# Consumer Analytics

## 消费者分析

Question:

When talking about consumer analytics,
what first comes to your mind?

当我们说消费者分析的时候，你最先想到的是什么？

# Wal-Mart's Shopycat-Gift Recommendation

Wal-mart's Shopycat app will help you buy the ideal gift for your friend during the holiday buying rush. Walmart's Shopycat recommends gifts for friends based on the social data extracted from their Facebook profiles. The app also provides links to the Walmart products so that users can easily purchase the product.

# 沃尔玛的 Shopycat 智能礼品推荐

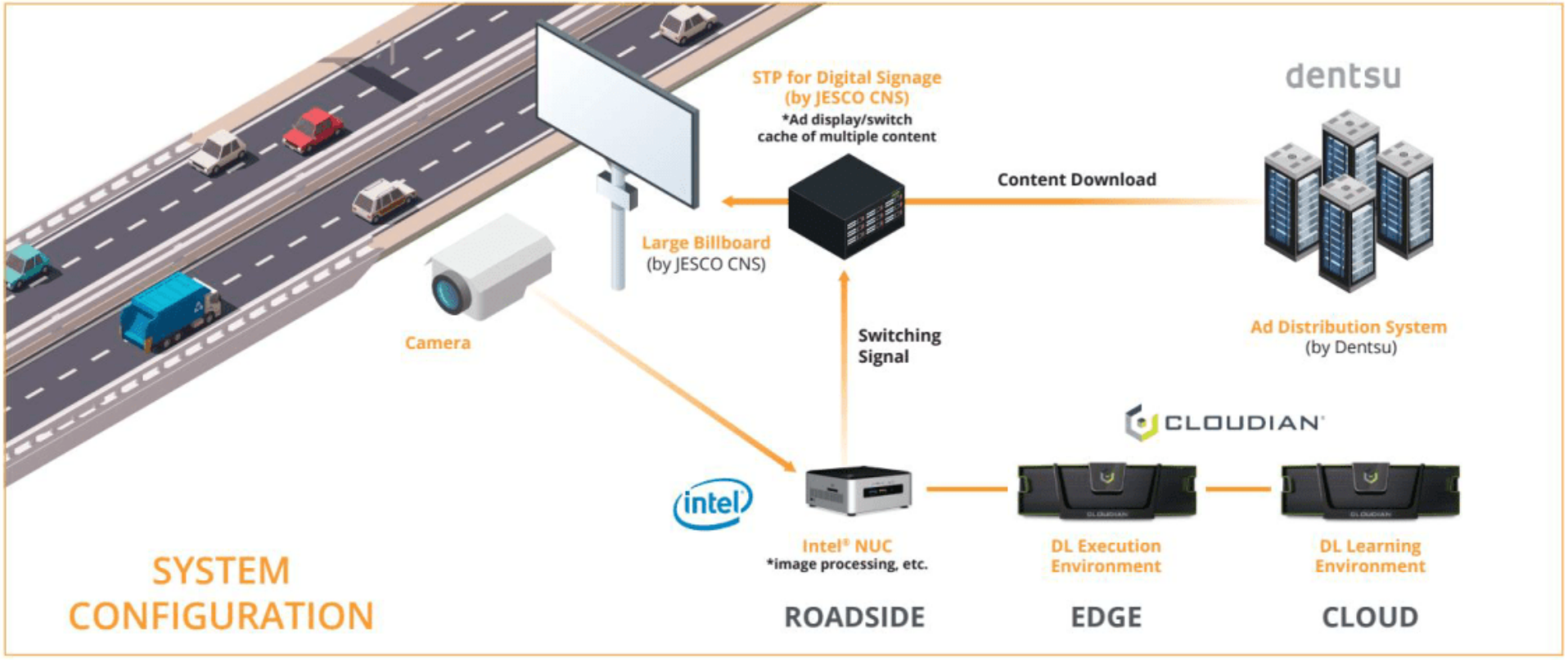
沃尔玛的 Shopycat 是一款应用，能够直接送你的 Facebook 账号中获取和分析你的社交信息，并且根据你的社交信息向你推荐不同的节日礼物。这个APP甚至会直接给你提供产品链接帮助你更方便的完成购物。

# Dentsu's Data Driven Advertising

Dentsu is one of the largest and most influential advertising agencies in the world, founded in 1901 and headquartered in Tokyo, Japan. In 2019, Dentsu partnered with Cloudian, Intel, and other companies on the "DeepAd project." This initiative aimed to track and capture car images on Tokyo roads and deliver dynamic advertisements on digital billboards as a result.

# 电通的数据驱动广告

电通是世界上最大和最有影响力的广告代理公司之一，成立于1901年，总部位于日本东京。2019年，电通与Cloudian，英特尔等公司合作进行了“DeepAd项目”。该倡议旨在在东京的道路上跟踪和捕捉汽车图像，并在数字广告牌上投放动态广告。


STP for Digital Signage
(by JESCO CNS)
*Ad display/switch
cache of multiple content
dentsu
Content Download
Large Billboard
(by JESCO CNS)
Camera
Switching
Signal
Ad Distribution System
(by Dentsu)
CLOUDIAN
intel
Intel® NUC
*image processing, etc.
DL Execution
Environment
DL Learning
Environment
SYSTEM
CONFIGURATION
ROADSIDE
EDGE
CLOUD

# Dentsu's Data Driven Advertising

Different ads were shown based on the type of car, for example:

- Luxury cars (e.g., Mercedes, BMW, Audi): Ads for golf resorts.
- Family cars (e.g., Toyota Prius, Honda Fit): Ads for amusement parks.
- Older vehicles: Ads for newer models of the same car.

