THE OHIO STATE UNIVERSITY

How to Scrape Online Information: With Application to Online Vape Shops

Tobacco Online Policy Seminar (TOPS)

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- We declare no conflict of interests

Overview – e-cigarette data collection from online stores:

- Motivation
- Price, volume, in stock status, and price promotion
- Nicotine strength, and nicotine form (freebase vs salt)
- VG/PG ratio, flavors, and brands
- Package images
- Customer numeric ratings and review contents

Motivation – Why do we need to collect e-cigarette product information from online stores?

- Sales data are necessary to describe the marketplace and ***inform policies*** at the federal, state, and local levels.
- However, existing sales data such as Nielsen Retail Scanner data only capture a portion of the market.
  - Convenience stores, gas stations, grocery stores, drugstores/pharmacies, and mass merchandiser outlets
- Need surveillance of products sold in **vape shops** and **online stores** to capture the full spectrum of e-cigarette products.

Photo source: Ganz *et al*. 2015 *Tobacco Control*

E-cigarette purchase locations by consumers in the US:

Purchase Locations from Braak et al. (2019, 2020)			
Locations	**Adults**	**AYAs < legal age**	**AYAs ≥ legal age**
Online	23%	16%	14%
Vape shops	40%	54%	56%
Other retail stores	37%	30%	30%

Sources: International Tobacco Control (ITC) 4 Country Smoking and Vaping Survey, and ITC Youth Tobacco and Vaping Survey

* AYAs = Adolescents and young adults

Methods to conduct surveillance of e-cigarette products sold online and in vape shops:

- Tobacco **surveys** containing product-related questions
  - Self-reported, subject to measurement errors
  - a variety of pack sizes and volumes - challenging to memorize
  - different models, e.g., disposables, rechargeables, pods, cartridges

Photo source: https://countertobacco.org/media-gallery/store-image-maps/

- The Standardized Tobacco Assessment for Retail Settings: **Vape Shops (vSTARS) surveillance tool** (Kong et al. 2017; Henriksen et al. 2016)
  - Costly – train staff to visit stores and document information
  - Capture popular or commonly sold brands – hard to document all products

- **Brand websites** surveillance (Hsu et al. 2018)
  - Sampling – brand mentions
- **Social media** surveillance (Lu et al. 2020; Zhou et al., 2018)
  - Focus on marketing, instead of marketplace
- ***Web scraping***
  - *Complement* alternative methodologies
  - Not subject to self-reported errors
  - Capture *a wide range of products* – **everything listed** by online stores
  - Capture *a wide range of brands* – do not need a predetermined brand list
  - Complement marketing data with *marketplace data*
  - Consumer ratings – **consumer reception of marketing**

- ***Web scraping*** complement **Nielsen Retail Scanner** data from *brick-and-mortar stores*
  - Nielsen data are quite important, though
    - Could take a lot of efforts to *identify product info based on UPC*
    - *Costly process* to obtain nicotine strength, flavors, etc.
- Web scraping algorithms –
  - **Automate** and **streamline** the process
  - *Straightforwardly* obtain nicotine strength, flavors, etc.
  - Relatively **costless** – could easily expand without much additional costs

What this project does:

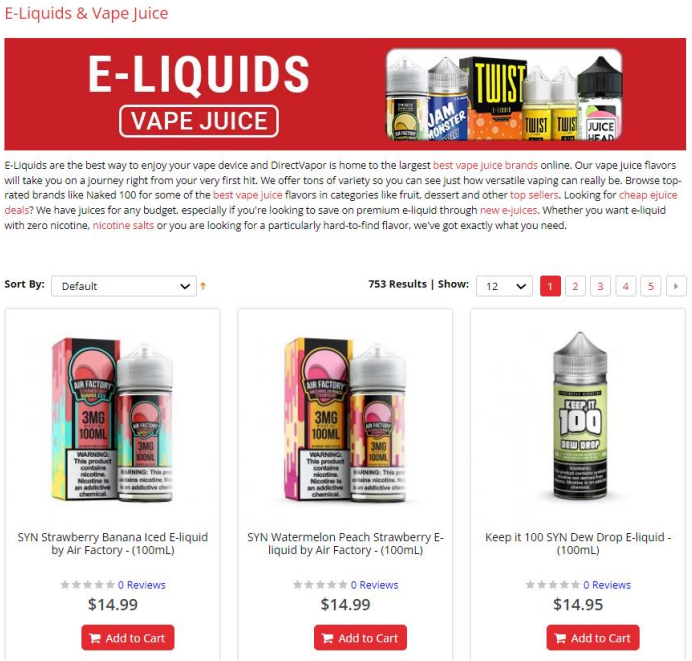
- To address the data limitation in e-cigarette marketplace
  - We scraped data from online stores
    - Price, volume, in stock status, and price promotion
    - Nicotine strength, and nicotine form (freebase vs salt)
    - The ratio of vegetable glycerin (VG) to propylene glycol (PG)
    - Flavors, and brands
    - Package images
    - Customer numeric ratings and review contents
- Focus on e-liquid products (disposables, devices, and starter kits to be cleaned)

Methods:

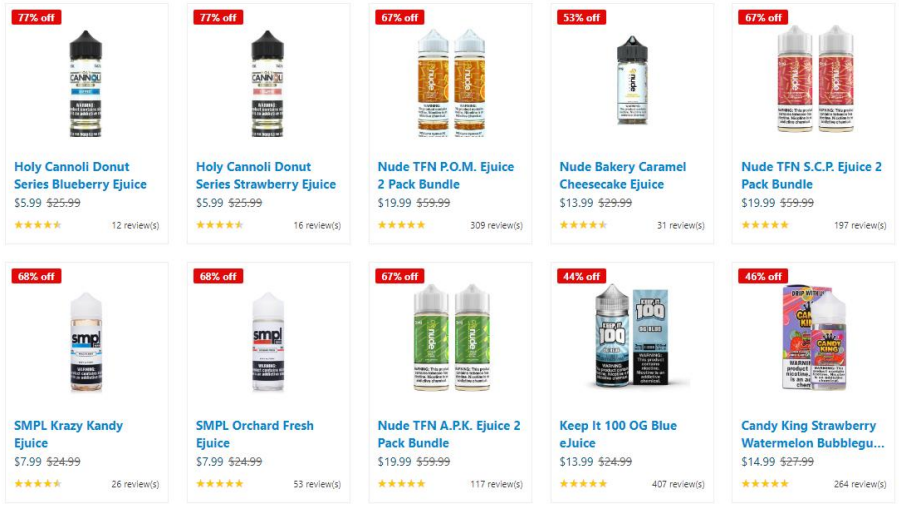
- Store selection process
  - We searched Google and Reddit using the key terms “best online vaping stores in 2020” (1/26/2021)
  - Selected 3 stores from Google search and 2 stores from Reddit search
  - Confirmed that these stores sell products nationwide in the US
  - Scrapped product data from online stores between February and May 2021
- 14K unique products from five stores

Five popular online vape shops:

