Some Data Tricks and Data Workshop

Log Transformation

A linear regression assumes that the relationship between the dependent variable and independent variable is linear, i.e., we specify the following relationship: $Y = a + bX$.

But sometimes we also take the log-transformation of the linear regression. For example, consider the following relationship:

$$\log Y = a + b \times \log X.$$

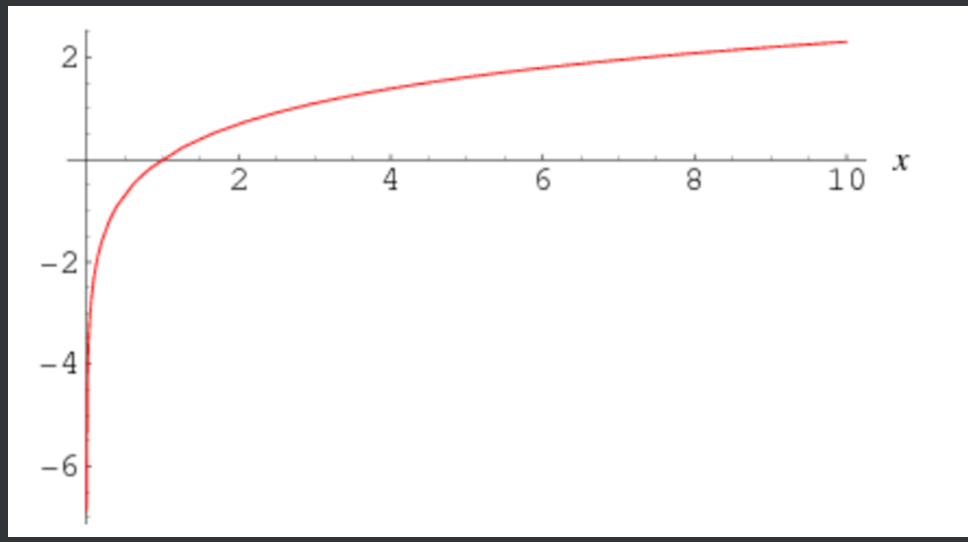
Here, we typically use the natural logarithms (base is $e \approx 2.718$) in log transformation.

Some basics of the logarithm function:

If $e^a = b$, then $\log(b) = a$, where $e \approx 2.718$.

For instance, we have

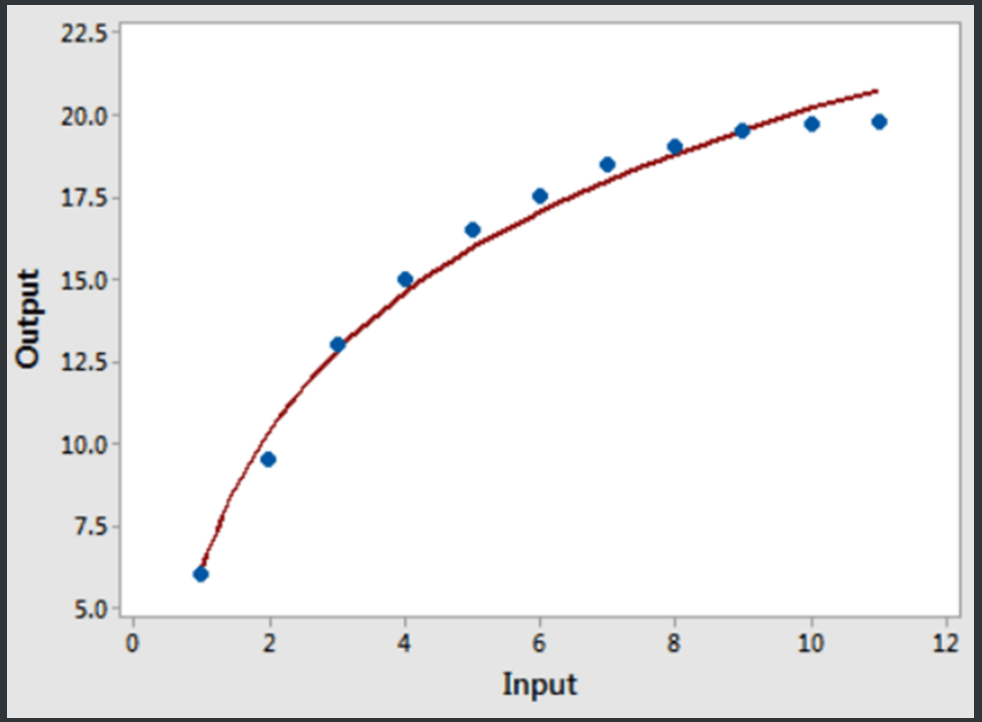
- $\log(10) \approx 2.3023$
- $\log(100) \approx 4.6052$



Question: When should we take log transformation?

Question: When should we take log transformation?

First, we can take log transformation of the independent variable when the relationship has a log format.



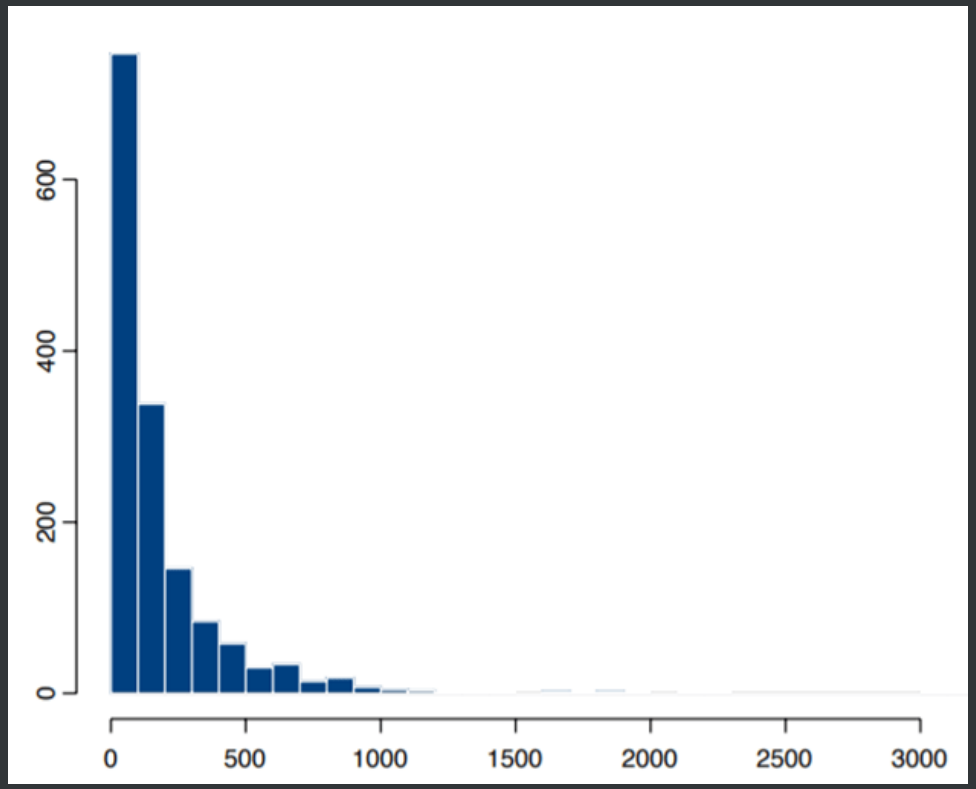
Question: When should we take log transformation?

When we run linear regressions, there is one underlying assumption: The residuals are normally distributed. But this condition does not always hold. Statisticians have found out that log transformation can serve as a good fix to this issue.