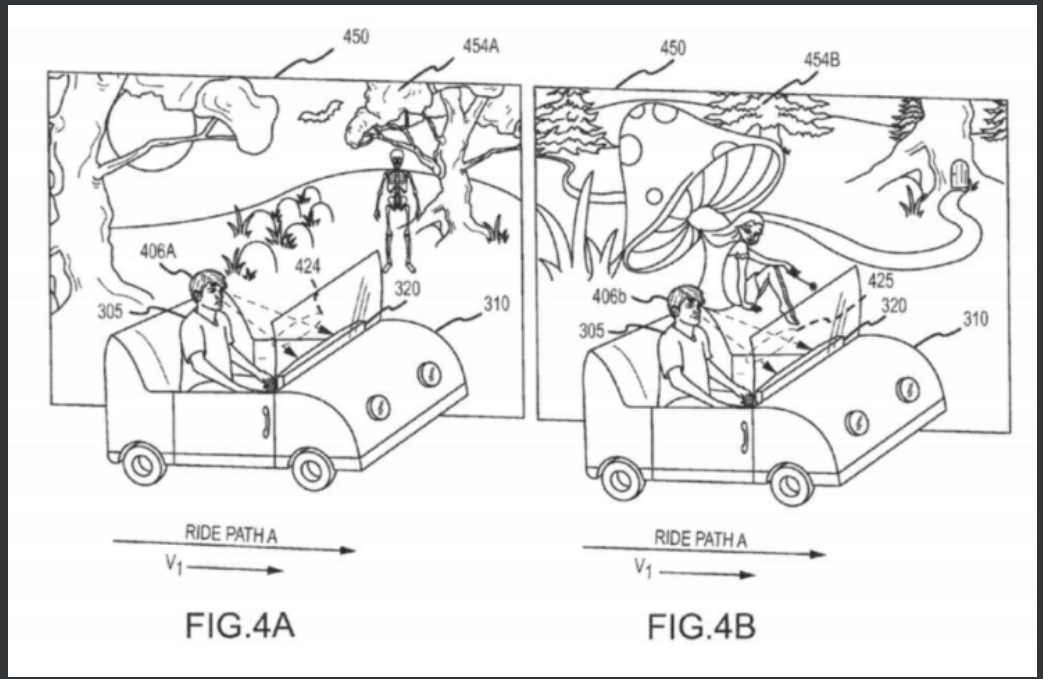
# 电通的数据驱动广告

根据车辆类型展示不同的广告，例如：

- 豪华车(如奔驰、宝马、奥迪): 高尔夫度假村广告。
- 家庭轿车(如丰田普锐斯、本田飞度)：主题乐园游乐园。
- 老旧车辆: 同款新车型广告。

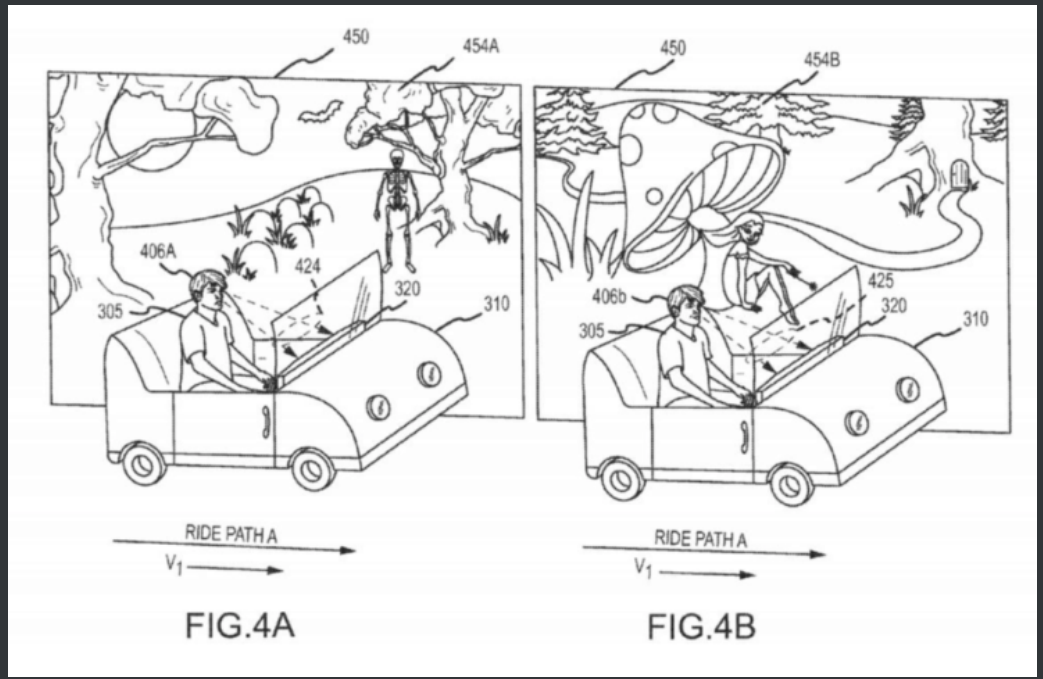
# Disney's Data Driven User Experience

In 2017, Disney filed a patent and here is a figure from the patent. Do you know what Disney is doing?



# 迪士尼的数据驱动用户体验

2017年，迪士尼申请了一项专利，并这是专利中的一个图示。您知道迪士尼在做什么吗?



# Disney's Data Driven User Experience

Titled "Sensing and Managing Vehicle Behaviour Based on Occupant Awareness", the patent seeks to develop technology which can read the facial expressions of riders, determining their emotions and customising the experience around those emotions.

