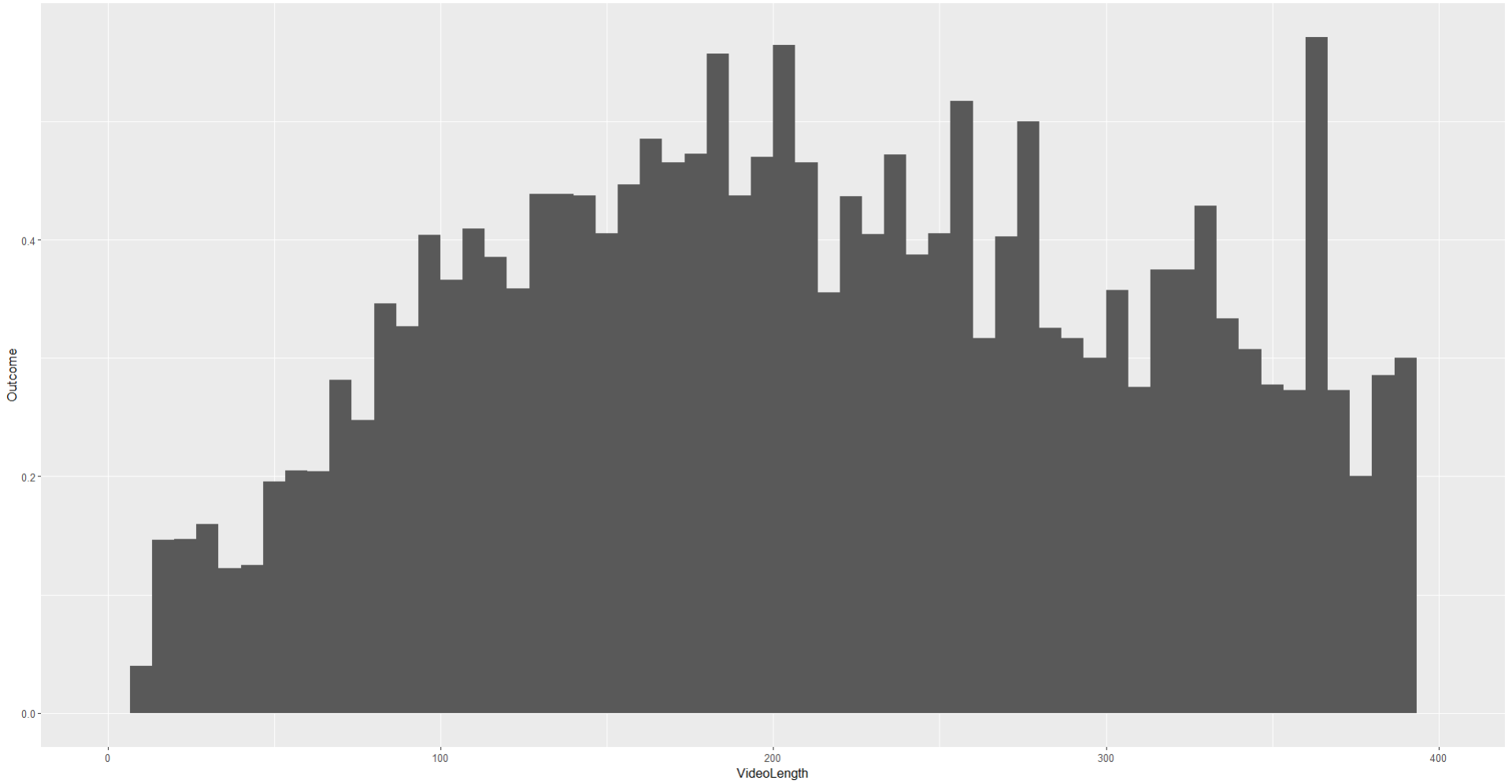
We want to investigate the relationship between video length and the chance of success. Let us prepare the data:

```
1 mydata <-
  read.csv("https://ximarketing.github.io/class/Kickstarter-
  Project.csv", fileEncoding = "UTF-8-BOM")
2 subdata = subset(mydata, IsVideoAvailable == 1)
```