- To mask store identities: referred to as ***stores 1-5***



Store 1

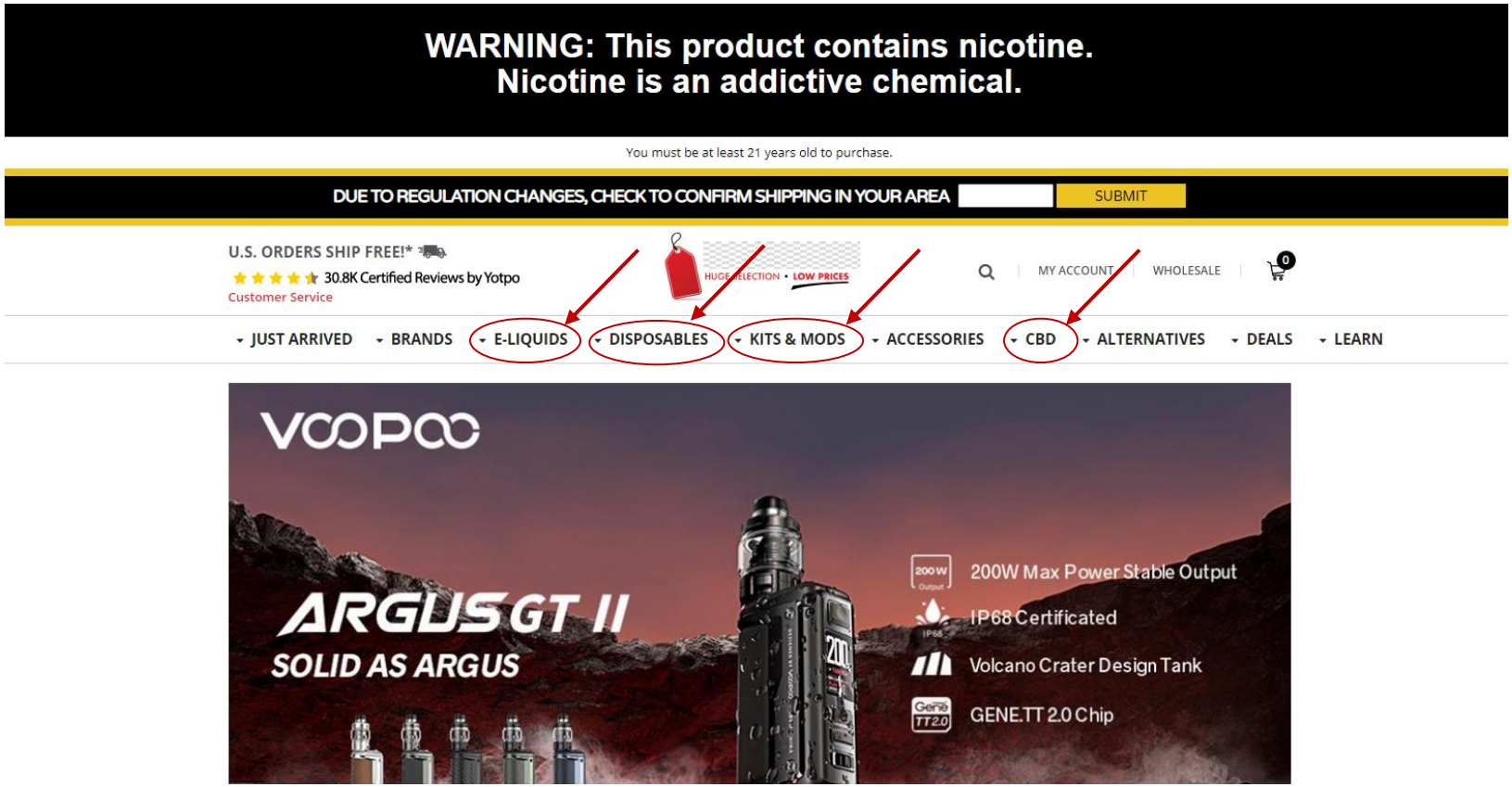


Store 5

Website example: store 1

- ***Age verification*** when visiting website –
  - Confirm the visitor is > 21 and of legal age of smoking in state of residence
- Once enter, ***e-cigarette health warning*** on homepage
- Multiple tabs – ***product types***

Website example: store 1 homepage layout

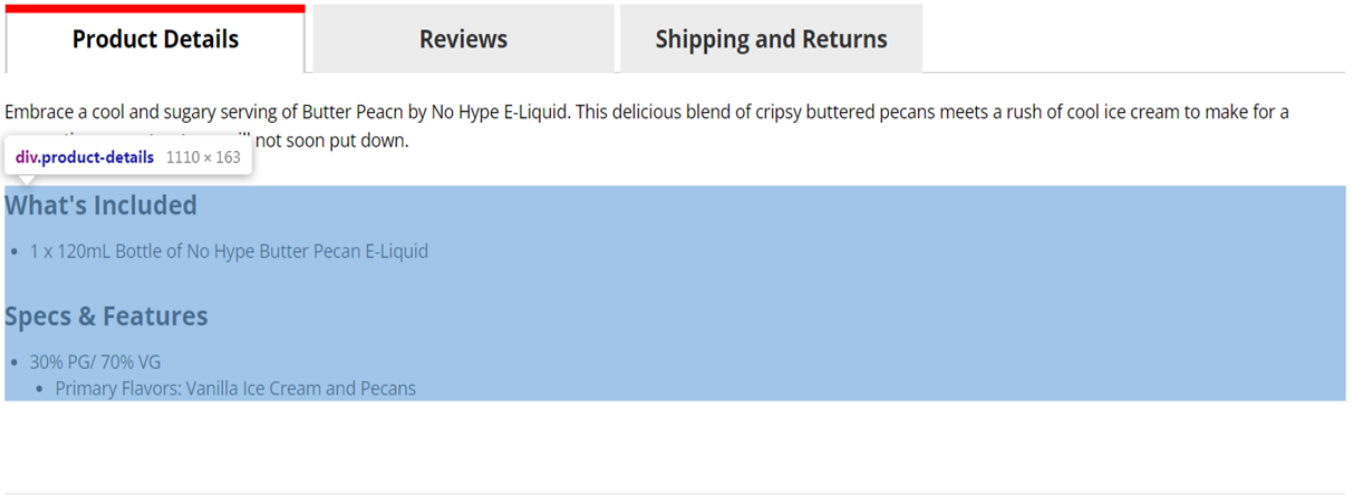


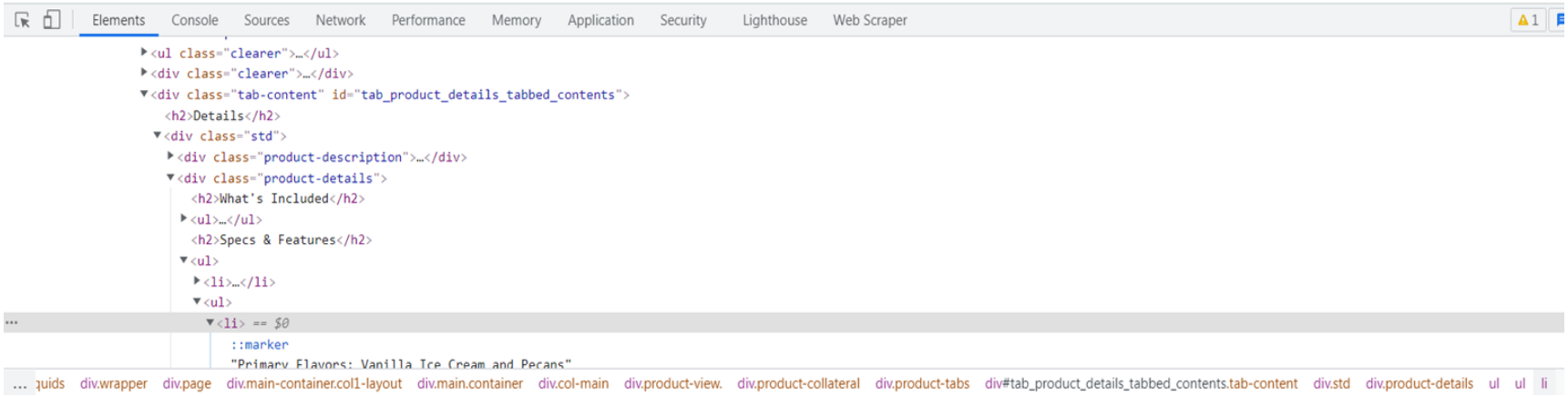
Web scraping tools:

In [ ]:
```
df = pd.DataFrame({
    'Name':[], 'TotalVolume':[], 'PackNum':[], 'VolumePerPack':[],
    'Price':[], 'OrgPrice':[], 'Nicotine':[], 'VG/PG':[], 'inStock':[],
    'Rating':[], 'ReviewCnt':[], 'Brand':[], 'ProductLink':[], 'ImgLink':[]
})
df.index.name = 'Index'

product_lists = []
for page_num in tqdm(range(1, 36)):
    # print(f'{page_num} / {77}')
    params_ = params
    params_['page'] = page_num
    params_['startIndex'] = (page_num-1) * 20
    response = requests.get('https://www.searchanise.com/getresults', headers=headers, params=params_)
    res = eval(re.search('(?<=\()\{.+\}(?=\);)', response.text).group().replace('\\', ''))
    #res['items'][0]['link']

    product_lists.extend(res['items'])

for product in tqdm(product_lists):
    # while True:
    #     try:
    product_url = product['link']
    product_page = BeautifulSoup(get_content(product_url), 'html5lib')

    product_img = product_page.find('meta', {'property':"og:image"})['content']
    product_name = product_page.find('meta', {'property':"og:title"})['content']
    try:
        org_price = product_page.find('div', {'class':'price--compare-at visible'}).find('span', {'class':'money'}).text.replace(
    except:
        org_price = 'N/A'

    try:
        vgpg = re.search('(?<=-vg-pg-ratio">)\d\d/\d\d(?=</a>)', str(product_page.find('div', {'class':'product-description rte'
    except:
        try:
            vgpg = re.search('(?<=-ratio">)\d\d/\d\d(?=</a>)', str(product_page.find('div', {'class':'product-description rte'})
```