Bored? Your vehicle may suddenly speed up, or start spinning like crazy. A little too excited? Then your vehicle can ease up a little, because imagine the utopia of a theme park with zero vomit.

# 迪士尼的数据驱动用户体验

题为“基于乘客意识感知和管理车辆行为”的专利旨在开发技术，可以读取乘客的面部表情，确定他们的情绪，并根据这些情绪定制体验。

感到无聊？你的车辆可能会突然加速，或者开始疯狂旋转。有点太兴奋？那么您的车辆可以稍微放慢速度，我们希望保证用户不会在车上呕吐。


ALLTID
24
ÖPPET
Mighty
McMuffin
& Co

# McDonald's Drive Thru Optimization

McDonald identifies a vehicle's license plate in the drive-thru and uses the information to recall past orders. By leveraging artificial intelligence, the technology can suggest menu items based on a customer's previous preferences, creating a more personalized and efficient ordering experience. In addition to personalized recommendations based on order history, the AI considers external factors such as weather conditions, wait times, and item popularity to tailor suggestions displayed on the drive-thru touchscreen.

# 麦当劳自驾车取餐优化

麦当劳在自驾车取餐窗口识别车辆的车牌，并利用这些信息回忆过去的订单。通过利用人工智能，这项技术可以根据顾客之前的偏好建议菜单项，从而创造出更个性化和高效的点餐体验。除了根据订单历史提供个性化推荐外，人工智能还考虑外部因素，如天气状况、等待时间和商品受欢迎程度，以定制在自驾车取餐触摸屏上显示的建议。

“顺手买一件”


上午9:20
确认订单
肌肉小王子旗舰店
【22袋肉】肌肉小王子鸡胸肉健身代餐即食鸡肉速食轻食品低脂零食
¥109.00
x1
可享先用后付
购买数量
1
服务
此商品性质不支持7天退货
配送方式
普通配送
快递 免邮
配送时间
现在下单，预计7月12日送达
隔日达
店铺优惠
省30元:组合优惠
- ¥ 30.00
订单备注
选填,请先和商家协商一致
共1件 小计: ¥79.00
顺手买一件
肌肉小王子豆浆粉无蔗糖添加七彩豆浆独立袋装代餐早餐冲饮速溶
口味:七彩豆浆粉1盒7袋*28克【第
现价 ¥9.90 价格 ¥49
共1件，合计: ¥79.00
提交订单
爱上黄昏


配送方式
普通配送
快递 免邮
运费险
退换货可赔付10元
¥ 2.98
请关注保险公司信息，并阅读《保险条款和重要说明》，本模块由蚂蚁保保险代理有限公司管理。
店铺优惠
省16元:组合优惠
- ¥ 16.00
开具发票
本次不开具发票
订单备注
选填,请先和商家协商一致
共2件 小计: ¥147.90
顺手买一件
全能猫砂
uah有哈猫砂混合猫砂膨润土豆腐猫砂无香无尘抑菌除臭7L
香味:全能混合猫砂*1包;
现价 ¥18.80 价格 ¥39.90

Instructor:

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Director, Asia Case Research Centre

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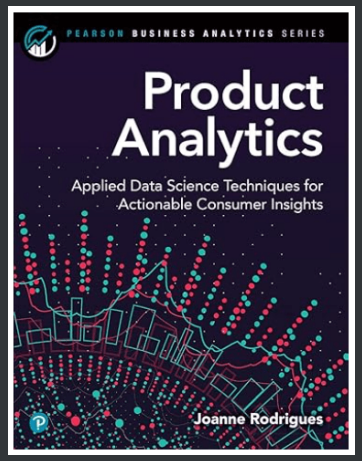
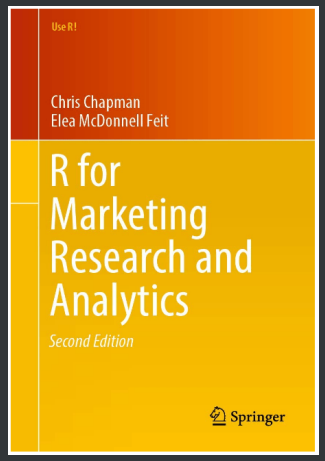
数字经济与创新中心副主任

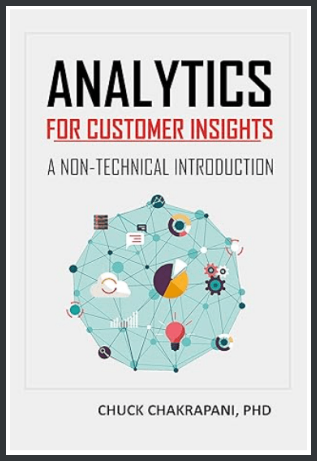
多伦多大学管理学博士
香港科技大学工业工程与物流管理哲学硕士
清华大学计算机科学与技术学士

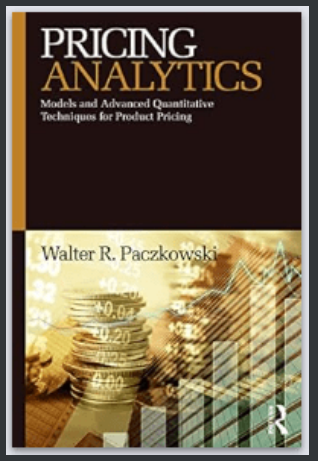
We do not have any textbooks. Our content is partly inspired by the following books:

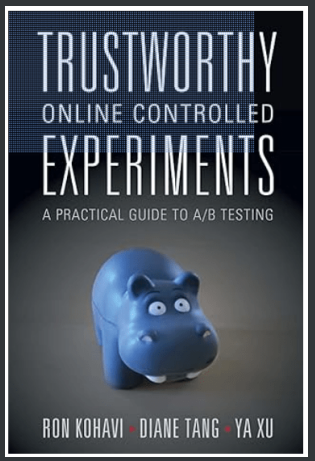
这是我们课程的一些参考读物 [供有兴趣的同学参考]



# Class Overview

## 课程概览

What is the brand of the HKU president's car?