Crowdfunding: An Example

We want to investigate the relationship between video length and the chance of success. Let us prepare the data:

```
1 library(ggplot2)
2 ggplot(subdata,  mapping = aes(VideoLength, Outcome)) +
3 stat_summary_bin(fun.y="mean", geom="bar", bins=60)+xlim(0,
  400)
```


Outcome
0.4
0.2
0.0
0
100
200
300
400
VideoLength

Crowdfunding: An Example

The relationship between video length and project success appears to be nonlinear. Shorter videos can enhance the success rate as their length increases; however, excessively long videos do not provide additional benefits to the project.

Crowdfunding: An Example

Let us try the following logistic regression:

$$\Pr[\text{Success}] = \frac{1}{1 + \exp(-(a + b_1 \times \text{Length} + b_2 \times \text{Length}^2))}$$

Consider the following code:

```
1 logit <- glm(Outcome ~ VideoLength + I(VideoLength^2), data =
  subdata, family = "binomial")
2 summary(logit)
```

```
Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)       -1.192e+00  8.958e-02 -13.307  < 2e-16 ***
VideoLength        6.541e-03  8.102e-04   8.074 6.81e-16 ***
I(VideoLength^2) -1.056e-05  1.584e-06  -6.666 2.63e-11 ***
```

Question: What is the optimal video length?

Optimal video length

Recall your high-school mathematics: A quadratic function $f = b_2 x^2 + b_1 x + a, b_2 < 0$ is maximized when

$$x = -\frac{b_1}{2b_2}$$

In our example, $b_2 = -1.056 \times 10^{-5}$ and $b_1 = 6.541 \times 10^{-3}$. With a little bit calculation you can find out that the optimal video length is about 300 seconds (i.e., 5 minutes).

Question

Suppose that you want to predict students' performance in exam. Two factors come into play: IQ and Hours of Study.

- A student with a higher IQ is more clever, and gets higher grades on average.
- A student who studies longer hours understands the content better, and gets higher grades on average.

Question

Let's run the following linear regression:

$$\text{Grades}_i = a + b_1 \times \text{IQ}_i + b_2 \times \text{Hours}_i$$

Is anything missing from the regression?

Question

Consider two types of students: High IQ students and low IQ students. High IQ students are clever, and they study more efficiently. That is, when a high IQ student studies for one hour, they learn more than a low IQ student who also studies for one hour.

How to incorporate this into our regression model?

Question

We consider the interaction between IQ and Hours of Study:

$$\text{Grades}_i = a + b_1 \times \text{IQ}_i + b_2 \times \text{Hours}_i + b_3 \times \text{IQ}_i \times \text{Hours}_i$$

Suppose that you find out $b_3 > 0$, what does it imply?

Interaction Effects

$$\text{Grades}_i = 10 + 0.2 \times \text{IQ}_i + 4 \times \text{Hours}_i + 0.01 \times \text{IQ}_i \times \text{Hours}_i$$

- Alice has an IQ 120. If she studies 8 hours, she will get 75.6. If she studies 9 hours, she will get 80.8. For Alice, one extra hour of study improves her grades by 5.2.
- Bob has an IQ 80. If he studies 8 hours, he will get 64.4. If he studies 9 hours, he will get 69.2. For Bob, one extra hour of study improves his grades by 4.8.
- Alice studies more efficiently than Bob!

Interaction Effects

Suppose that your dependent variable is a programmer's salary. You have two independent variables: the programmer's knowledge of Python and his/her knowledge of R. You find that

$$\text{Salary}_i = 1 + 3 \times \text{Python}_i + 2 \times \text{R}_i - 0.5 \times \text{Python}_i \times \text{R}_i$$

How would you interpret this result?