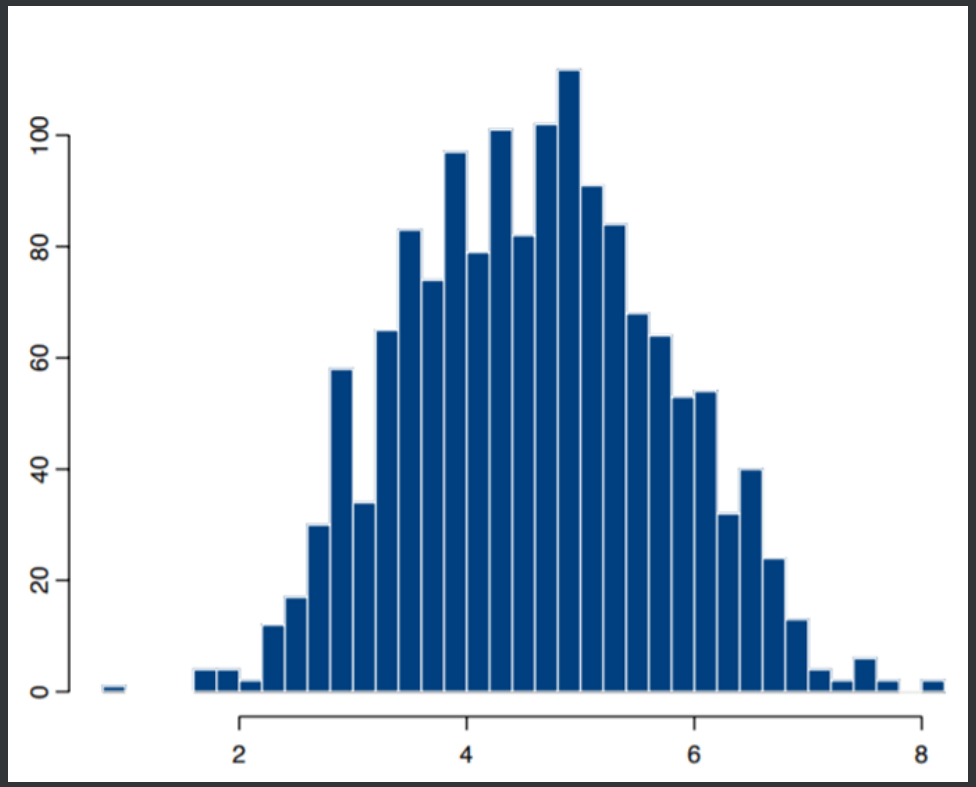
Question: When should we take log transformation?

Second, we typically take the log transformation when the original variable is right-skewed, i.e., when the right tail is much longer than the left tail.

A highly right-skewed distribution



The log transformed distribution



Types of log transformation

- Linear-log models: $Y = a + b \log X$.
- Log-linear models: $\log Y = a + bX$.
- Log-log models: $\log Y = a + b \log X$.

Interpreting your results

- $Y = 0.4 + 11.7 \times \log X$: When X increases by 1%, Y will increase by $11.7 \times 0.01 = 0.17$.
- $\log Y = 1.2 + 0.031X$: When X increases by 1, Y will increase by 3.1%.
- $\log Y = 2.2 + 0.7 \log X$: When X increases by 1%, Y will increase by 0.7%.

Why is this so?

Suppose that $Y = \alpha + \beta \log X$. Using Taylor expansion, we can show that when ϵ is small,

$$\log(X(1+\epsilon)) = \log X + \log(1+\epsilon) \approx \log X + \epsilon$$

In this case, we can show that an ϵ relative increase in X lead to a $\beta \times \epsilon$ absolute increase in Y.

Fixed Effects

Fixed Effects

Consider the following regression: You want to analyze how the sales of a car changes with the color (black, green, yellow, red, white etc.) However, color is not a number, how can you run a regression?

Fixed Effects

You can assign numbers to the color, e.g., `black = 1`, `red = 2`, `white = 3`. However, this is not a great idea: For example, if you find $\text{Sales} = 100 + 5 \times \text{Color}$, can you say "when color increases, sales also increase?" This does not make any sense!

Fixed Effects

The solution is to use fixed effects. Instead of creating one single variable for color, we create one variable for each color. For example, for color black, we create the following variable:

$$\text{black} = \begin{cases} 1 & \text{if color is black,} \\ 0 & \text{if color is not black.} \end{cases}$$

Then, we put these variables into our regression equation.

Fixed Effects

```r
data = read.csv("https://ximarketing.github.io/data/fixed_effects.csv")
head(data)
result = lm(sales ~ price + factor(color), data = data)
summary(result)
```

```
Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)       4264.47223    4.83268  882.42   <2e-16 ***
price              -33.88337    0.05926 -571.77   <2e-16 ***
factor(color)red   -77.70687    4.05458  -19.16   <2e-16 ***
factor(color)white 132.51899    3.36567   39.37   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Fixed Effects

The regression output suggests that

$$\text{Sales} = 4264.47 - 33.88 \times \text{Price} + \begin{cases} 0 & \text{if color is black,} \\ -77.71 & \text{if color is red,} \\ 132.52 & \text{if color is white.} \end{cases}$$

Here, black is treated as a benchmark and we compare other colors against this benchmark.

Why do we set a benchmark?

Note that the following two equations are identical:

$$\text{Sales} = 4264.47 - 33.88 \times \text{Price} + \begin{cases} 0 & \text{if color is black,} \\ -77.71 & \text{if color is red,} \\ 132.52 & \text{if color is white.} \end{cases}$$

$$\text{Sales} = 4263.47 - 33.88 \times \text{Price} + \begin{cases} 1 & \text{if color is black,} \\ -76.71 & \text{if color is red,} \\ 133.52 & \text{if color is white.} \end{cases}$$

Here, the benchmark just fixes one parameter to 0.

Why do we set a benchmark?

Why color black is set as a benchmark? This is because R adopts alphabetical order, and “black” is before “red” and “white.” However, you can change your benchmark as well:

```
data$color = relevel(factor(data$color), ref = "red")
result = lm(sales ~ price + factor(color), data = data)
summary(result)
```

Multinomial Logit Model

Consider the following multinomial logit model:

$$\Pr(Y = A) = \frac{\exp(X)}{\exp(X) + \exp(1 + 2X) + \exp(2 + 3X)}$$

$$\Pr(Y = B) = \frac{\exp(1 + 2X)}{\exp(X) + \exp(1 + 2X) + \exp(2 + 3X)}$$

$$\Pr(Y = C) = \frac{\exp(2 + 3X)}{\exp(X) + \exp(1 + 2X) + \exp(2 + 3X)}$$

Multinomial Logit Model

Mathematically, the equations are equivalent to

$$\Pr(Y = A) = \frac{\exp(2X)}{\exp(2X) + \exp(1 + 3X) + \exp(2 + 4X)}$$

$$\Pr(Y = B) = \frac{\exp(1 + 3X)}{\exp(2X) + \exp(1 + 3X) + \exp(2 + 4X)}$$

$$\Pr(Y = C) = \frac{\exp(2 + 4X)}{\exp(2X) + \exp(1 + 3X) + \exp(2 + 4X)}$$

Once again, there are infinitely many ways to write the same regression equations, and they are all equivalent. In this case, we just normalize the system by forcing the first term to be $\exp(0 + 0 \times X) = 1$:

$$\Pr(Y = A) = \frac{1}{1 + \exp(1 + X) + \exp(2 + 2X)}$$

$$\Pr(Y = B) = \frac{\exp(1 + X)}{1 + \exp(1 + X) + \exp(2 + 2X)}$$

$$\Pr(Y = C) = \frac{\exp(2 + 2X)}{1 + \exp(1 + X) + \exp(2 + 2X)}$$

Changing the benchmark in multinomial logit model:

```r
library(nnet)
mydata <-
read.csv("https://ximarketing.github.io/data/multinomial_route_choice.csv")
mydata$Choice <- relevel(factor(mydata$Choice), ref = "Freeway")
result <- multinom(Choice ~ Flow + Distance +
                     Seat_belt + Passengers + Age + Male +
                     Income + Fuel_efficiency, data = mydata)
result
```

The Crowdfunding Data

Suppose that you have a great idea, and you believe that your idea can change the world.

But you need resources to implement the idea and turn it into reality. This may cost you hundreds of thousands of dollars.

But you do not have much money yourself. What should you do?

If you have a rich dad, then ask him to fund you.

If you have a rich friend, then ask him/her to support you.

If you are famous in the industry, then you can seek help from venture capitalists or private equities.

Now, you have a new option: crowdfunding (in Chinese: "众筹"). Crowdfunding is the practice of funding a project or venture by raising small amounts of money from a large number of people, typically via the Internet.

Crowdfunding Platforms

https://www.youtube.com/embed/Vqvomrib6x0?enablejsapi=1

Equity Based Crowdfunding

The backer receives shares of a company, usually in its early stages, in exchange for the money pledged.

Debt Based Crowdfunding

Debt-based crowdfunding is a crowdfunding model used to raise capital by taking loans from several investors (lenders) who expect to be repaid their loan with an added interest over the period that the loan was “used”. The entire process takes place through a crowdfunding platform.

Donation Based Crowdfunding

Donation-based crowdfunding is when money is raised to support a good cause. As the name suggests, funding is raised through a crowd of people who decide to donate a certain amount of money to the cause, normally via online platforms specifically designed for the purpose.

Rewards Based Crowdfunding