猜一猜: 香港大学校长开什么车?




# Discrete Choice Modeling 离散选择模型

We are familiar with linear regression, which allows you to use your independent variable $X$ to predict your dependent variable $Y$, i.e., $Y = \alpha + \beta X$. In linear regression, the output, $Y$, is a real number, e.g., $Y = 1.319$.

线性回归中，我们的方程是$Y = \alpha + \beta X$，其中$X$是自变量，$Y$是因变量。这里，$Y$必须是一个实数，例如 $Y = 1.319$.

# Discrete Choice Modeling

But when consumer makes choices, the choices are often discrete: It can be purchase or nonpurchase, it can be the brand that you choose (CCB vs. BOC vs. ICBC).

Linear regression does not work here! We can use discrete choice models to model consumers' choices.

# 离散选择模型

但现实中，消费的选择往往是离散的。在买东西时，消费者选择可能是买或者不买。消费者的选择也可能是某一个品牌(建设银行 vs 中国银行 vs 工商银行)。

线性回归对于这种问题无能为力：我们的因变量是一个个离散的数据。

# Discrete Choice Modeling

We introduce three discrete choice models:

- Logistic regression: The dependent variable is either 1 or 0 (e.g., purchase vs. non-purchase).
- Multinomial logit model (MNL): The choice depends on the choice maker's characteristics (e.g., age, gender).
- Conditional logit model: The choice depends on the alternatives' characteristics.

# 离散选择模型

我们介绍三种离散选择模型:

- 逻辑回归: 解释变量可以取两个值，即1或0 (例如购买和非购买两个选项).
- Multinomial logit model (MNL): 多个选择，选择本身是基于消费者的个人特征 (如年龄，性别，工作信息).
- Conditional logit model: 多个选择，选择本身是基于选项的特征(例如价格，品牌，质量等)

# 离散选择模型

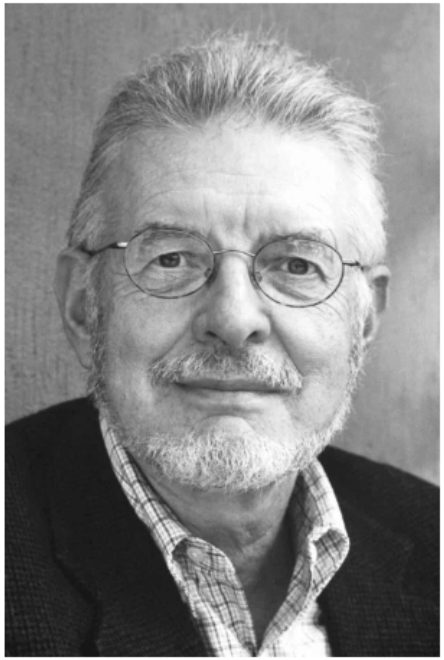


Photo from the Nobel Foundation archive.

Daniel L. McFadden
The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2000

Born: 29 July 1937, Raleigh, NC, USA

Affiliation at the time of the award: University of California, Berkeley, CA, USA

Prize motivation: “for his development of theory and methods for analyzing discrete choice”

Prize share: 1/2

# Causality and AB Testing

With a bit knowledge of statistics, we can often find that two things are correlated. But this does not necessarily mean one thing has caused another. A famous example is the correlation between chocolate consumption and winning Nobel prize.