Interaction Effects

$$\text{Salary}_i = 1 + 3 \times \text{Python}_i + 2 \times \text{R}_i - 0.5 \times \text{Python}_i \times \text{R}_i$$

If you know more about Python, you can make a higher salary.

If you know more about R, you can maker a higher salary.

However, if you already know Python well, then knowing more about R does not help much, and vice versa.

This result suggests that Python and R are substitutes: After learning about one language, learning about the other does not help you much.

Interaction Effects

Suppose that your dependent variable is a person's health score. You have two independent variables: the amount of swimming and running.

$$\text{Health}_i = 4 + 5 \times \text{Running}_i + 3 \times \text{Swimming}_i + 2 \times \text{Running}_i \times \text{Swimming}_i$$

How would you interpret this regression result?

Interaction Effects

Suppose that your dependent variable is a person's health score. You have two independent variables: the amount of running exercise and whether or not the person is overweight.

$$\text{Health}_i = 4 + 5 \times \text{Running}_i - 2 \times \text{Overweight}_i + 3 \times \text{Running}_i \times \text{Overweight}_i$$

How would you interpret this regression result?

A Crowdfunding Example

We want to investigate the relationship between the total funding, the creators' experience and the number of products offered. Let us prepare the data:

```
1 mydata <-
  read.csv("https://ximarketing.github.io/class/Kickstarter-
  Project.csv", fileEncoding = "UTF-8-BOM")
2 mydata$LogFunding = log(mydata$FundingRaised + 1)
```

A Crowdfunding Example

We want to investigate the relationship between the total funding, the creators' experience and the number of products offered. Let us run a regression with an interaction term:

```
result = lm(LogFunding ~ Created * NumberOfProducts, data = mydata)
summary(result)
```

A Crowdfunding Example

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	3.039097	0.071653	42.414	< 2e-16	***
Created	0.240761	0.042393	5.679	1.41e-08	***
NumberOfProducts	0.443064	0.008182	54.148	< 2e-16	***
Created:NumberOfProducts	-0.012090	0.005019	-2.409	0.016	*

$$\text{LogFunding} = 3.04 + 0.24 \times \text{Created} + 0.44 \times \#\text{ of Products} - 0.012 \times \text{Created} \times \#\text{ of Products}$$

What do you learn from the results?

A Crowdfunding Example

Let's explore something more interesting...

We already know that in a crowdfunding project, putting your face in front of the camera makes the project more successful.

However, does it make a difference whether this is a female face or a male face? What's your intuition?

A Crowdfunding Example

```
1 subdata = subset(mydata, IsVideoAvailable == 1)
2 result = lm(LogFunding ~ factor(Gender) * Human, data =
  subdata)
3 summary(result)
```

```
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)           5.1768     0.3778  13.704  < 2e-16 ***
factor(Gender)M       0.4710     0.4003   1.177  0.23939
factor(Gender)U       1.9207     0.4057   4.734 2.26e-06 ***
Human                 2.3467     0.4137   5.672 1.48e-08 ***
factor(Gender)M:Human -1.1873     0.4411  -2.692  0.00713 **
factor(Gender)U:Human -0.5688     0.4453  -1.277  0.20153
```

A Crowdfunding Example

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	5.1768	0.3778	13.704	< 2e-16	***
factor(Gender)M	0.4710	0.4003	1.177	0.23939	
factor(Gender)U	1.9207	0.4057	4.734	2.26e-06	***
Human	2.3467	0.4137	5.672	1.48e-08	***
factor(Gender)M:Human	-1.1873	0.4411	-2.692	0.00713	**
factor(Gender)U:Human	-0.5688	0.4453	-1.277	0.20153	

This result tells us that, featuring a human in your video is beneficial. Nonetheless, featuring a male is less helpful compared to featuring a female.

Exercise

Play with the Kickstarter dataset yourself and see if you can find any interesting interaction effects. Share it with us!