Chrome extension “Web Scraper”, and Python

Source code from *store 1* website:


Product Details
Reviews
Shipping and Returns
Embrace a cool and sugary serving of Butter Peacn by No Hype E-Liquid. This delicious blend of cripsy buttered pecans meets a rush of cool ice cream to make for a
not soon put down.
div.product-details 1110 × 163
What's Included
1 x 120mL Bottle of No Hype Butter Pecan E-Liquid
Specs & Features
30% PG/ 70% VG
Primary Flavors: Vanilla Ice Cream and Pecans


Elements
Console
Sources
Network
Performance
Memory
Application
Security
Lighthouse
Web Scraper
<ul class="clearer">…
…

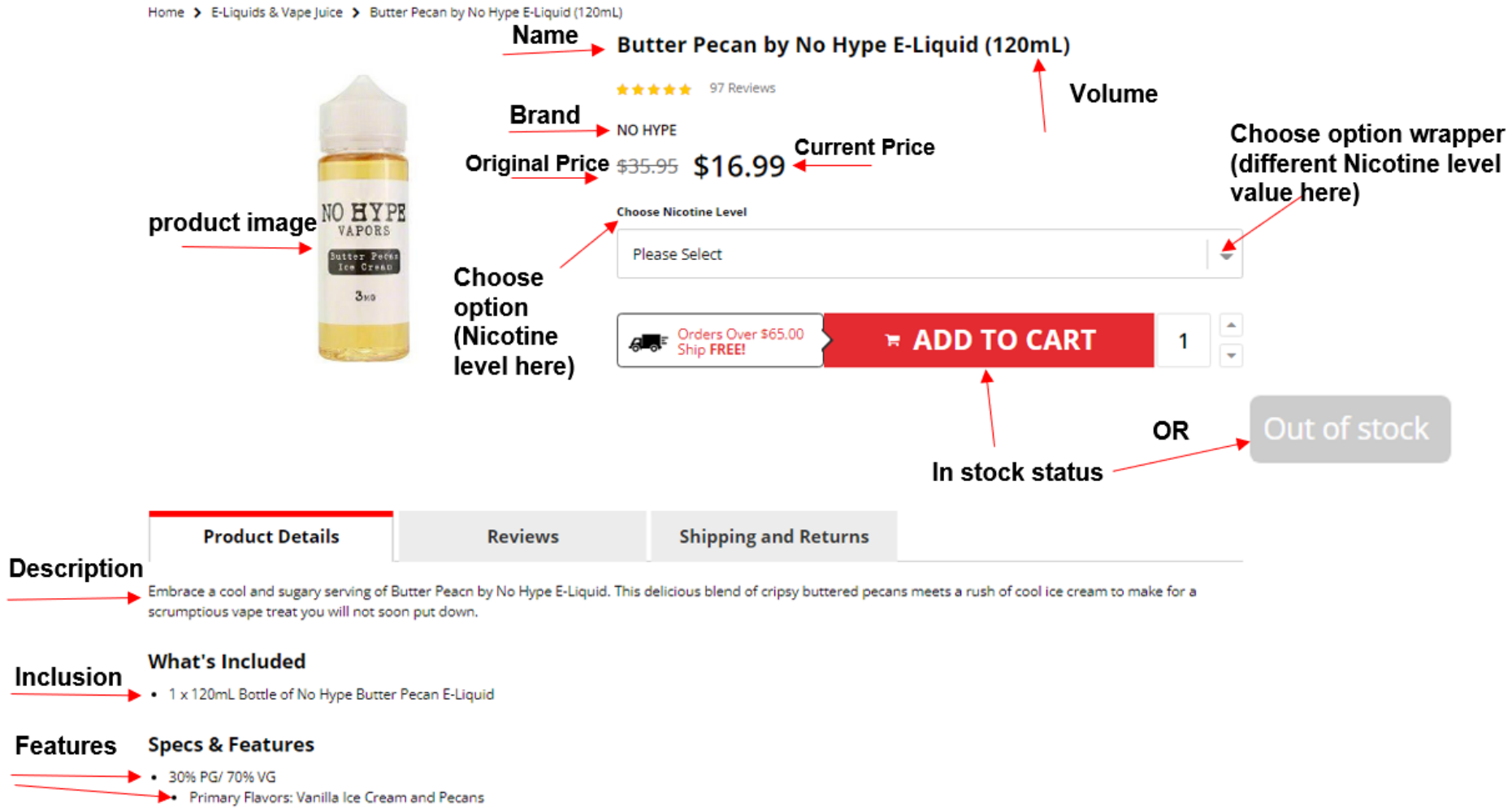
<h2>Details</h2>

…

<h2>What's Included</h2>
…
<h2>Specs & Features</h2>

…

 == $0
::marker
"Primary Flavors: Vanilla Ice Cream and Pecans"
div.wrapper
div.page
div.main-container.col1-layout
div.main.container
div.col-main
div.product-view.
div.product-collateral
div.product-tabs
div#tab_product_details_tabbed_contents.tab-content
div.std
div.product-details
ul
ul
li


Home › E-Liquids & Vape Juice › Butter Pecan by No Hype E-Liquid (120mL)
Name
Butter Pecan by No Hype E-Liquid (120mL)
97 Reviews
Volume
Brand
NO HYPE
Original Price
$35.95
$16.99
Current Price
Choose option wrapper (different Nicotine level value here)
product image
NO HYPE
VAPORS
Choose Nicotine Level
Please Select
Choose option (Nicotine level here)
Orders Over $65.00 Ship FREE!
ADD TO CART
1
OR
Out of stock
In stock status
Product Details
Reviews
Shipping and Returns
Description
Embrace a cool and sugary serving of Butter Peacn by No Hype E-Liquid. This delicious blend of cripsy buttered pecans meets a rush of cool ice cream to make for a scrumptious vape treat you will not soon put down.
Inclusion
What's Included
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Features
Specs & Features
• 30% PG/ 70% VG
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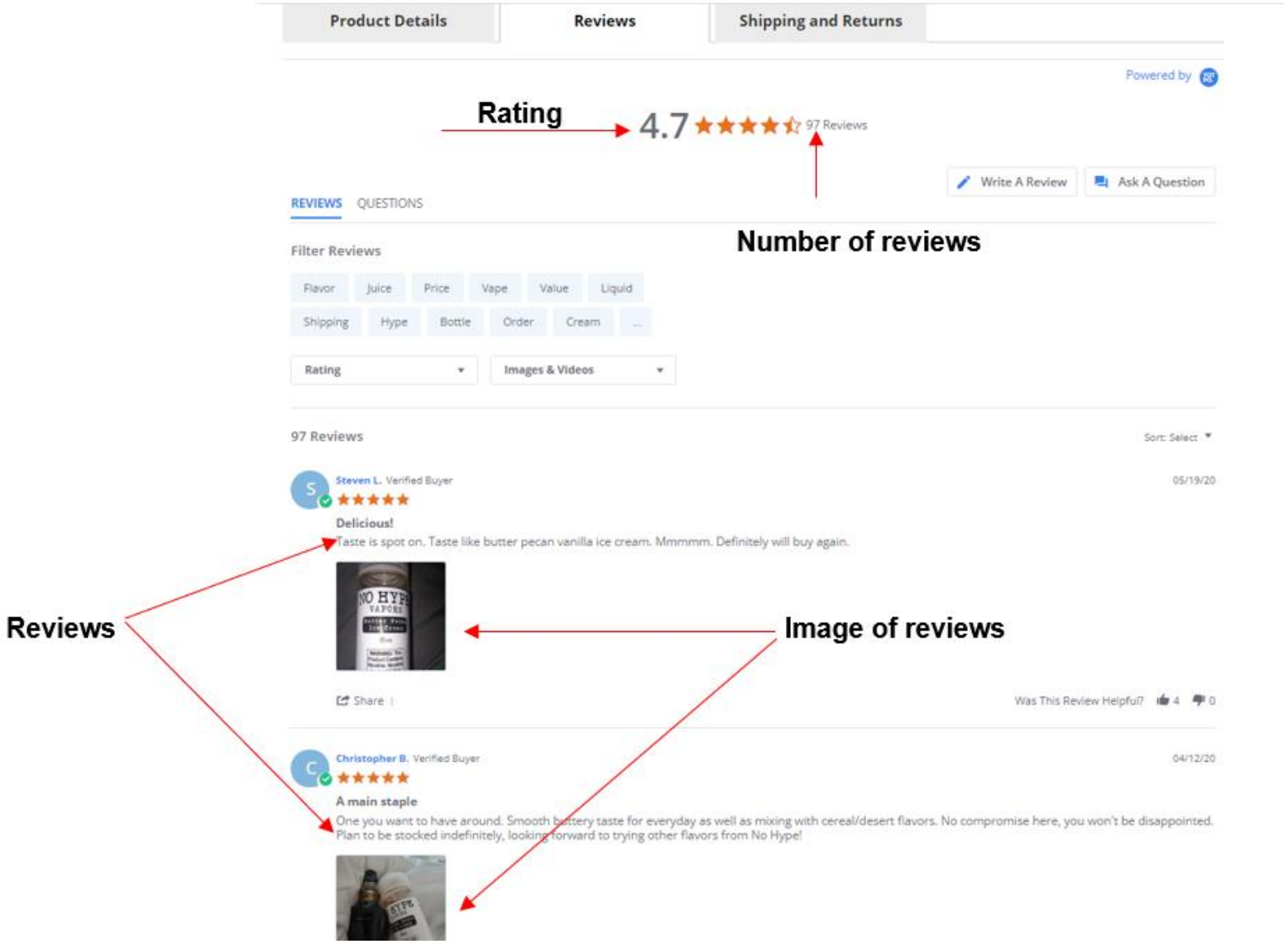