Rewards-based, or seed, crowdfunding is a type of small-business financing in which entrepreneurs solicit financial donations from individuals in return for a product or service. There are about 19 times as many rewards campaigns as there are for its closely related counterpart, equity-based crowdfunding.

It is closely related to marketing and we focus on it in our class.

“ Crowdfunding has the potential to revolutionize the financing of small business, transforming millions of users of social media such as Facebook into overnight venture capitalists, and giving life to valuable business ideas that might otherwise go unfunded.

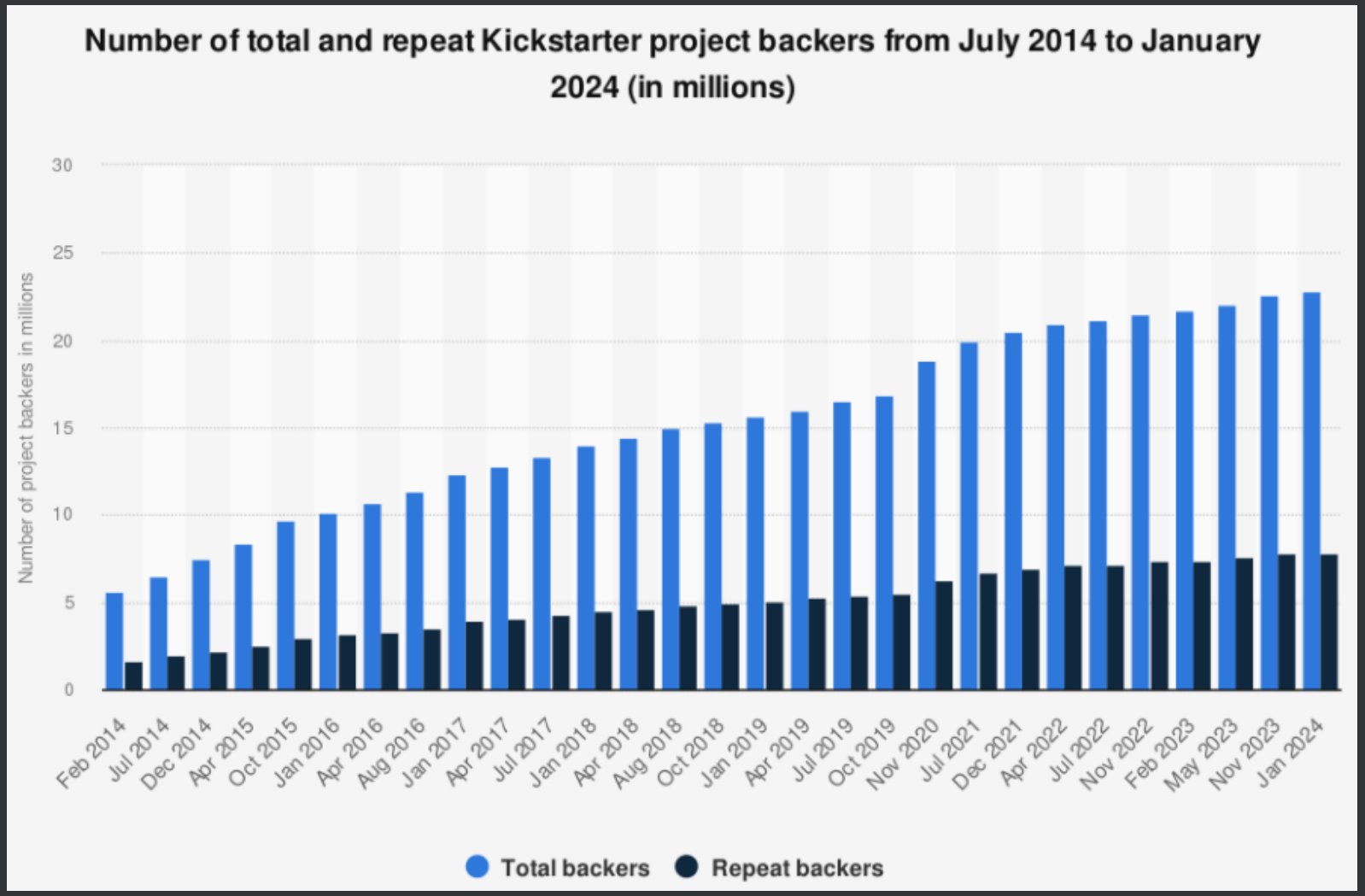
——The Wall Street Journal

“ Besides, isn’t this the type of innovation we should be encouraging? Unlike exotic derivatives and super-fast trading algorithms, crowdfunding generates capital for job-creating small businesses

——The New York Times

“ While founders raising cash from a big pool of small amounts of money are benefiting from quick access and the boost of popular interest, they are also forgoing some of the advice and experience of more traditional angel or venture-capital investors

——The Financial Times


Number of total and repeat Kickstarter project backers from July 2014 to January 2024 (in millions)
Number of project backers in millions
30
25
20
15
10
5
0
Feb 2014
Jul 2014
Dec 2014
Apr 2015
Oct 2015
Jan 2016
Apr 2016
Aug 2016
Jan 2017
Apr 2017
Jul 2017
Jan 2018
Apr 2018
Aug 2018
Oct 2018
Jan 2019
Apr 2019
Jul 2019
Oct 2019
Nov 2020
Jul 2021
Dec 2021
Apr 2022
Jul 2022
Nov 2022
Feb 2023
May 2023
Nov 2023
Jan 2024
Total backers
Repeat backers

Product Categories in Kickstarter

Kickstarter supports almost all kinds of product categories including Art, Comics, Crafts, Dance, Design, Fashion, Film & Video, Food, Games, Journalism, Music, Photography, Publishing, Technology, and Theater.

Within each category, there are also several subcategories. For example, within the technology category, we have subcategories including gadgets, hardware, DIY electronics, flight, 3D printing, apps, camera equipment, etc.

Pebble Watch

