Class 11 Application of RCT

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Section 1

Tips to Design A/B Testing

Motivating Example

- Tom is considering whether or not to introduce a loyalty program for his bubble tea business. This decision is essentially a cost-benefit analysis
  - Cost: it takes money and time to develop the loyalty program
  - Benefit: it may increase spending and retention rate, and hence future CLV
- Cost can be estimated through budgeting, but how to estimate the benefit from introducing LP?
- How you design the experiment is more an art than a science.

Step 1: Decide on the Unit of Randomization

In the first step, we decide the level of granularity random assignment should occur at.

- individual/household/store/city level

Step 1: Proposal I

Proposal 1: It decides at random to test 'No' in West London and 'Yes' in East London.

- Do you expect the "at random" to be true randomization?

Step 1: Proposal II

Proposal 2: It randomizes each individual customer to either the 'No' condition or 'Yes' pricing condition.

- Is this true randomization?
- What problems can we still have?

Step 1: Pros and Cons of Granularity

Disadvantages of granularity:

- Costs and logistics
- Spillovers and crossovers

Advantages of granularity:

- Reduces the chance that the unobserved factors matter ex ante
- Reduces the chance that there might be a systematic error/unbalance of covariates

Additional Questions:

- How can we randomize individualized price discounts to customers?

Step 2: Ensure No Spillover and Crossover Effects

- **Crossover Effects**: A crossover occurs when an individual who was supposed to be assigned to one treatment is accidentally exposed to another treatment.
  - Solution: Make sure that the same unit receives the same treatment throughout the experiment
- **Spillover effects**: The behavior of the treatment group can affect control group as well
  - Solution: Randomize at the level of plausibly isolated social networks such as a community, rather than individual level.

Step 2: Ensure No Spillover and Crossover Effects

Proposal: How should Tom mitigate spillover and crossover effects

Step 3: Decide on Randomization Allocation Scheme

- Individuals (or the relevant unit of randomization) are simply allocated at random into a treatment.
- In R, we can use the random number generator to determine the randomization

Proposal: We can use complete randomization as customer purchase history data may not be available.

Step 4: Collect Data

- Any field experiment should be aware of the potential need for a large sample size
  - The larger sample size, the higher statistical power for the experiment
  - run a power calculation [link for tutorial] if there is a budget
- Collect both data on the outcome variables of interest and consumer characteristics data

Proposal: We need to collect customers' retention rate data and link the retention data with their treatment assignment.

Step 5: Interpreting Results from a Field Experiment

Step 5.1: Randomization check

- We need to check if the treatment group and control group are indifferent and well-balanced in terms of their **pre-treatment** characteristics.

Step 5.2: Analyze the data and estimate the ATE

- **t-test** to examine the difference in the average outcome between the treatment group and control group. In R, we can use `t.test()`
- **Regression analysis** (next week)

Section 2

Synopsis

Case Background

Andrew and Hammond, 2 recently graduated MBA students, were tasked with developing an **ad-serving learning algorithm** for Vungle, a **mobile ad-serving** company.

Zain Jaffer, the firm's CEO, planned to **test the developed method in parallel with the existing Vungle algorithm**.

The hope was that the new algorithm would increase **conversion rates** and, more specifically, **profits** (as measured by **eRPM**).

To test this, two conditions (A, Vungle's existing algorithm, and B, the data science approach) were evaluated in parallel on **randomly assigned users**.

Case Core Question

The case examines the results of an A/B test of the two algorithms during the month of June 2014. You will need to determine whether B outperformed A.

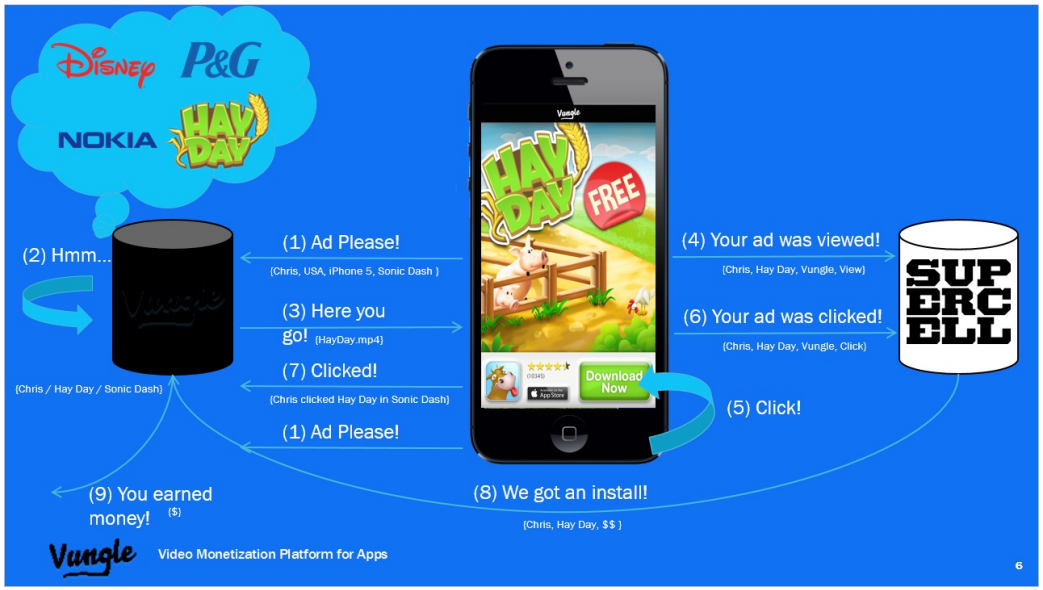
- How might Jaffer conclude that B is better than A?
- If it is, what would the financial benefits be?
- Finally, how long would Jaffer need to wait before declaring a winning algorithm?