Group Data Project II: HK Property Valuation

Do we have anyone living at Novum West (翰林峰)?

Do you know the selling price of your flat?

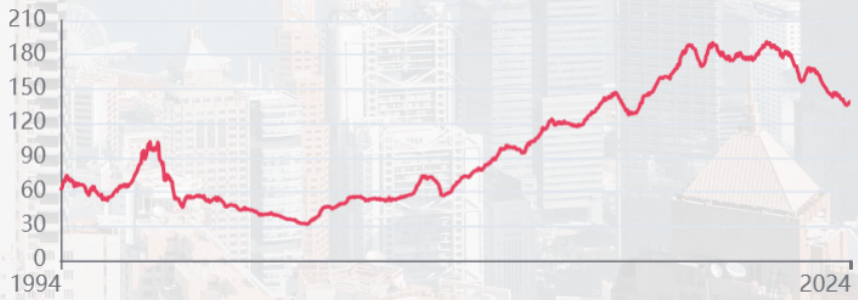
It’s all available here!

How much has Hong Kong housing price increased since 1997? Please make your guess!

中原城市領先指數 CCL

本週公佈	較上週	較上月
138.56	↑ 0.54%	↑ 1.23%

每週五公佈 – 最新2024/11/29公佈，反映2024/11/18至2024/11/24(預計簽署正式買賣合約時段)的二手私人住宅樓價。一般在簽署臨時買賣合約後14日內簽署正式買賣合約



1997年7月第1週指數為100點

查詢過往數據

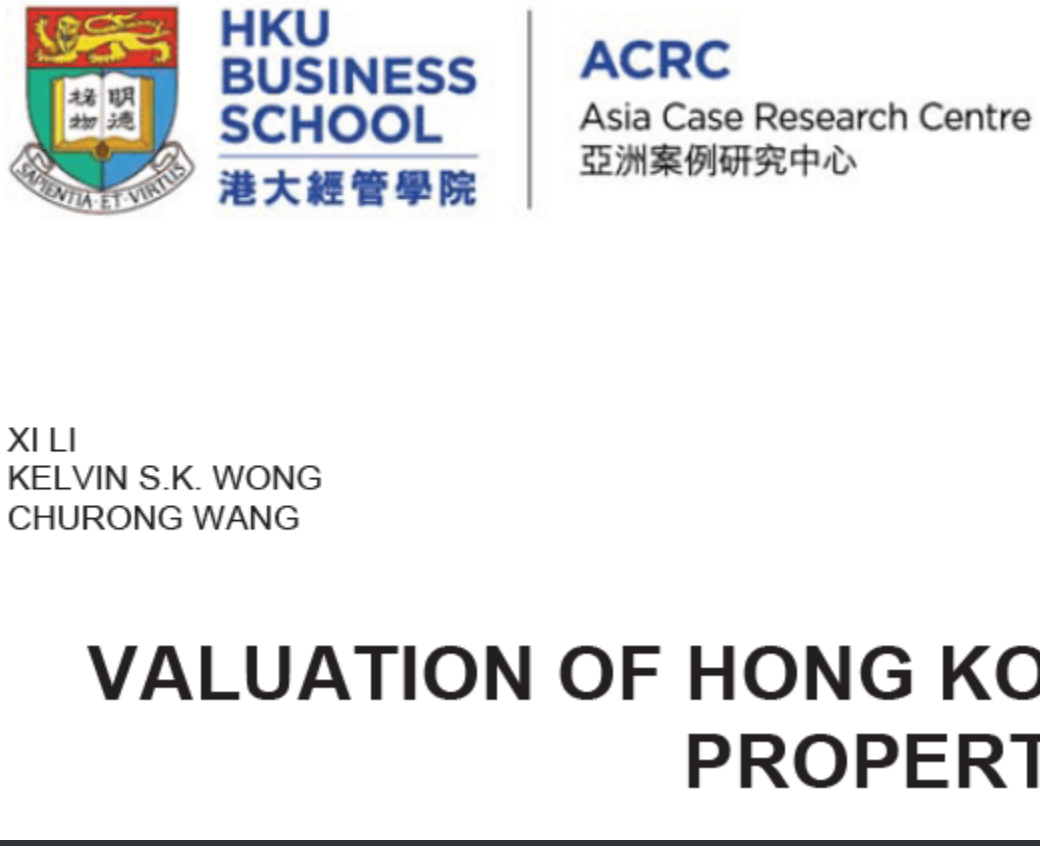
Not much. Less than 40%.