# 因果关系与AB测试

通过使用基本的数据分析，我们很容易发现两个事情是相关的。但是相关并不意味着一件事导致了另一件事。一个著名的例子是巧克力消费与诺贝尔奖之间的相关性。

# 因果关系与AB测试

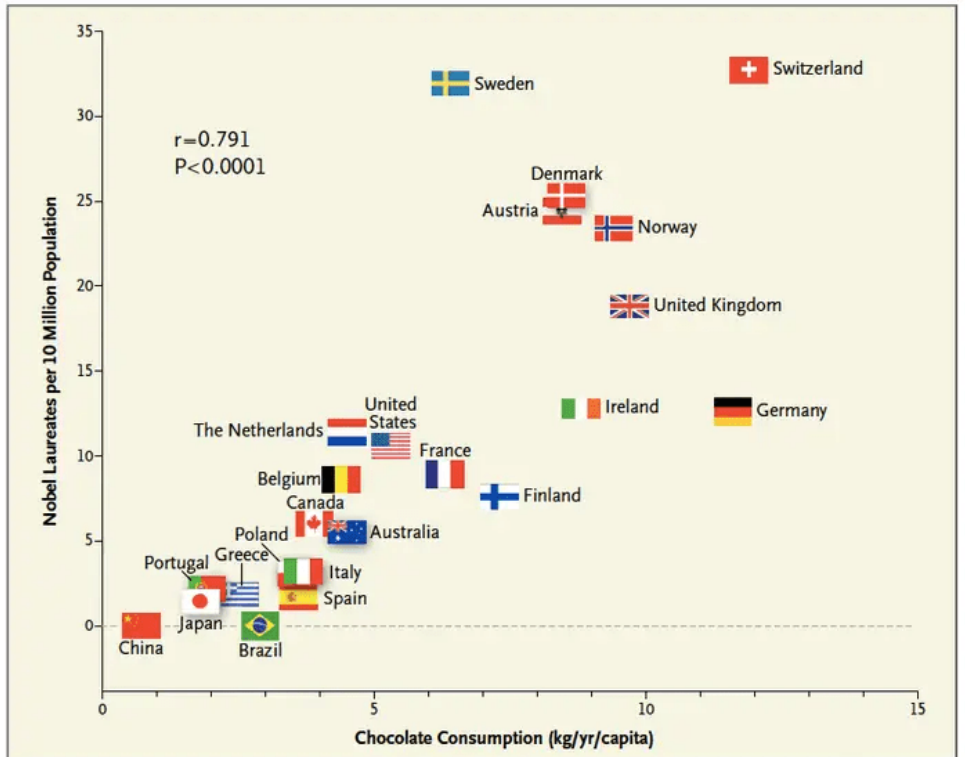
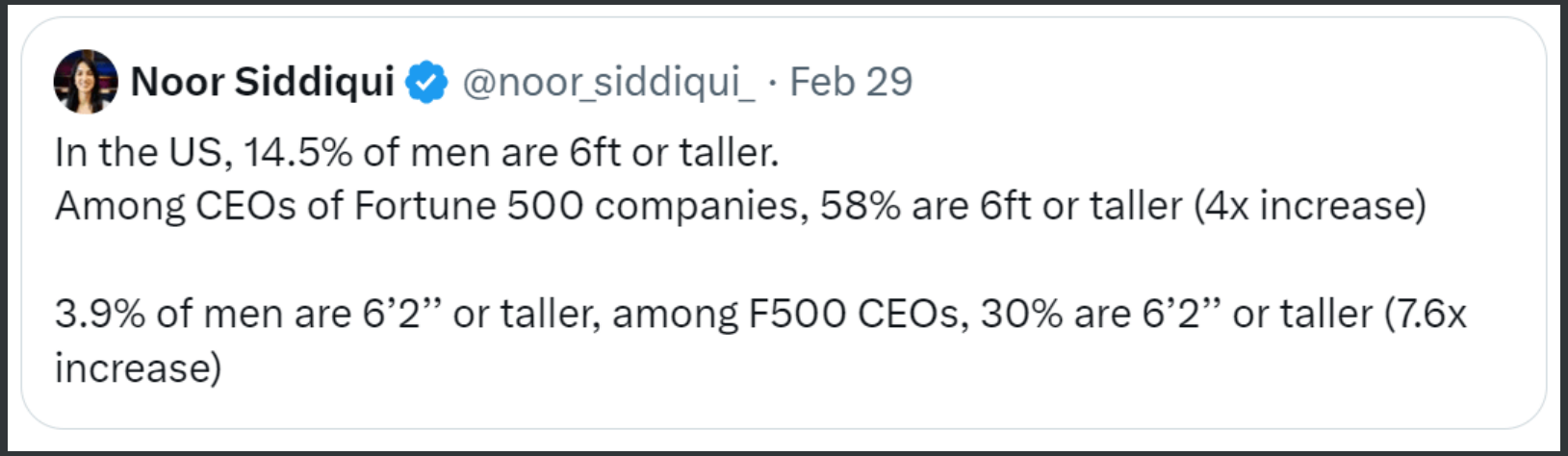



**Figure 1.** Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.

# 因果关系与AB测试




《财富》世界500强的CEO中，有58%的身高超过1.82米，30%的超过1.88米。身高越高越容易当CEO?

# Causality and AB Testing

How to identify causality? We can establish AB tests which are common used in big tech firms nowadays.

We will learn

- How to compare clicks/purchases in AB tests;
- How to compare profits/revenues in AB tests;
- How to compare distributions in AB tests.

# 因果关系与AB测试

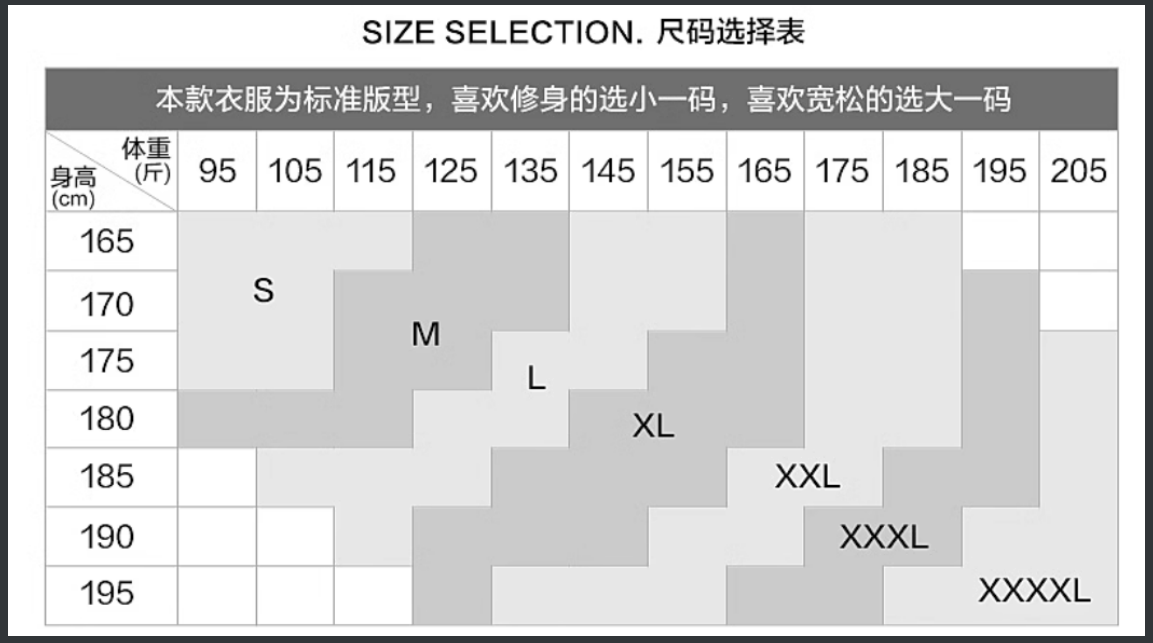
如何建立因果关系？ 一个常见的方法是使用 AB 测试，这一方法在科技企业越来越流行。