Section 3

Situation Analysis

Company

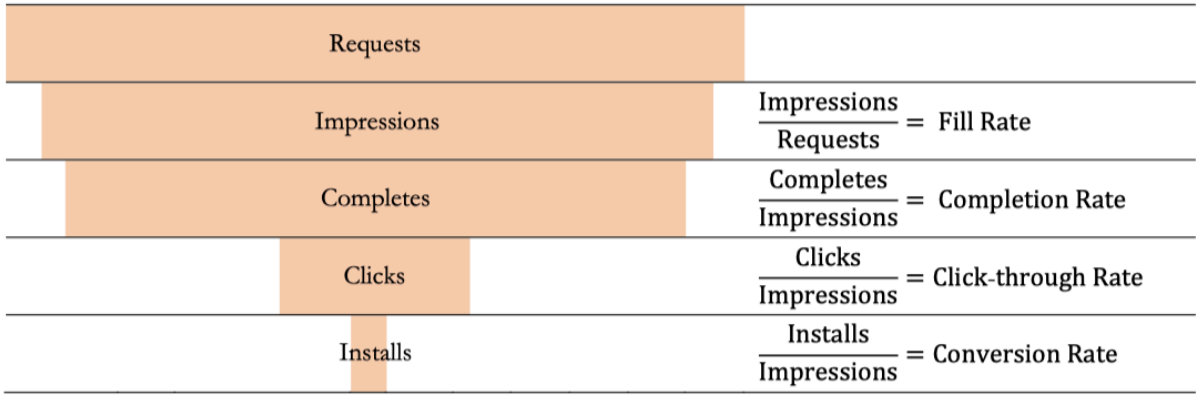
- Business model of Vungle?
- What are the key players in this mobile video ads market (i.e., Vungle)? Find the info in the case.
  - As a comparison, what are the key players in website ads case?



Company

- How does Vungle make money? Find the info in the case.

Figure 1. Mobile in-app advertising funnel.



Source: Created by case writer.

- How can Vungle improve its revenue using what we've learned in Marketing Analytics so far?