Pebble Watch was a smartwatch developed by the Pebble Technology Corporation. Funding was conducted through a Kickstarter campaign running from April 11, 2012 to May 18, 2012, which raised $10.3 million; it was the most funded project in Kickstarter history, at the time.

Let's visit Pebble Watch's initial crowdfunding webpage to know more about here. Click here to go.

Recall that it is in 2012.

Pebble Watch


PERSONAL TECH

The New York Times

GADGETWISE

A Smartwatch Gains Some Style, but Few New Tricks


THE WALL STREET JOURNAL.

English Edition ▾ | Print Edition | Video | Podcasts | Latest Headlines

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TECH | PERSONAL TECHNOLOGY: REVIEW

Pebble Time Review: The Smartwatch That Beats Android Wear


Harvard Business Review

Pebble: Wearables Pioneer

Pebble Watch

In 2015, Pebble launched its second generation of smartwatches: the Pebble Time and Time Steel. The devices were similarly funded through Kickstarter, raising $20.3 million from over 75,000 backers and breaking records for the site. See the Kickstarter webpage here.

In 2016, Pebble shut down their subsequent Time 2 series watches and refunded Kickstarter backers, citing financial issues. It was purchased by Fitbit later.

Everyday Backpack

This versatile pack was designed by photographers who felt other camera bags on the market lacked the ability for them to fit all of their other equipment. The bag comes with a number of zippered pockets and waterproof pouches to fit anything you need, as well as versatile handles and anti-theft straps. The campaign's original goal was $500,000, but they ended up with 26,000 backers and $6,565,782 before they packed up and went home.

See the webpage here.

“All-or-Nothing”

Most crowdfunding platforms like Kickstarter strictly implement an “all-or-nothing” policy. That is, the creator (entrepreneur) must set up a target for the project. If the collected fund exceeds the target, the project is successful, and the creator uses the fund to run the project. Otherwise, the project fails, and all the money will be fully refunded to the investors (backers, consumers).