Guess

In Hong Kong, what do people care about most when buying or renting a flat?

Valuation of Hong Kong Residential Property

In this project, we want to understand the HK real estate market. We have collaborated with Centaline (中原地產), one of the largest property agencies in Hong Kong, to get the property transaction data in Hong Kong.



Kelvin Wong is Professor of Real Estate at the University of Hong Kong. Churong Wang is currently my PhD student.

Churong Wang (王楚绒)

Ph.D. Candidate in Marketing, HKU
M.Sc in Business Analytics, HKU
B.A. in Architecture, HKU

She ranked No. 19 in National College Entrance Examination (高考) in Yunnan Province in 2016

Valuation of Hong Kong Residential Property

Sign up here: https://acrc.internad.hk/

Adding the course content here:
https://acrc.internad.hk/enrol/1000025503

Loading the data:

```
1 mydata =
  read.csv('/dataset/Centaline/Centaline_train.csv',header=TRUE)
```

Valuation of Hong Kong Residential Property

Transaction_price: The transaction price of the property (in Hong Kong dollars). You may want to take the log transformation of this variable.

Transaction_year: The year in which the transaction takes place (e.g., 2020).

Transaction_month: The month in which the transaction takes place (e.g., 10 for October). When using this variable, you may want to take it as a fixed effect.

Valuation of Hong Kong Residential Property

Location and Estate: The location and estate for each property. Please do not use them in your data analysis.

HMA: It stands for "Housing Market Area", a term used to describe the area at which the property is located (e.g., Pok Fu Lam).

Developer: The developer of the property (e.g., Hang_Lung_Group for 恆隆集團). If the developer is a small developer not included in the dataset, then the value is "Other".

Valuation of Hong Kong Residential Property

Gross_size: 建築面積 in Chinese. It is measured in square foot. If data is unavailable for a property, then its Gross_size = -1.

Saleable_size :使用面積 in Chinese. It is measured in square foot. If data is unavailable for a property, then its Saleable_size = -1.

No_of_rooms: The number of rooms in the property. 0 means studio; -1 means data is not available.

Floor: The floor of the property (10 for 10th floor).

Valuation of Hong Kong Residential Property

Region: The region of the property; it takes values Hong Kong, Kowloon and New Territories.

Primary_school:小學學區 in Chinese. Primary school Net divides Hong Kong's primary schools into 36 zones

Secondary_school: 中學學區 in Chinese. Secondary schools use a zoning system based on the 18 districts in Hong Kong.

Age_of_property: The age of the property in years; -1 means the property is not built yet (-1 對應樓花).

Valuation of Hong Kong Residential Property

Uncompleted: Whether the construction is completed. 0 means completed and 1 means under construction.

MTR_station: The name of the nearest MTR station. -1 means property is distant from all MTR stations.

Close_to_MTR: Whether the property is close an MTR station. 1 means close to and 0 means far from MTR stations.

Valuation of Hong Kong Residential Property

Shopping_Mall, Swimming_Pool, Sport_facility, Club, Garden, Sauna_Shower, Playground, Cinema, Bar_karaoke, Study_Room, Ballroom: These are all binary variables. 1 means the amenity is available while 0 means there are no such amenities.

Valuation of Hong Kong Residential Property

District: One of Hong Kong's 18 districts.