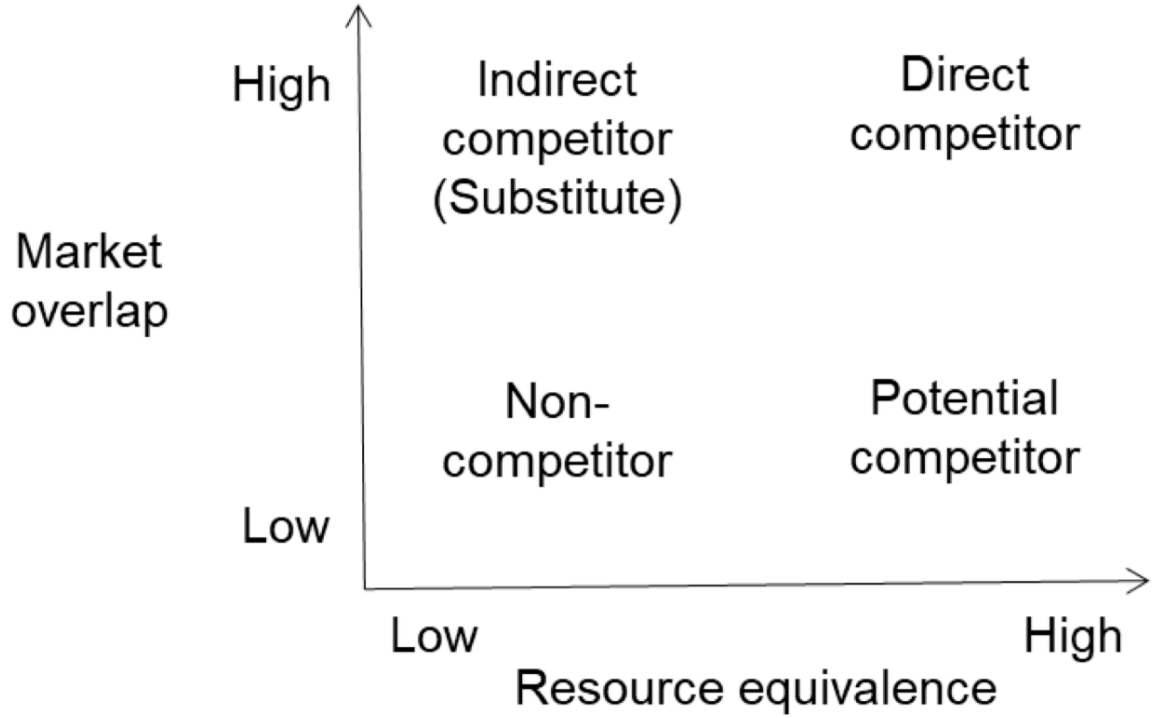
Customer

- Due to the nature of business model (multi-sided market), who are Vungle's customers? Find the info in the case.

Collaborators

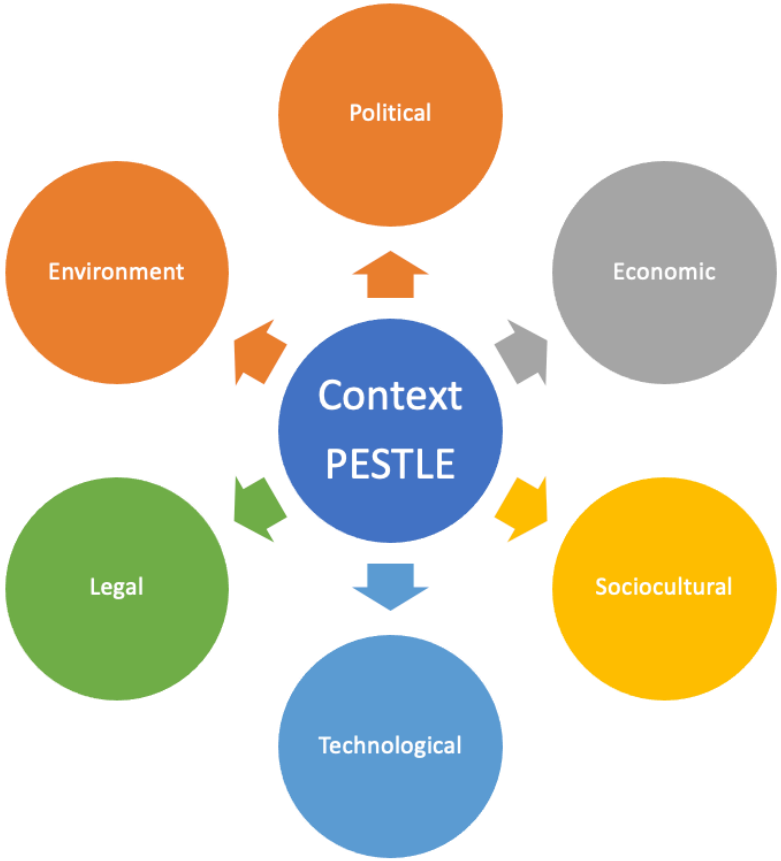
- Who are the collaborators of Vungle?

Competitors



- Direct competitors
- Indirect competitors
- Potential competitors

Context



- Legal: GDPR
- Technological: penetration of mobile phones
- ...

Section 4

Implementation of Experiment

Step 1: Decide on the Unit of Randomization

- What would be the best unit of randomization?
- How about website-based online ads, say Google ads?

Step 2: Ensure No Spillover and Crossover Effects

- What are the potential problems for spillover and crossover?
- How about website-based online ads, say Google ads?

Step 3: Decide on Randomization Allocation Scheme

- How did Vungle implement the randomization scheme? Is it sensible?

Step 4: Collect Data

- What data did Vungle collect?
- Can you do better?

Step 5: Interpreting Results from a Field Experiment

- Which step is missing in Vungle A-B testing?
- How to draw statistical conclusions from the Exhibits A and B?

Step 5: Paired t-test

```
pacman::p_load(dplyr)
```

```
data_vungle <- read.csv("https://www.dropbox.com/s/nsxnworjggreh4s/UV69

t.test((data_vungle%>%filter(Strategy == "Vungle A"))$eRPM,
       (data_vungle%>%filter(Strategy == "Vungle B"))$eRPM,
       paired = TRUE)
```

```
    Paired t-test

data:  (data_vungle %>% filter(Strategy == "Vungle A"))$eRPM and (data_
t = -3.2837, df = 29, p-value = 0.002677
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -0.17959566 -0.04173767
sample estimates:
mean difference
     -0.1106667
```

Conclusion

Guerin was curious to see how the superior condition would be chosen. How would one conclude that B was better than A?