Product Details
Reviews
Shipping and Returns
Powered by
Rating
4.7
97 Reviews
Write A Review
Ask A Question
REVIEWS
QUESTIONS
Number of reviews
Filter Reviews
Flavor
Juice
Price
Vape
Value
Liquid
Shipping
Hype
Bottle
Order
Cream
Rating
Images & Videos
97 Reviews
Sort: Select
Steven L. Verified Buyer
05/19/20
Delicious!
Taste is spot on. Taste like butter pecan vanilla ice cream. Mmmmm. Definitely will buy again.
Reviews
Image of reviews
Share
Was This Review Helpful?
Christopher B. Verified Buyer
04/12/20
A main staple
One you want to have around. Smooth buttery taste for everyday as well as mixing with cereal/desert flavors. No compromise here, you won't be disappointed. Plan to be stocked indefinitely, looking forward to trying other flavors from No Hype!

Online store traffic:

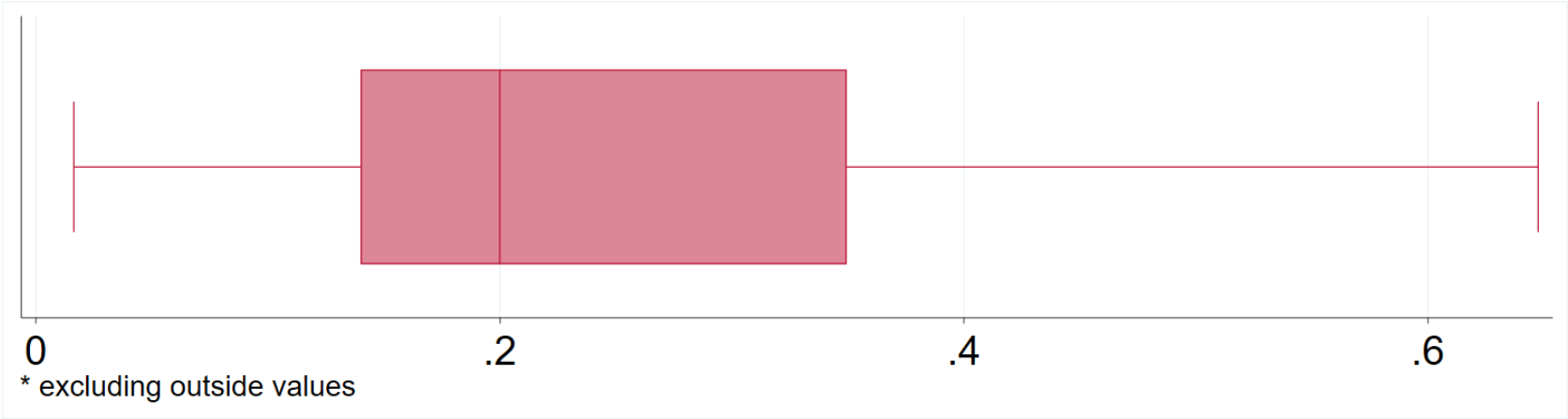
- With data on ***organic store traffic*** -
  - Keep *monitoring* the popularity of stores in our sample
  - *Expand* our efforts and scrape data from
    - *More stores*
    - *Stores with the heaviest traffic*
  - *Representativeness* - reflect the rapidly changing online market

Data format and standardization:

	Image	Name	Price	OrgPrice	Volume
305		360 Triple Melon E-Liquid by Twist (180mL)	$21.95	$29.95	180
306		360 Triple Red E-Liquid by Twist (180mL)	$21.95	$29.95	180
324		Apple Twist Crisp Apple Smash by Twist E-Liquid (120mL)	$21.95	$24.95	120
343					

- $Standardized\ price = \frac{actual\ price\ of\ the\ product}{total\ volume\ of\ the\ product}$
- $Price\ promotion = \frac{original\ price - actual\ price}{original\ price} * 100$

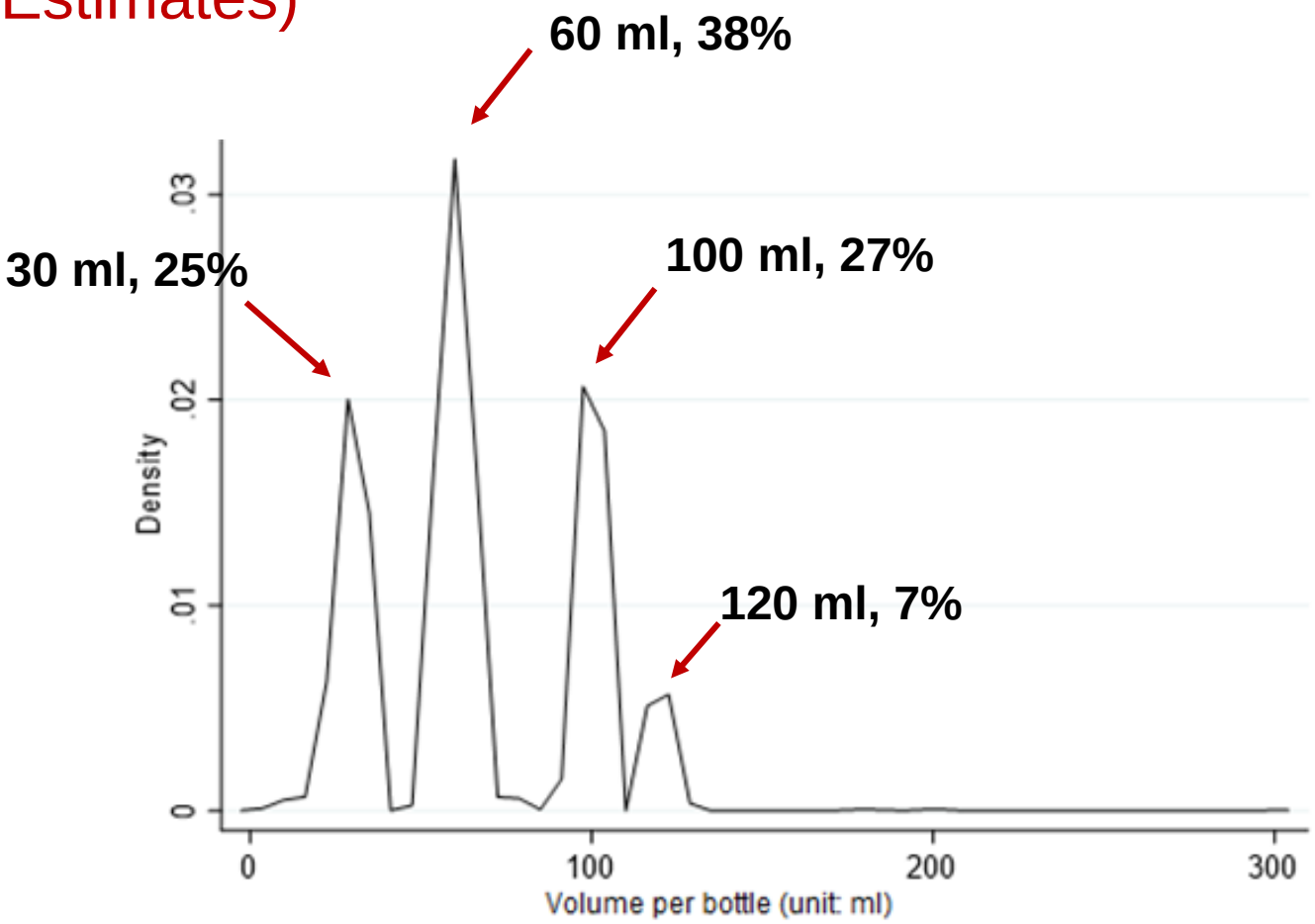
E-liquid Price Distribution



- *E-liquids are very affordable*

Percentile	5%	10%	25%	50%	75%	90%	95%
Standardized price ($/ml)	0.10	0.12	0.14	0.21	0.37	0.43	0.50