Our Mission

We want to know more about the emerging crowdfunding industry. By doing so, we can

- help entrepreneurs launch better projects and raise more funds from backers;
- help crowdfunding platforms design better features and recommend better projects to backers;
- help the government and public policymakers understand crowdfunding and regulate this industry.

Our Mission

But how to learn about online crowdfunding? You may rely on online materials, conduct surveys, interview experts…

But these methods are really outdated…

Today, you are going to use *real data* to investigate the crowdfunding industry! This is also what data scientists are doing nowadays!

Before Seeing the Data...

Please go to the Kickstarter website, browse a few projects.

If you an entrepreneur trying to launch a successful crowdfunding campaign, what do you want to learn from Kickstarter?

To answer these questions, what data will you collect?

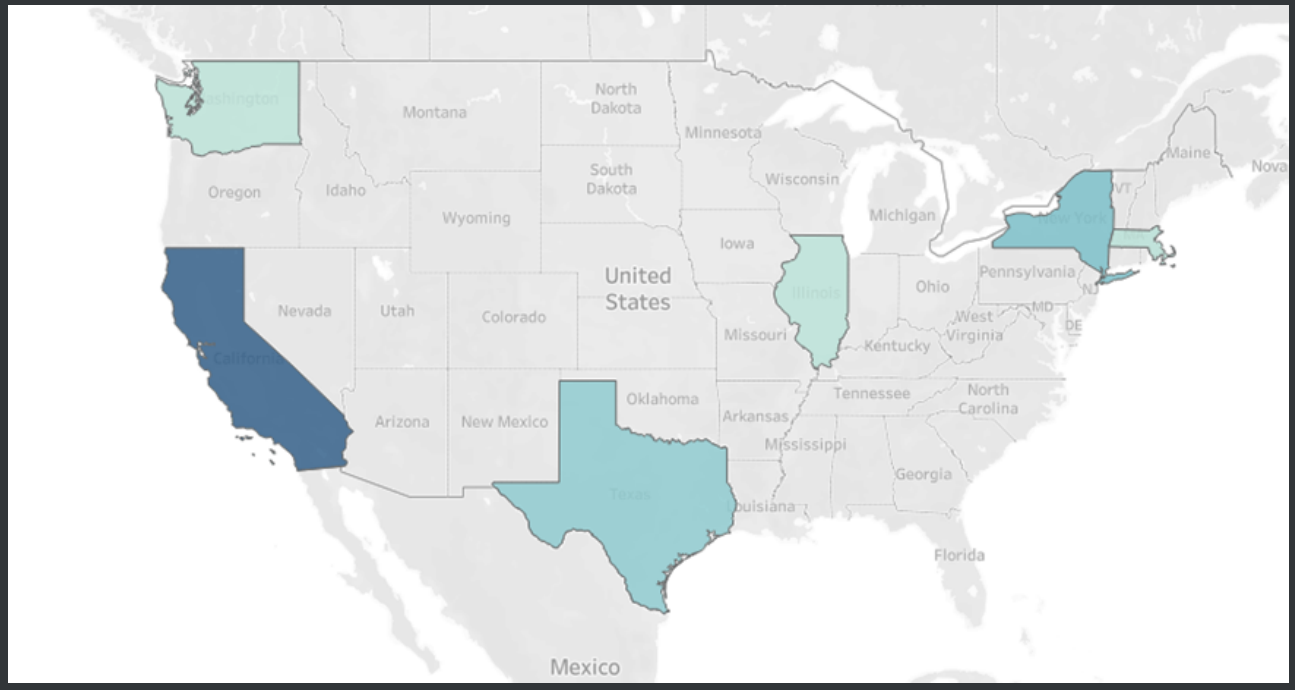
Data

The dataset was scraped from Kickstarter, the largest online crowdfunding website.

- It covers Kickstarter's technology category.
- The data is collected from the following US markets: California, Illinois, Massachusetts, New York, Texas, and Washington State.

Location

The dataset covers projects from six US states: California (CA), New York (NY), Texas (TX), Massachusetts (MA), Washington (WA), and Illinois (IL).



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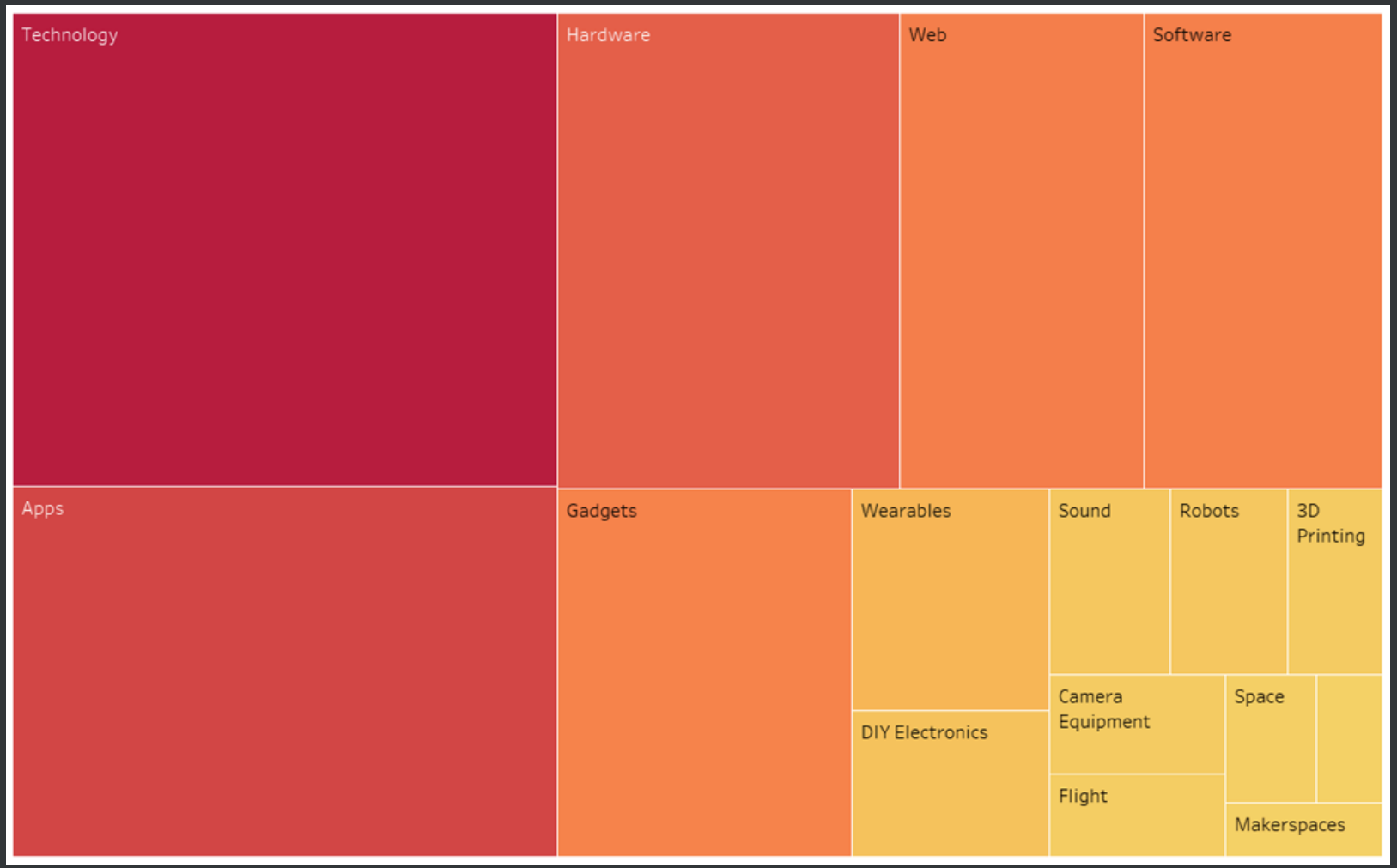
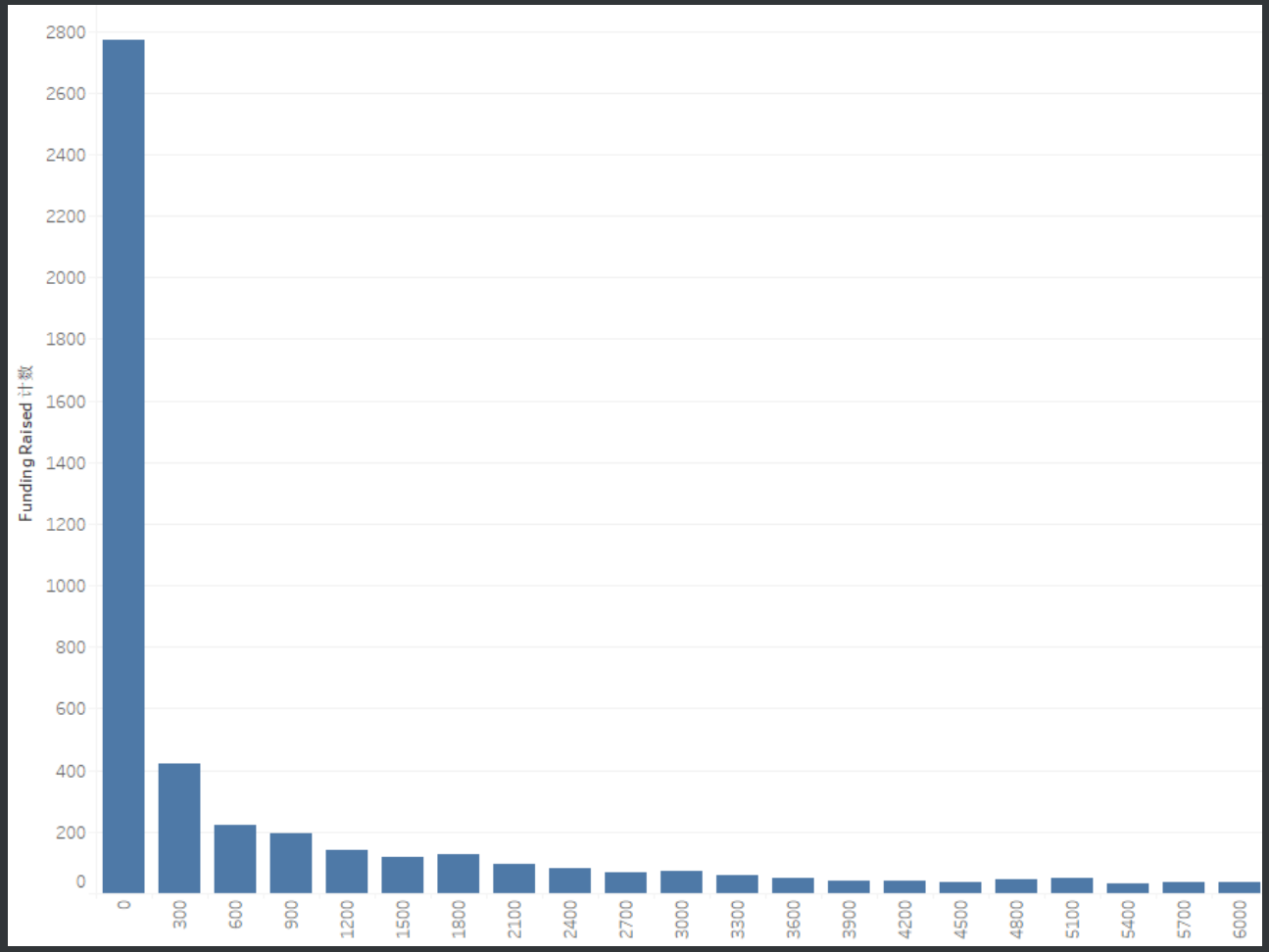

Technology
Hardware
Web
Software
Apps
Gadgets
Wearables
Sound
Robots
3D Printing
Camera Equipment
Space
DIY Electronics
Flight
Makerspaces

Total Funding Raised



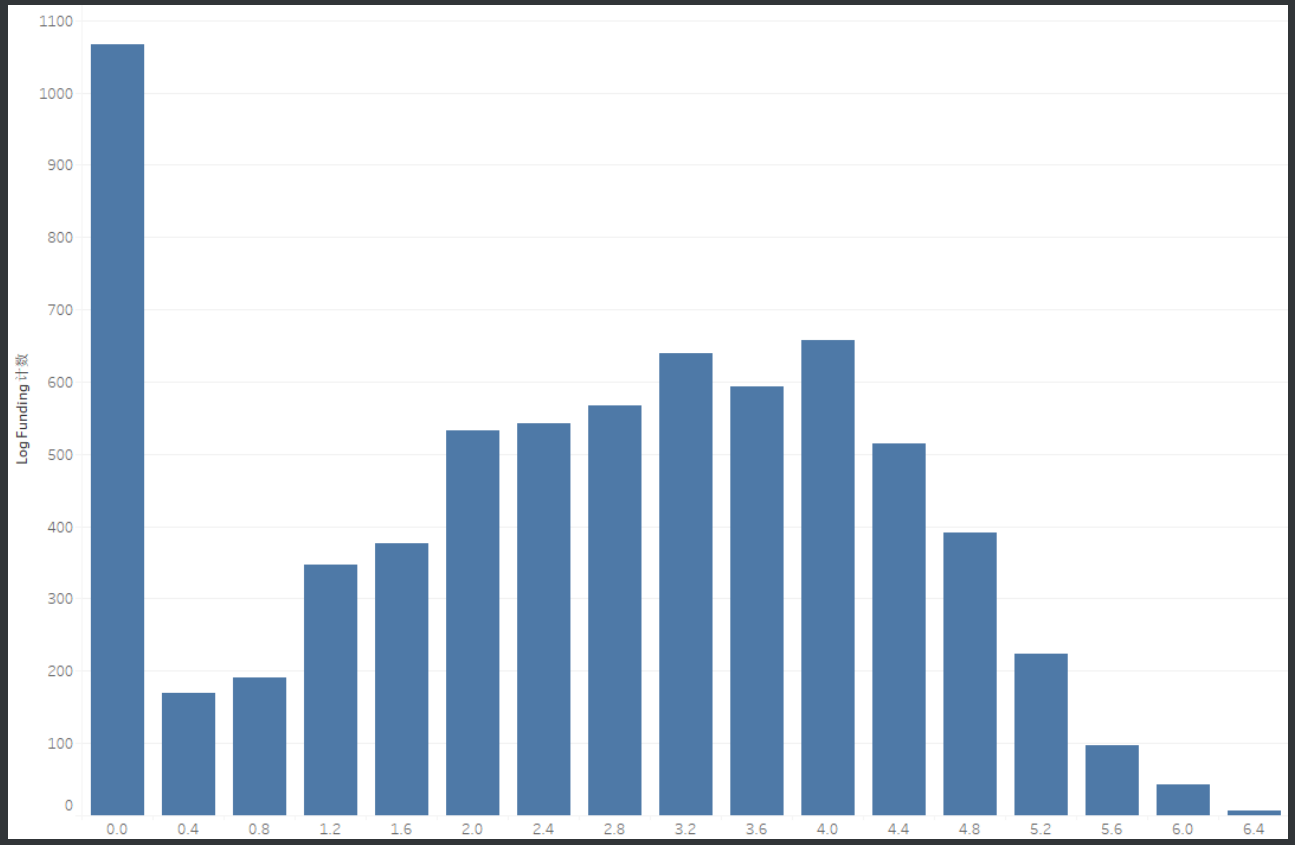
Total Funding Raised

The distribution is highly right skewed, and we take log transformation of this variable:

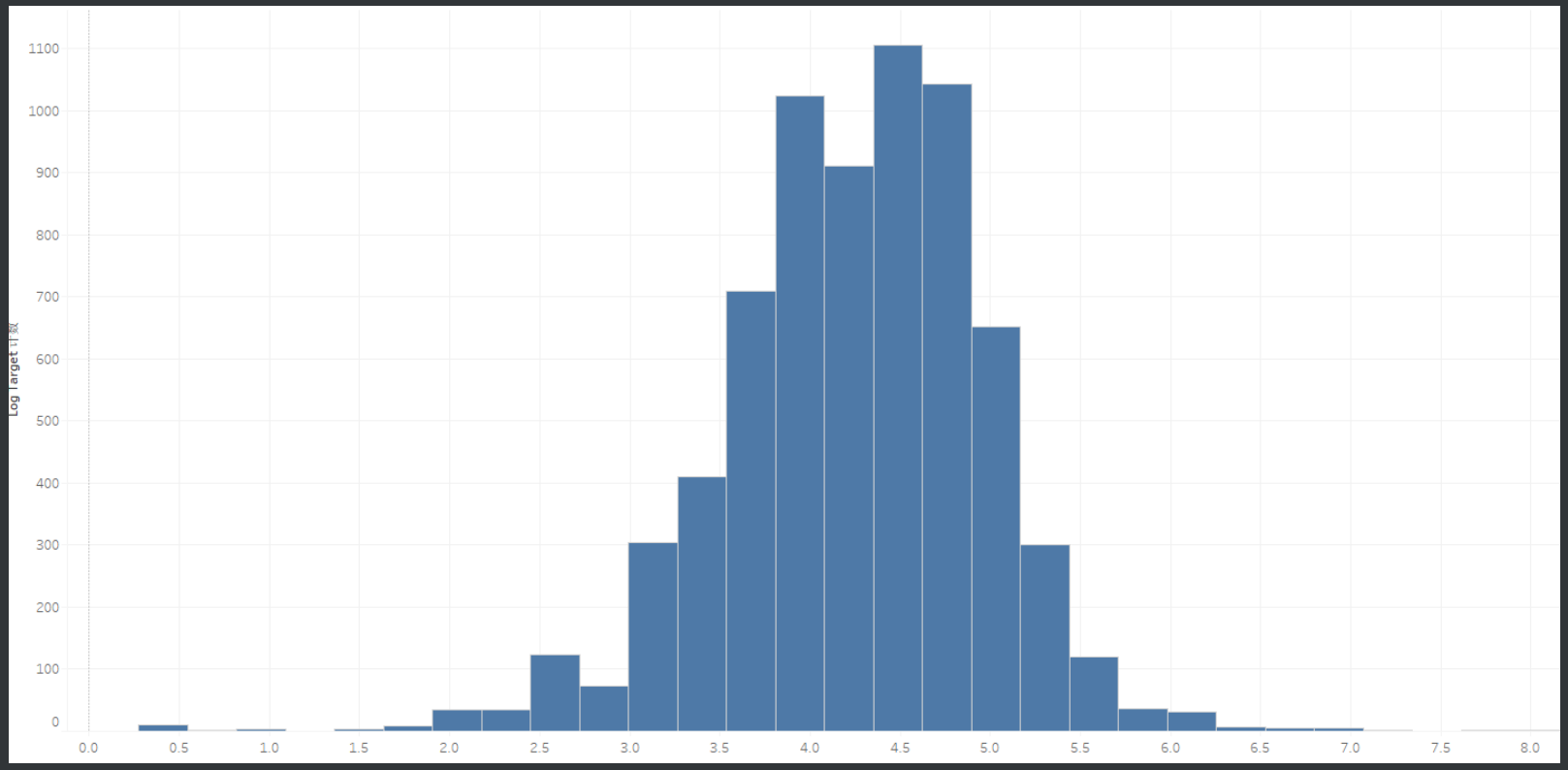
```
mydata$LogFundingRaised = log(mydata$FundingRaised + 1)
hist(mydata$LogFundingRaised)
```