我们将学到:

- 怎么在 AB 测试中分析用户点击的不同。
- 怎么在 AB 测试中分析利润或者收入的不同。
- 怎么在 AB 测试中分析统计分布的不同。

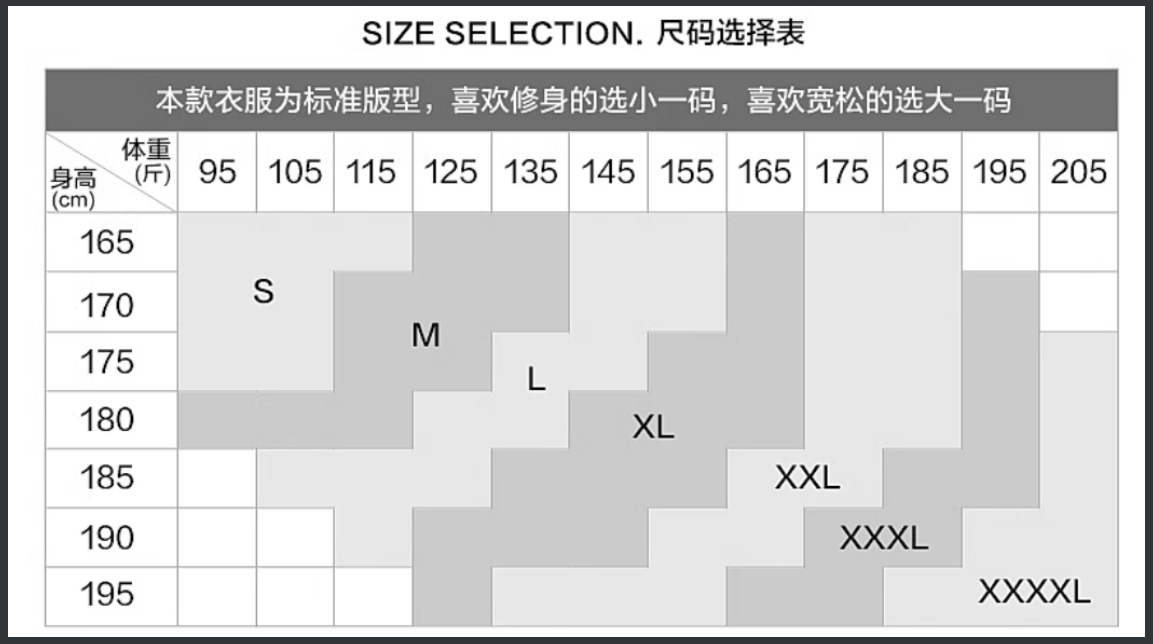
# Segmentation

## How to determine sizes for your clothing?



# 消费者细分

## 服饰商应该如何消费者设计尺码表?



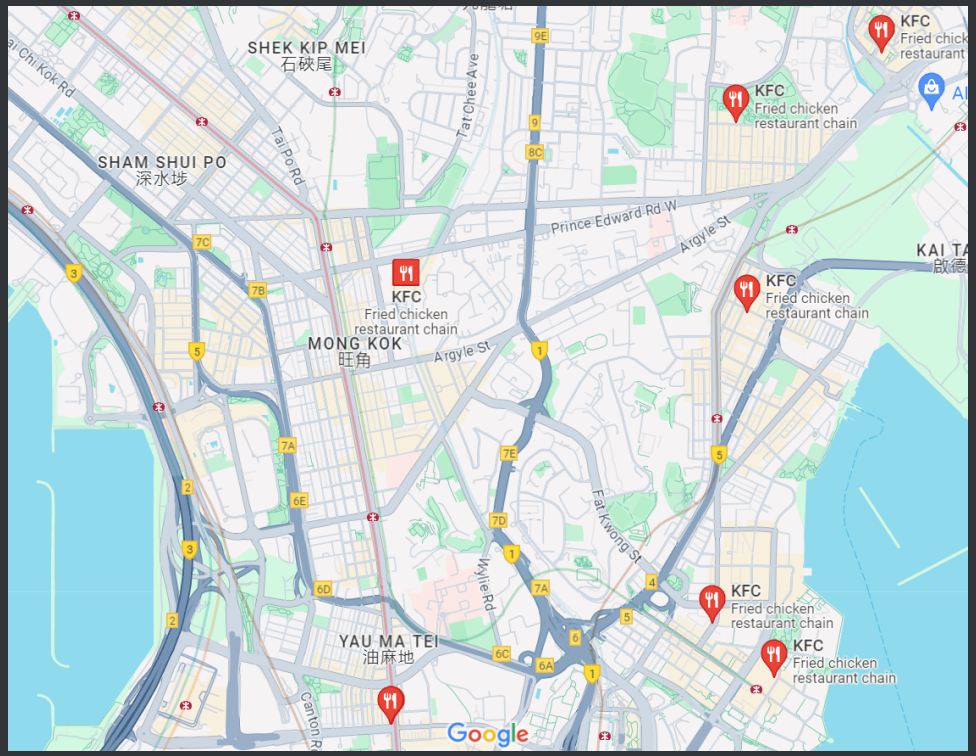
SIZE SELECTION. 尺码选择表

本款衣服为标准版型，喜欢修身的选小一码，喜欢宽松的选大一码

| 身高(cm) \ 体重(斤) | 95 | 105 | 115 | 125 | 135 | 145 | 155 | 165 | 175 | 185 | 195 | 205 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 165 | S | S | S | M | M | | | | | | | |
| 170 | S | S | S | M | M | | | | | | L | |
| 175 | S | S | S | M | L | L | L | | | | L | L |
| 180 | | | | | | XL | XL | XL | | | L | L |
| 185 | | | | | | | | XXL | XXL | XXL | L | L |
| 190 | | | | | | | | | XXXL | XXXL | XXXXL | XXXXL |
| 195 | | | | | | | | | | | XXXXL | XXXXL |