Distribution of e-liquid volume per bottle (Kernel Density Estimates)



Price promotion strategies:

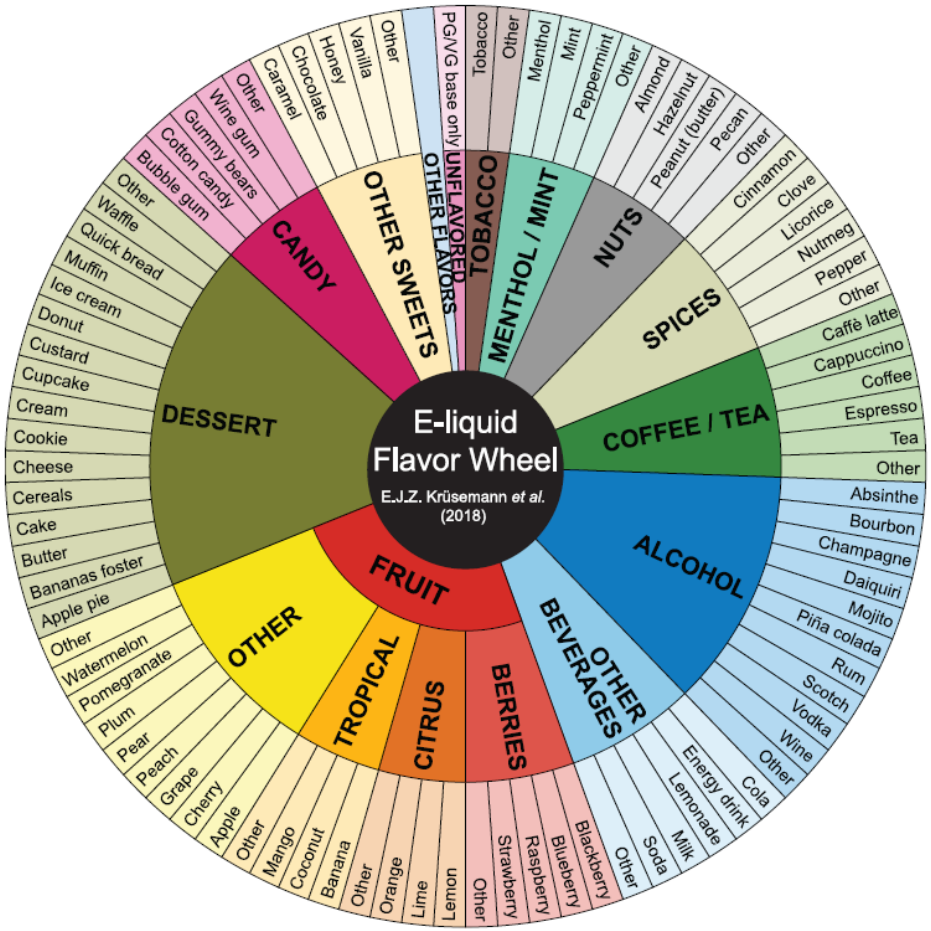
- Price promotion (% off) calculated for each e-liquid product sold in our scraped data
  - $Price\ promotion = \frac{original\ price - actual\ price}{original\ price} * 100$
- Data of bundled products
- We checked sitewide discounts as well as shipping policies on store websites at two time points, July 7 and September 12, 2021
- Quantity discount in the form of buy x get y free

Promotion strategies in each online vape shop:

Promotion Strategies	Stores
Sales (Percentage Off)	All five stores
Sitewide discount	Stores 1, 2, 3 and 5
Free shipping	Stores 1, 2, 3 and 5
Product bundling	Stores 1, 4 and 5
Buy X get Y free	Store 1

- Average discount (% off) was 39%
- We also documented frequency of pack sizes, and percentage of bundled products in each store

E-liquid flavors: how to code it?



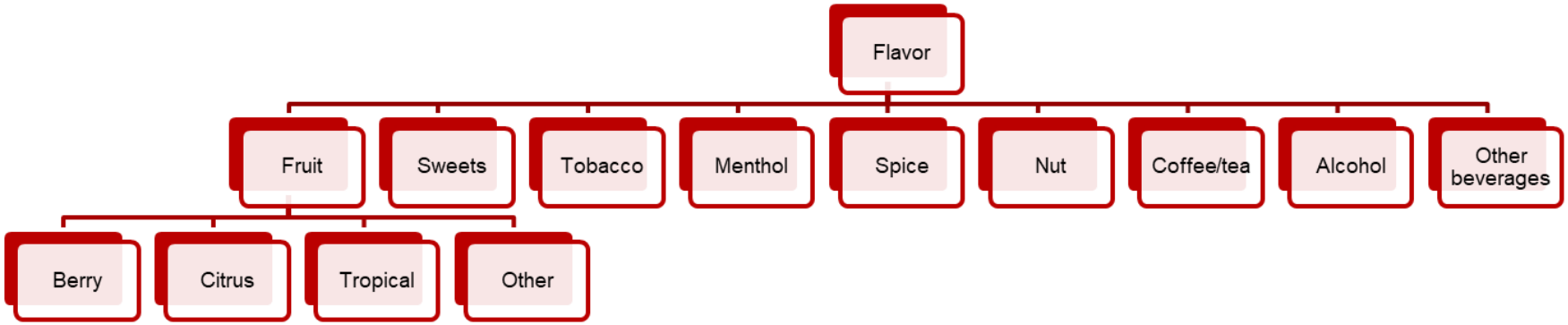
Source: Krüsemann, Erna JZ, et al. "An e-liquid flavor wheel: a shared vocabulary based on systematically reviewing e-liquid flavor classifications in literature." *Nicotine and Tobacco Research* 21.10 (2019): 1310-1319.

Expand on automatic flavor identification and categorization

- Expand the flavor taxonomy using existing database: *WordNet* (Princeton University 2010 https://wordnet.princeton.edu/)
- Develop algorithms to extract flavors from the following:
  - Source code of product webpage
  - Flavor filter provided by each online vape shop
  - Product description box on list page (aided by *keyword matching*)

Flavor data hierarchy

- N = 833 key terms



Flavor marketing observation:

- Multiple flavored are often mentioned in different placements: flavor description, flavor filter, and marketing description
    - Example: Berries, Menthol
- Primary vs. secondary flavors are not distinguishable in marketing description or flavor filter
- Concept flavors: e.g., ice, blue razz, refresher

E-liquid flavor – ***rich information***

Summer Vibes By Ripe Vapes 60ml

☆☆☆☆☆

~~$23.99~~ **$13.99**

Envision palm trees swaying in the wind, tropical sunsets and moonlit beaches while you vape by grabbing Summer Vibes by Ripe Vapes.

CLEAR

NICOTINE 3 MG

In stock

- 1 + ADD TO CART

DESCRIPTION

Summer Vibes By Ripe Vapes 60ml Review

Do you want to envision palm trees swaying in the wind, tropical sunsets and moonlit beaches while you vape? If this sounds too good to be true, you've got to grab Summer Vibes by Ripe Vapes. This island-inspired treat will have you feeling blissed out with its authentic tropical goodness that will make you want to do the hula in your bedroom. A thirst-quenching trio of juicy strawberries, creamy coconut, and sweet bananas is spritzed with the perfect amount of zesty lime to make your palate go wild. Talk about a truly euphoric ADV experience in the comfort of your own home.