Why do we use `Funding Raised + 1` here?

Log Total Funding Raised



Log Target


Log Target
1100
1000
900
800
700
600
500
400
300
200
100
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

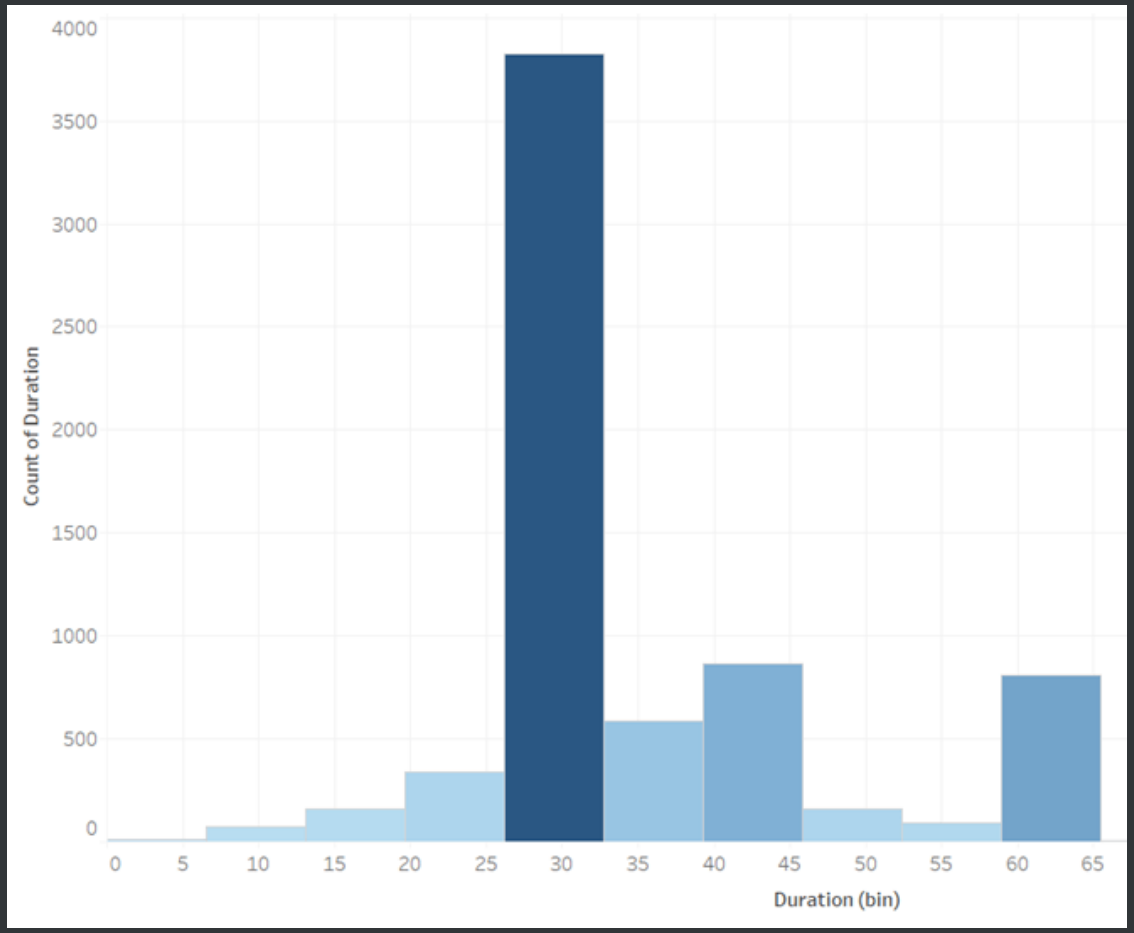
Other Measures of Project Success

- Outcome: Whether or not the project succeeded. It is a binary variable (1 = success, 0 = failure).
- Backers: Number of people supporting the project. If you divide funding raised by the number of backers, you will get the average fund contributed by a backer.

Entrepreneurs' Personal Background

- Created: Number of projects created by the same entrepreneur in the past. For example, 4 means the same entrepreneur had already created another 4 projects on Kickstarter.
- Backed: Number of projects backed by the same entrepreneur in the past (i.e., the entrepreneur supporting others' projects on Kickstarter).
- FbNumber: Number of Facebook friends the entrepreneur has.

Duration (Days)



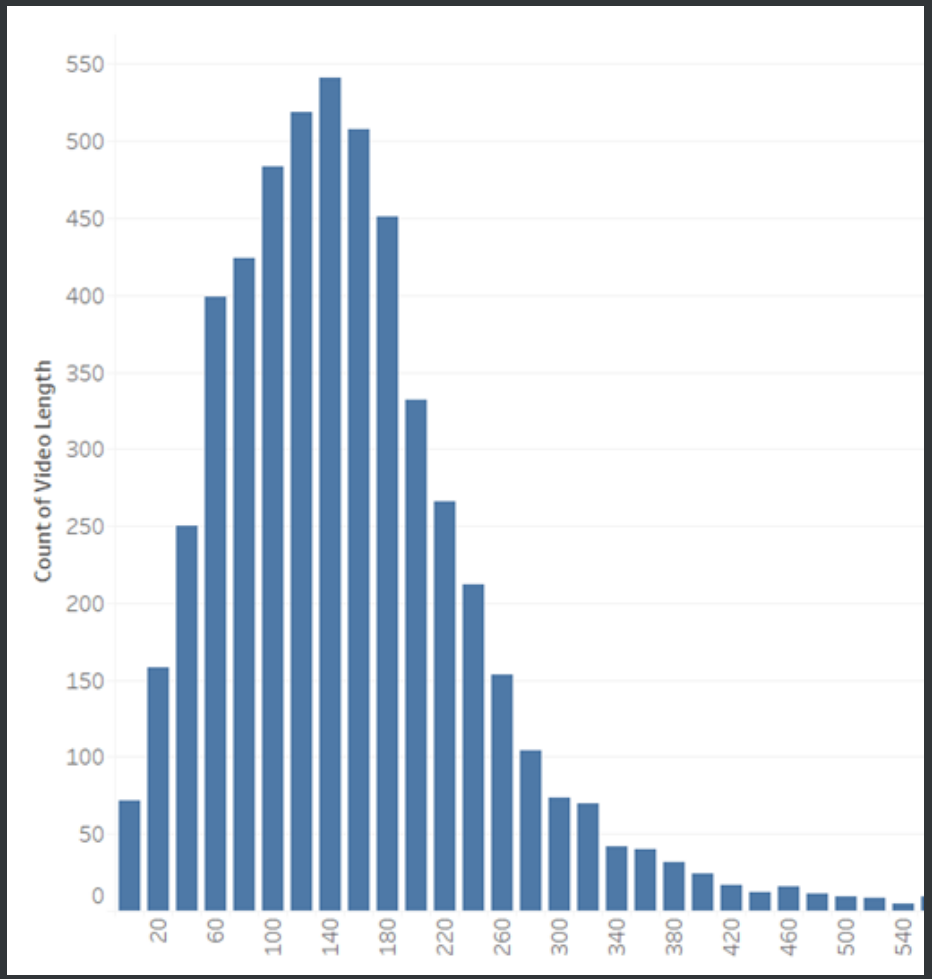
Gender

In the dataset, we have three genders: males (M), female (F), and unknown (U). The gender is obtained by analyzing the creators' first name. Unknow refers to the case in which the name cannot be identified (e.g., a team name such as "marketing").

Video Related Variables

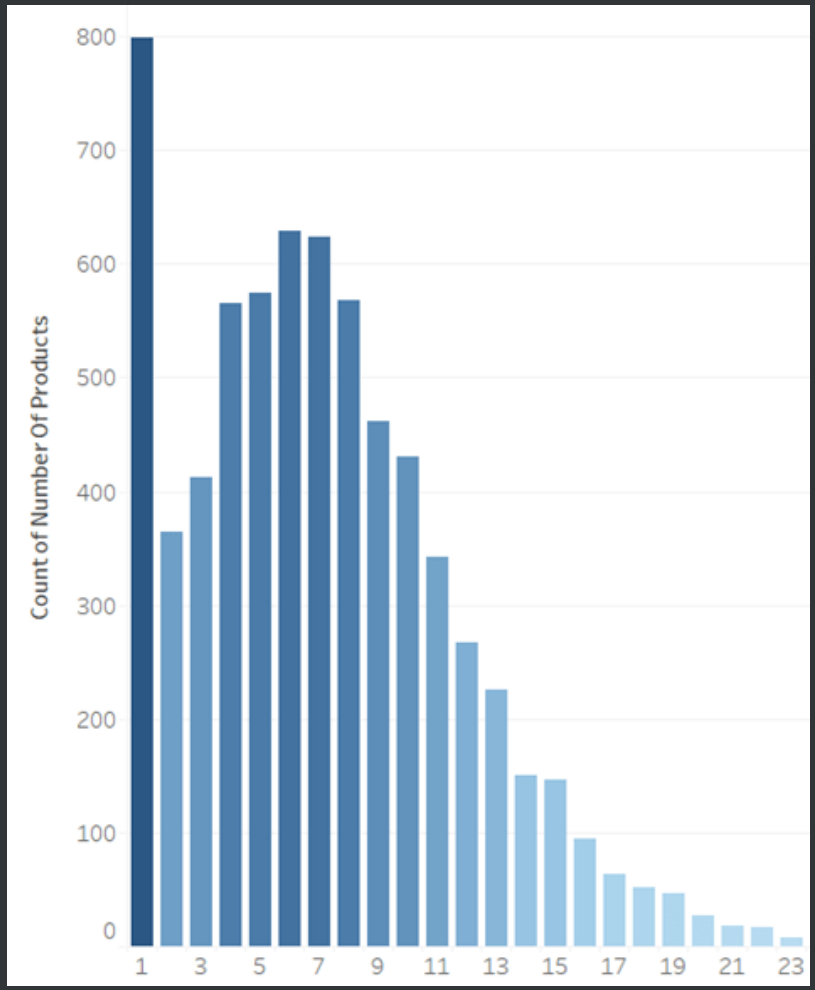
- Video: Whether or not the project has a video. In the dataset, 76% of the projects have a video. Here, 1 means has video and 0 means no video.
- Human: Whether or not the project's video features human-beings (usually the entrepreneurs themselves). 1 means has human and 0 means non-human. This variable is set to 0 is the project does not have a video.
- Computer: Whether or not the project's video features a computer. 1 means has computers and 0 means no computers. This variable is set to 0 is the project does not have a video.

Video Length (Seconds)



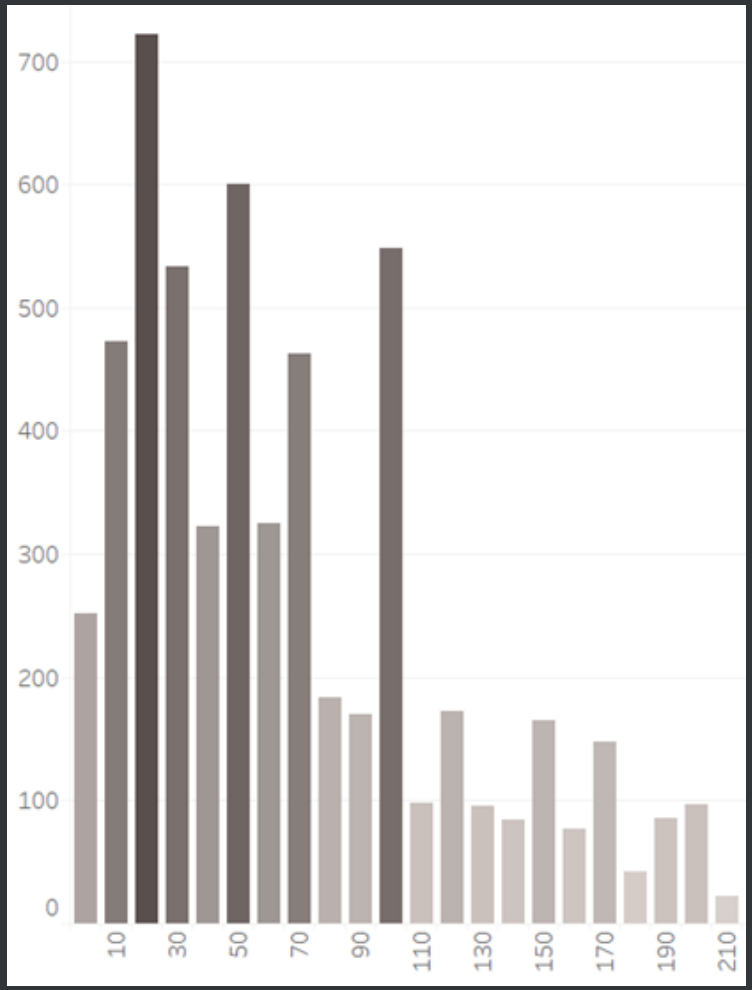
The value is 0 if there is no video at all.

Number of Products



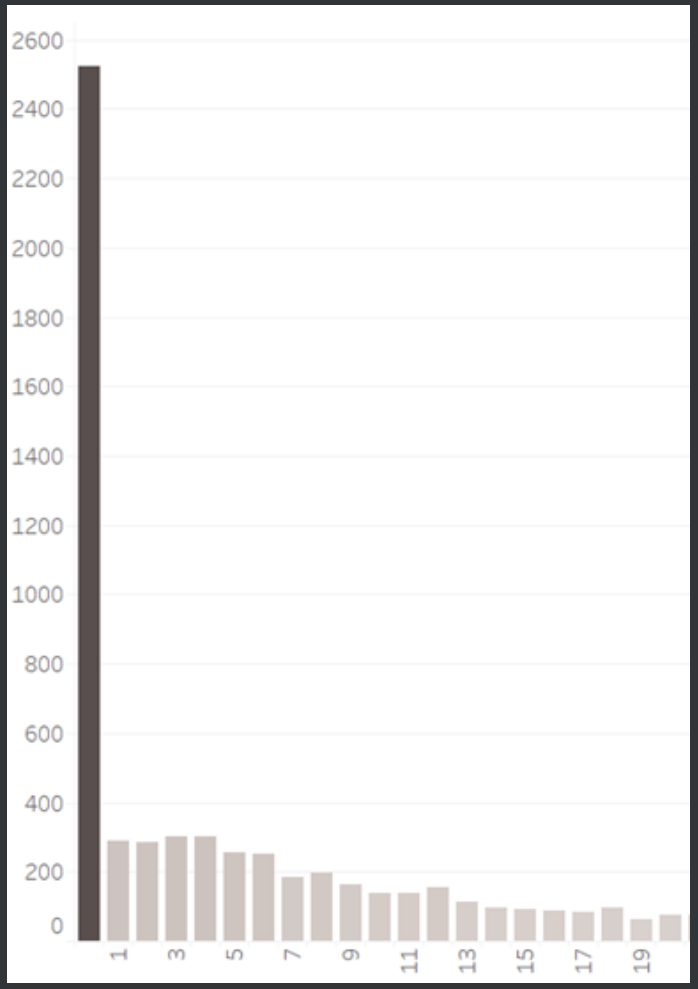