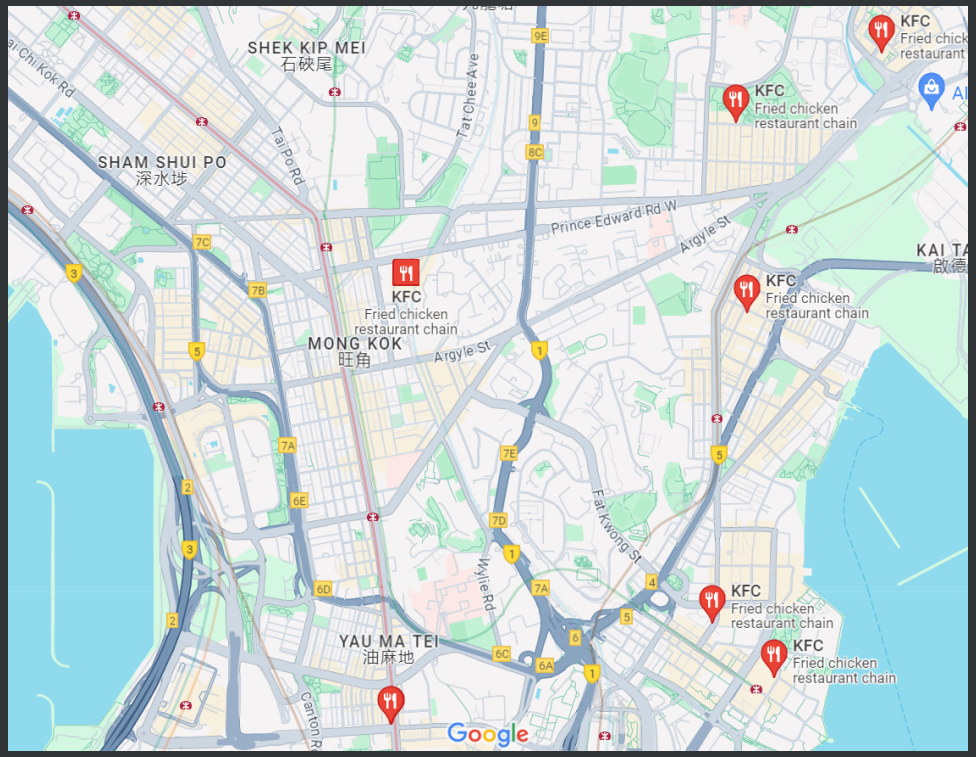
# Segmentation

## How to choose locations for your store?



# 消费者细分

## 肯德基是如何为店面进行选址的?



# Recommendation System

Will Alice like Movie 3?

| | **Movie 1** | **Movie 2** | **Movie 3** | **Movie 4** |
|---|---|---|---|---|
| Alice | 4 | 4 | | 1 |
| Bob | | 2 | 2 | 3 |
| Carol | 1 | 5 | 3 | |
| Dennis | 3 | | 4 | 1 |
| Emma | 5 | 2 | 1 | 4 |
| Flora | 3 | 1 | | 5 |

# 推荐系统

Alice 会喜欢 3 号电影吗?

| | **Movie 1** | **Movie 2** | **Movie 3** | **Movie 4** |
|---|---|---|---|---|
| Alice | 4 | 4 | | 1 |
| Bob | | 2 | 2 | 3 |
| Carol | 1 | 5 | 3 | |
| Dennis | 3 | | 4 | 1 |
| Emma | 5 | 2 | 1 | 4 |
| Flora | 3 | 1 | | 5 |

# Market Basket Analysis


Which products do consumers tend to purchase together?

When they buy beers, should we also recommend them some potato chips as well?

# 购物篮分析


哪些产品总是同时被购买?

当消费者买啤酒的时候，我们是不是应该建议他们买点薯条?

# Pricing

How to set price for this new electric surfboard?

# 定价

这个新的电动滑板应该卖多少钱?

# Schedule 课程计划

1. Introduction and R Basics 课程简介与R语言基础
2. Discrete Choice Models 离散选择模型
3. Causality and AB Testing 相关性和AB测试
4. Segmentation 消费者细分
5. Recommendation Systems 推荐系统
6. Market Basket Analysis and Pricing Analytics
   购物篮分析和定价

| Question | Method |
| --- | --- |
| How do consumers make choices among different alternatives? | discrete choice models |
| Does something really cause another?<br>Which of the strategies work best? | A/B testing |
| How do I segment the market?<br>How many types of consumers do I have? | Segmentation |
| Which products should be recommended to my consumers? | Recommendation system |
| What are the underlying relationship between different products?<br>Which products do consumers buy together? | Market basket analysis |
| How much will buyers pay for my product?<br>What is my optimal price? | Price analytics |

| 问题 | 方法 |
| --- | --- |
| 消费者是如何在不同产品中进行选择的? | 离散分析 |
| 这些因素到底有没有相互影响?<br>哪个设计最有效? | AB 测试 |
| 我应该如何将消费者分类?<br>我的消费者有哪几种? | 消费者细分 |
| 我应该推荐什么给消费者? | 推荐系统 |
| 不同的产品之间有那些联系?<br>哪些产品往往被一起购买? | 购物篮分析 |
| 消费者愿意花多少钱买我的产品?<br>我应该卖多少钱? | 定价分析 |

From Physics to the Science of Marketing

从物理学到市场科学

## Heisenberg's Uncertainty Principle:
## 海森堡测不准原理:

It is impossible to measure the exact state, or position, and the momentum of a particle, because of the act of measuring it changes it.