At first, that strawberry's brightness lifts your mood, making it seem as though you are indulging in something refreshing. Then, exquisite banana slides down the tongue, teasing your sweet tooth along the way. A bath of coconuts soak the tongue before that citrus splendor livens things up once enough vapor has escaped. You won't be able to resist taking another draw, that's for sure.

Summer Vibes vape juice from Ripe Vapes comes in a medium-sized bottle with a delectable cloud and flavor chasing blend of 75/25 VG/PG that makes it even more blissful for vapers everywhere to have with their favorite mods.

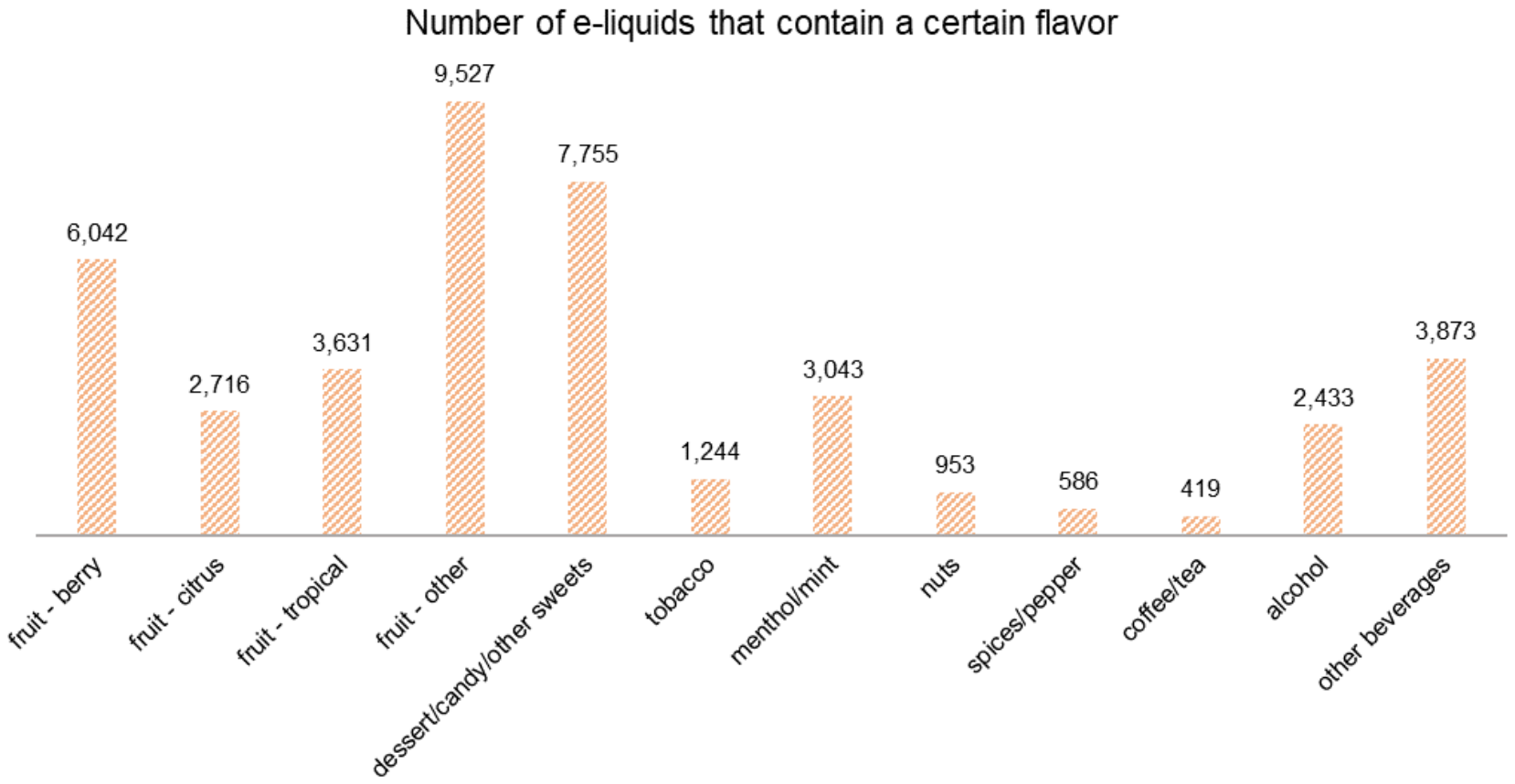
So, what are you waiting for? Now is the time to finally feel those 'vibes' of 'summer' and just enjoy your own fruity vaping paradise, all when simply taking a few pulls of this paradise-filled E-Liquid sensation today. Trust us, you'll be glad you took this getaway as those cravings will also be on vacation as well. Go grab some today while it lasts!

Package Contents Include:

- 1 x 60ml bottle of Summer Vibes by Ripe Vapes

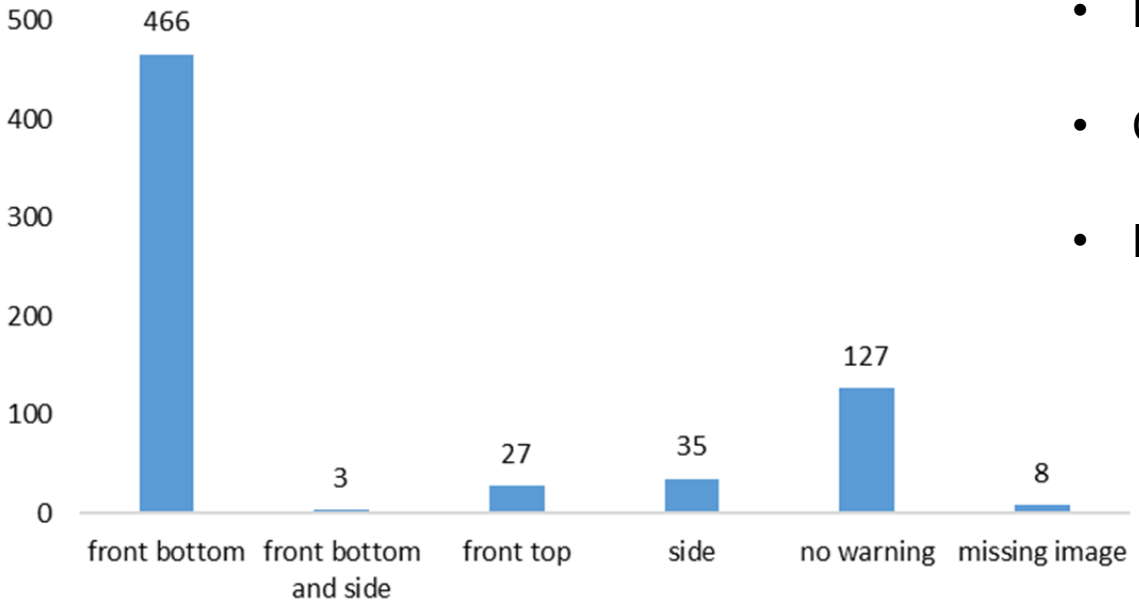
VG/PG: 75/25

Flavor: Strawberry, Coconut, Banana, Lime



Frequencies of E-liquids Containing a Certain Flavor (Product Total N = 14,477)

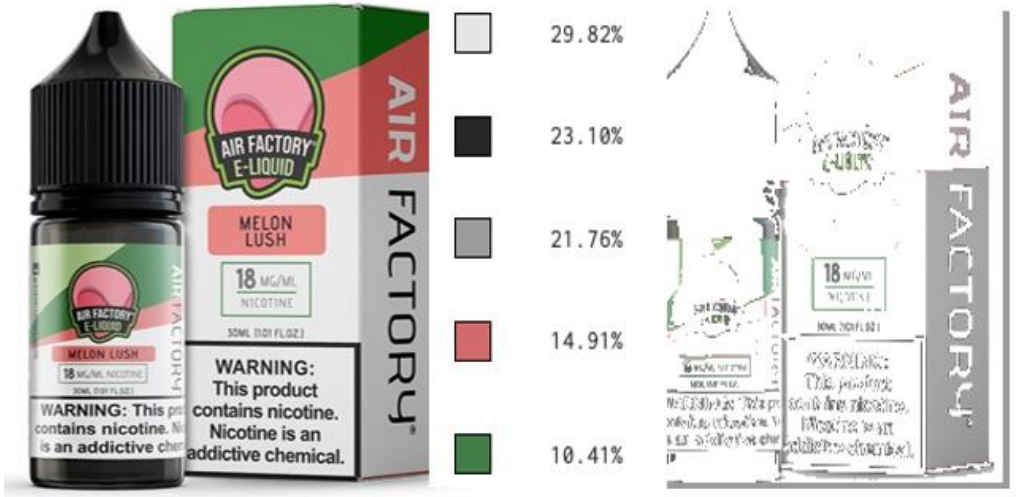
Double-coding policy-relevant packaging attributes