How many products are offered in the project.

Price



Median price among all product offerings.

Photo Number



The number of photos in the campaign page.

Comments

Number of comments posted by consumers.

Audio Variables

- Energy: Whether or not the audio pitch sounds energetic. A large number of an energetic audio pitch.
- Content: Whether or not the audio pitch shows signs of content.
- Upset: Whether or not the audio pitch shows signs of upset.
- Angry: Whether or not the audio pitch shows signs of anger.
- MaxAmpVol: The max sound volume. A greater number means louder sound.

What should I do?

Use the data to provide recommendations for the platform or the entrepreneurs. You can focus on anything that can be helpful for the platform or the entrepreneurs:

1. How do male and female entrepreneurs behave differently on Kickstarter? (e.g., compared to females, males may be too aggressive in setting high targets.)
2. Which type of video is most productive in terms of generating funds? (e.g., is having a lengthy video always beneficial?)
3. What makes a successful crowdfunding project?

What should I do?

Each group should only ask one big or two small research questions 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 platforms or entrepreneurs.

What should I do?

A big question needs to be answered with multiple analyses. For example, you may need to run a few regressions to answer a big question.

A small question can be answered within one or two steps.

Sample Analysis

```
1 mydata <-
  read.csv("https://ximarketing.github.io/class/Kickstarter-
  Project.csv", fileEncoding = "UTF-8-BOM")
2 summary(mydata)
3 mydata$LogTarget = log(mydata$Target + 1)
4 mydata$LogFundingRaised = log(mydata$FundingRaised + 1)
5 result <- lm(LogFundingRaised ~ LogTarget + factor(Gender),
  data = mydata)
6 summary(result)
```

Deliverables

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

Deadline: Dec 19, 2024 (one week from today)

Class A: 12:30 pm, Class B: 5:00 pm, Class C: 9:30 pm

No reports. No presentations. Nothing else.