Median_income: The median income in the HMA.

Median_age: The median age of residents in the HMA.

Population: The total population of the HMA.

Unit: Number of property units in the HMA.

Sample Codes (run on DAP)

```r
library(stargazer)
mydata = read.csv('/dataset/Centaline/Centaline_train.csv',header=TRUE)
head(mydata)
mydata$LogPrice = log(mydata$Transaction_price)
result <- lm(LogPrice ~ Age_of_property * Close_to_MTR, data = mydata)
summary(result)
```

What should we do in this project?

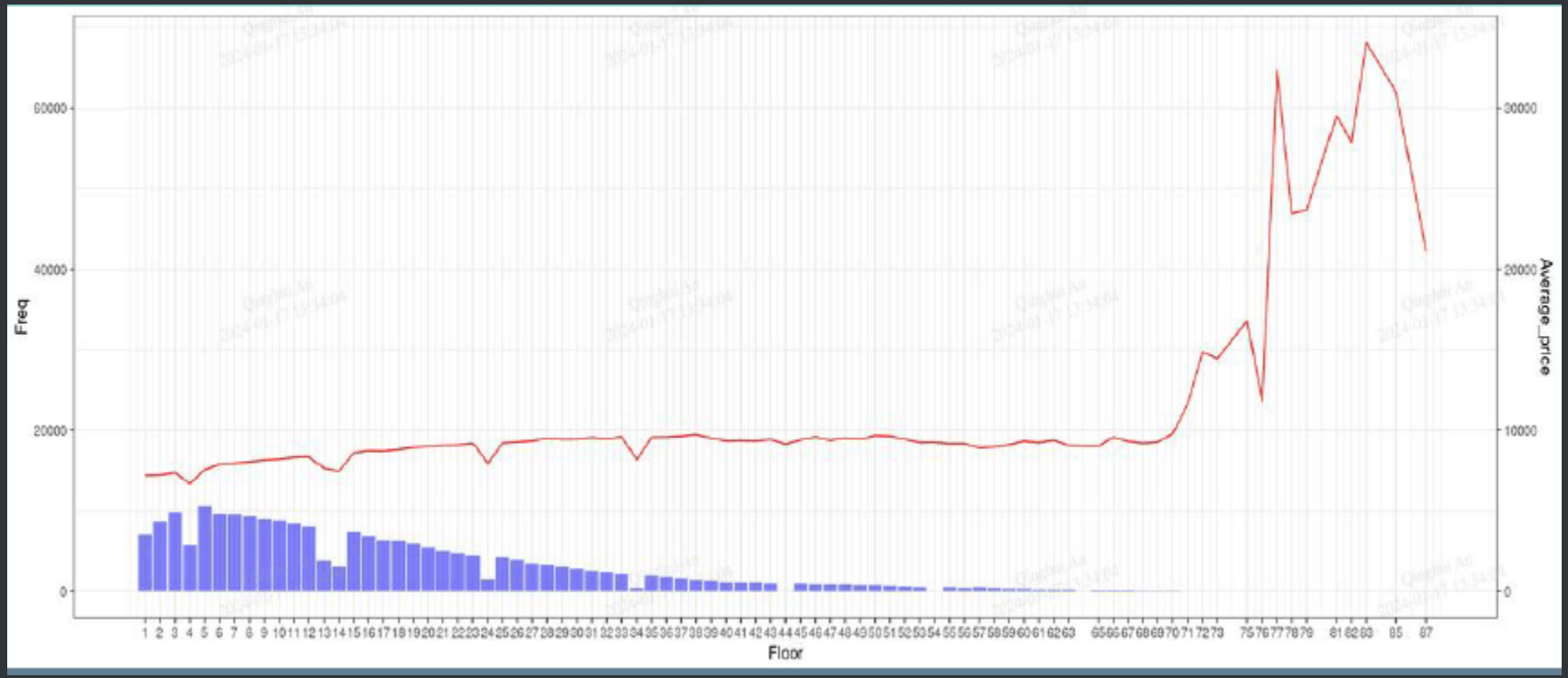
Each group should only ask one big research question in your project. Quality beats quantity. Choose the right data analysis methods and come up with a good answer to your questions, with implications for sellers, buyers, developers, property agencies and the government.