Warning placement (store 1)

- Placement of warnings
- Colors
- Flavor descriptions

Data visualization tools and algorithms



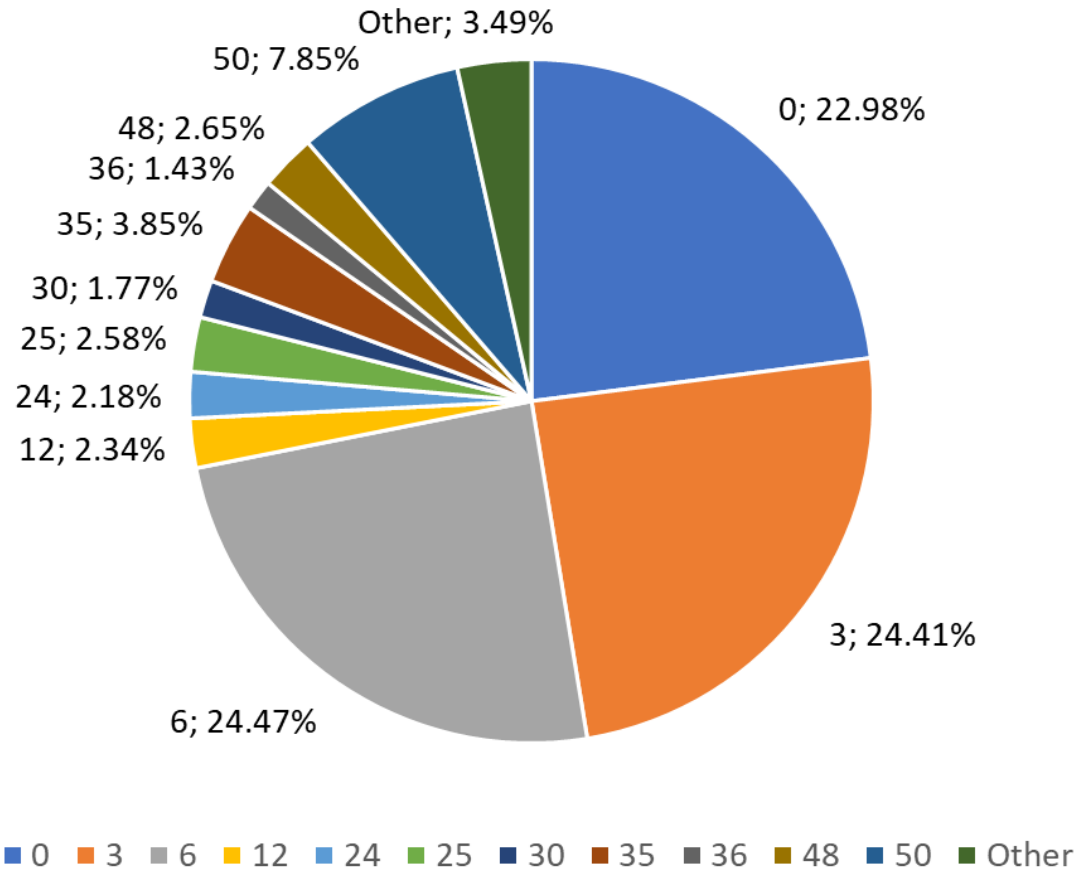
Extracting information from package images

- Automatically parse out information
- Extract package colors and layout
- Machine coding + **human coding** (two coders who code information independently)

Web data by e-cigarette product types

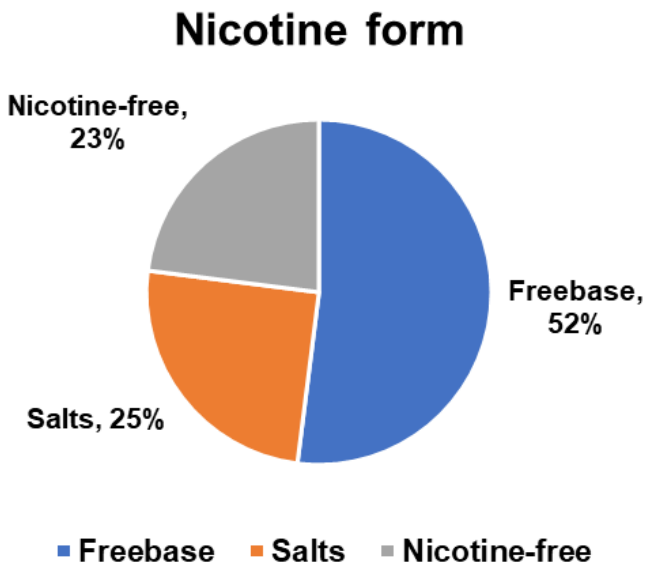
- Scrape and analyze ***e-liquids*** as first-step
  - Not well captured in Nielsen data; hard to code volume
  - Web scraping could make the greatest contribution
- Other product data that we have obtained –
  - Disposables, and cartridge-based e-cigarettes
    - Measured in Nielsen data
  - Starter kits, and devices that use with e-liquids
  - CBD products

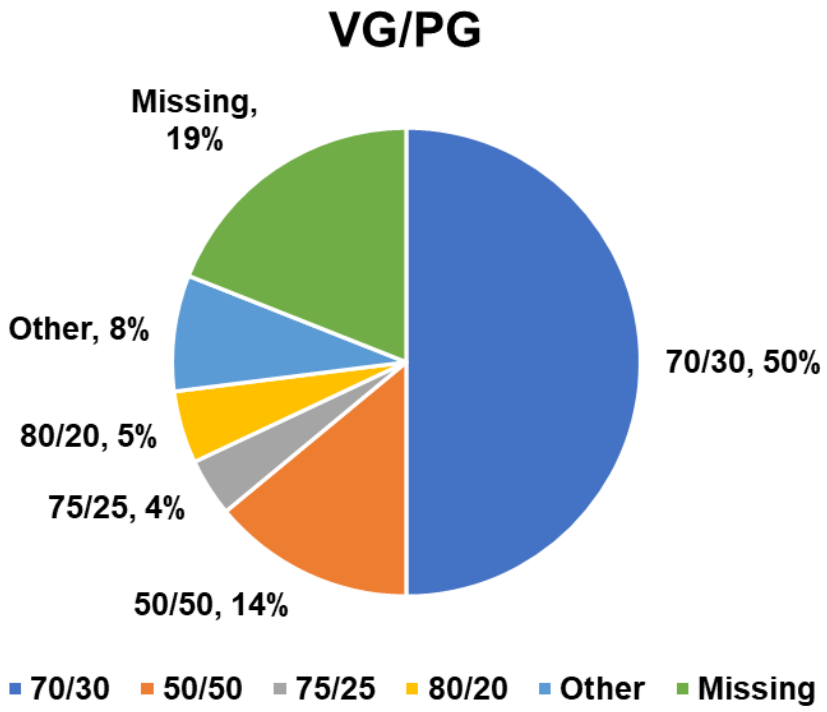
Nicotine strength in mg/ml, N = 14,427



Average nicotine strength is 12 mg/ml.