你无法观测出一个粒子精确的位置和动量，
因为观测本身就会影响粒子的足迹。

## Heisenberg's Uncertainty Principle:

When you are measuring a particle, you use light (photons) to do so. However, when your photon hits a particle, it also changes the movement of the particle, and you do not know how it behaves before it was hit by your photon.

In other words: The act of measuring a particle changes its behavior.

## 海森堡不确定原理的解释

当你观测一个粒子的时候，你会发射光子来观察它。然而，一旦光子撞到粒子上，粒子的运动轨迹就被改变了。因此，你是无法知道粒子被光子撞击之前的运动轨迹。

换句话说，观察一个事物可能会改变这个事物本身。

The Marketing Principle 市场学原理:

The act of measuring consumers changes their behavior.
观测消费者本身会改变消费者的行为。

Example:

In the 2016 election poll, people state that they will vote for Clinton.

在2016年美国大选时，大多数人说他们会投给希拉里。

If you ask if consumers watch porn, they will say no.

你问用户会不会看黄片，他们会说不。

If you ask if moms feed their kids junk food, they will say no.

你问妈妈她们会给孩子喂垃圾食品吗？她们会说不。

## The Lesson

Don’t listen to your consumers, observe their choices.

不听其言，只观其行。

# The R Software

Our class uses R for teaching. Please install R and RStuido on your laptop and bring it with you for the next class. You can

- Download R here
- Download RStudio here

Note that your installation path should not contain any non-English letters, otherwise you will be unable to use some functions.

安装路径必须为纯英文，否则某些功能无法正常使用！

# R 软件

我们课程将用到 R 语言。请按照下面的连接下载并安装 R 和 RStudio 两款软件。

- 请在 这里下载 R
- 请在 这里下载 RStudio

注意安装路径必须为纯英文，否则某些功能无法正常使用！

# 为什么选择 R

- R 包含丰富的统计库，让数据分析变得简单。
- R 拥有一个巨大的用户社区。
- 作为一门程序语言，R 对学习者比较友好，基本操作比较简单。
- R 是完全免费的。

# A Review of Regression
# 回顾：线性回归

# Regression

Imagine that you want to examine how income changes with Age, then you can consider the following regression:

$$\text{Income}_i = \alpha + \beta \times \text{Age}_i$$

where $\alpha$ and $\beta$ are parameters to be estimated.

# 回归分析

假设我们想知道收入是如何随着年龄变化的，我们可以考虑下面简单的线性回归：

$$\text{Income}_i = \alpha + \beta \times \text{Age}_i$$

其中 $\alpha$ 和 $\beta$ 是未知的参数。

# Regression 回归

```
1 file = "https://ximarketing.github.io/class/teachingfiles/r-exercise.txt"
2 mydata <- read.table(file, header = TRUE)
3 result <- lm(Income ~ Age, data = mydata)
4 summary(result)
```

# Regression 回归

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   -74588      10950  -6.812 5.68e-10 ***
Age             4097        332  12.341  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

$$\text{Income}_i = -74,588 + 4,097 \times \text{Age}_i$$

# Fixed Effects

Consider another 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?

# 固定效应

我们考虑另一个回归分析： 我们想分析汽车的销量是如何受汽车颜色的影响 (例如黑色，红色，蓝色，白色，黄色等)。然而，颜色并不是一个数字，我们应该如何开展回归分析呢?

# 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!

# 固定效应

一个简单的思路是，我们可以给每个颜色编号，例如，`black = 1`，`red = 2`，`white = 3`。但这不是一个好的想法。你可能会得到如下的结果 $\text{Sales} = 100 + 5 \times \text{Color}$，你该怎么解读这个结果呢？当颜色增加的时候，汽车的销量也会增加？

# 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.

# 固定效应

更好的解决方法是使用固定效应。相较之前的用一个变量表示颜色，我们对每种颜色都创造一个新的变量。比如对于黑色，我们创造如下的新变量：

$$\text{black} = \begin{cases} 1 & \text{如果颜色是黑色,} \\ 0 & \text{如果颜色不是黑色.} \end{cases}$$

然后，我们把这些新的变量丢到回归公式中进行分析。

# 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.

# 固定效应

上述回归的结果可以这样解释：

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

这里，我们把黑色作为一个基准颜色，把其他颜色同这一基准进行比较。

# 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.

# 为什么需要基准?

我们注意到这两个回归公式其实是完全相同的:

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

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

通过将基准固定为0，我们可以确定唯一的回归公式。

# 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)
```

# 为什么需要一个基准?

那为什么选择黑色为基准颜色呢? 这是因为 R 语言采用字母顺序，而黑色 “black” 排在红色 “red” 和白色 “white”的签名。当然，你可以随时更换你的基准:

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

课后讨论问题：

我们今天介绍了消费者分析的一些方法。你能在你的工作中用到这些方法吗？它们可以解决哪些问题？

请点击这个链接或者扫描二维码回答问题