What should we do in this project?

You need to include at least one interaction term or a square term in your analysis.

A full-score example (last year)

Floor Numbers and Housing Price



There is a significant drop in prices when floor is 13 or ends with 4. But not for 18.

Special Numbers and Housing Price

The higher the floor, the higher the unit price.

However, the marginal effect of floor on unit price is decreasing with the floor level.

Submission

To save your time, you only need to submit a few pages of slides (no more than 12 pages for main text + no more than 6 slides for appendix) to Moodle covering your research question(s), data analysis (e.g., regression equations), findings, and implications.

No reports/presentations are needed!

Deadline: Jan 11, 2024

12:30 for Class A, 17:00 for Class B, and 21:30 for Class C

Individual Project

Why do we have an individual project?

As a professor, I hate all kinds of individual assignment; it means I need to grade 200+ copies myself...

But I have no other choice. For a group project, we always have free-riders or students who do not analyze the data.

Individual Project

I understand that not everyone is going to become an analyst in the future. So it is fine that you don't work on data. That's why we have two options for each of you.

Option 1: Collect and analyze your own dataset

Option 2: Find and discuss an innovative data strategy

Option 1

This is similar to your group projects; the difference is that you need to collect your own dataset now. Let me give you a few sources for data.

Option 1

Kaggle, a platform with all types of datasets. [Video]

Amazon Reviews, good for text mining.

Yelp Reviews

Stanford Social Network Data

Harvard Datasets

Don't be too aggressive! Try some small datasets that you are able to handle. We do have a deadline for this.

Option 1

You can also scrape data yourself (this may be a bit risky because you may face a lot of practical issues; e.g., the website is a dynamic website, your IP address is blocked)

You can also hire a scraper on Taobao to help you (cost usually a few hundred RMB). But make sure you can finish the task on time.

双旦狂欢8.7折起 | 包邮 | 淘金币抵钱 | 开票服务 | 天猫超市 | 7+天内退货 | 公益宝贝 | 通用排序

深度学习python代编程模型神经网络办公自动化直播间信息采集...

¥100.00 200+人付款 浙江 杭州

思媚尔python爬虫店

爬虫数据抓取python爬虫接单代做编程网络页数据爬取爬虫软件...

¥50.00 9000+人付款 浙江 杭州

回头客4千 峰荐网络科技工作室

爬虫数据抓取爬虫python接单代做编程网络爬虫网站页数据爬取...

¥100.00 7000+人付款 上海

镜数字辉煌服务

爬虫数据抓取python爬虫接单软件开发网页小程序app网站数据...

¥300.00 1000+人付款 上海

回头客5千 博远工作室

Option 1

If you still have no data and don’t have time, let me know.

Option 2

Discuss the innovative data strategy of a company (like writing a case study). You need to search for resources online. For instance, you can discuss

- How does Uber use data to set prices?
- How does Freshippo (盒马) use data to optimize its retail operations?

Deliverables

If you choose option 1, you need to submit up to 20 pages slides explaining your data sources, question, analysis, findings, and implications.

If you choose option 2, you need to submit up to 5 pages report (in PDF format, not including title page) discussing the company's big-data marketing strategy.

What is a good project?

Option 1: Find a good data, ask an interesting question and obtained useful, especially surprising findings.

Option 2: Find some innovative uses of data that were not well-known before (e.g., Uber collects your phone battery data; Target collects satellite images).

Deadline

Two weeks from today, that is,

Deadline: Jan 16, 2024

12:30 for Class A, 17:00 for Class B, and 21:30 for Class C