Nicotine form, and VG/PG ratio:



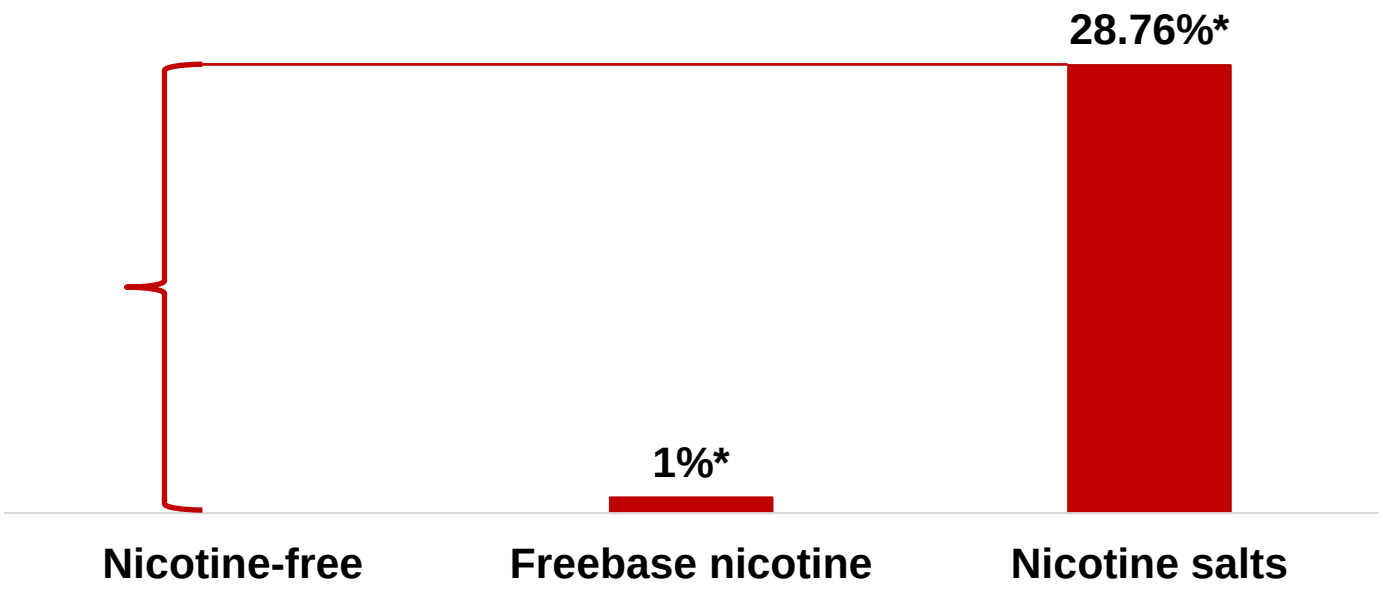


- Nicotine salts are less bitter and harsh than freebase
- Higher the VG/PG ratio, bigger the vapor clouds

Estimating willingness to pay:

- *Stated preference* data - discrete choice models; hypothetical setting
- **Revealed preference** -
  - Hedonic pricing model; observational data
    - Measure *relative importance* of product attributes
  - $log(StandardizedPrice_{ij}) = \beta_0 + \beta_1 * NicotineStrength_i + \beta_2 * NicotineForm_i + \beta_3 * VGPG_i + \beta_4 * Flavor_i + s_j + \varepsilon_{ij}$
    - i denotes product, and j denotes store; s_j are store fixed effects; and ε_{ij} are the error terms
  - Coefficients of interest, β_1 through β_4, indicate the % change in the standardized price in response to the change in a certain product attribute

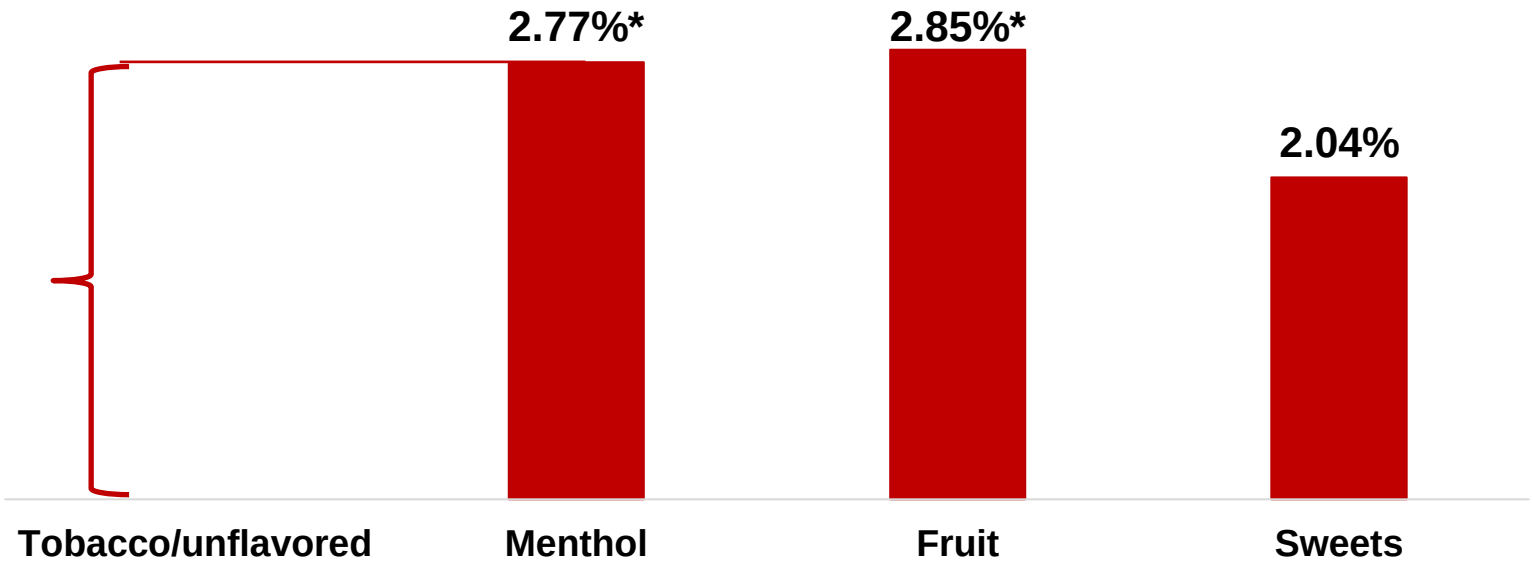
Findings: *associations between e-liquid prices and nicotine form*



* Generalized estimating equation (GEE) model; both statistically significant at 1% level

Consistent with market observation: uptake of nicotine salts sold by JUUL

Findings: *associations between e-liquid prices and flavors,* ***among nicotine salts***



* Generalized estimating equation (GEE) model; all statistically significant at 10% level

Flavor categories used in the analysis

Flavors	Percentage
Tobacco/unflavored	4%
Fruit	36%
Sweets	8%
Menthol	27%
Nut/spice/alcohol/other beverages	25%

- 1) containing fruity flavor, without menthol/mint; 2) sweets flavor, without menthol or fruit; 3) containing menthol/mint flavor(s); 4) containing any flavor(s) that are not menthol/mint, fruits, sweets, or tobacco; 5) tobacco flavor only, or unflavored

Findings:

- No statistically significant associations between e-liquid prices and ***flavors***, among nicotine-free or freebase nicotine e-liquids
  - Most e-liquids in our data contain **fruity** flavors

Policy Environment:

- In Jan, 2021, FDA issued warnings to firms that produced and sold e-liquids online without a **premarket tobacco product application (PMTA)** by *Sep. 9, 2021 deadline*
  - In our scraped data from online stores (Feb. - May 2021), ***241 different e-liquid brands*** remained in the market, and only **23%** of over 14K unique products are **nicotine-free**.
  - Keep monitoring brand availability in online stores and provide data on *PMTA enforcement* and *changes in the online market*

Policy Environment:

- In Apr. 2022, FDA issued two proposals that would *ban menthol flavor in cigarettes* and *all non-tobacco flavors in cigars*
  - If these proposals lead to policy actions, the **flavor availability in e-cigarettes** may *incentivize the transition* from combustible smoking to e-cigarette use.
- Flavor is a main reason of **AYAs experimenting** with e-cigarettes
  - FDA banning flavors other than menthol/mint and tobacco in *cartridge-based* e-cigarettes
  - **Sales growth in disposables** such as puff bars
- Assess importance of flavors to product popularity, and inform about the impact of flavor bans or restrictions

Limitation:

- Unlike ***sales*** data from Nielsen, web scraping does not allow us to obtain information on *transactions*

Web scraping could serve as a cheaper alternative tool, to help us obtain data that complements existing data sources

Future directions:

- *Online store traffic* will allow us to **improve the sampling**
- Use web scraping tools to *obtain a great amount of data*
  - **rich and in-depth product-level information**
- *Expand* efforts to scrape data from *more stores*
- **Web data** serve as a *complementary* source to retail scanner data
- **Content analysis** on consumer ratings and *reviews*
  - consumer preferences - which **attributes** are important to them
- Use *algorithms* to extract information from ***package images***

Questions and comments

shaoying.ma@osumc.edu

https://shaoyingma.com/

Scan to keep following our web scraping efforts

Scan to read our paper and download the price data

After data cleaning and analysis, our team will publish all data with our research papers