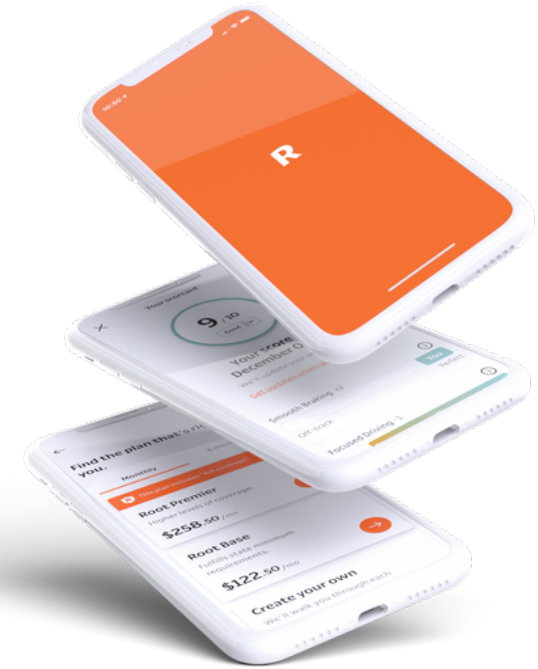
Root Insurance Challenge

Erdős Institute Data Science Boot Camp

May 30, 2021



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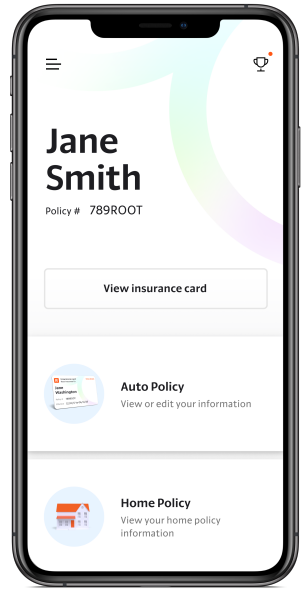
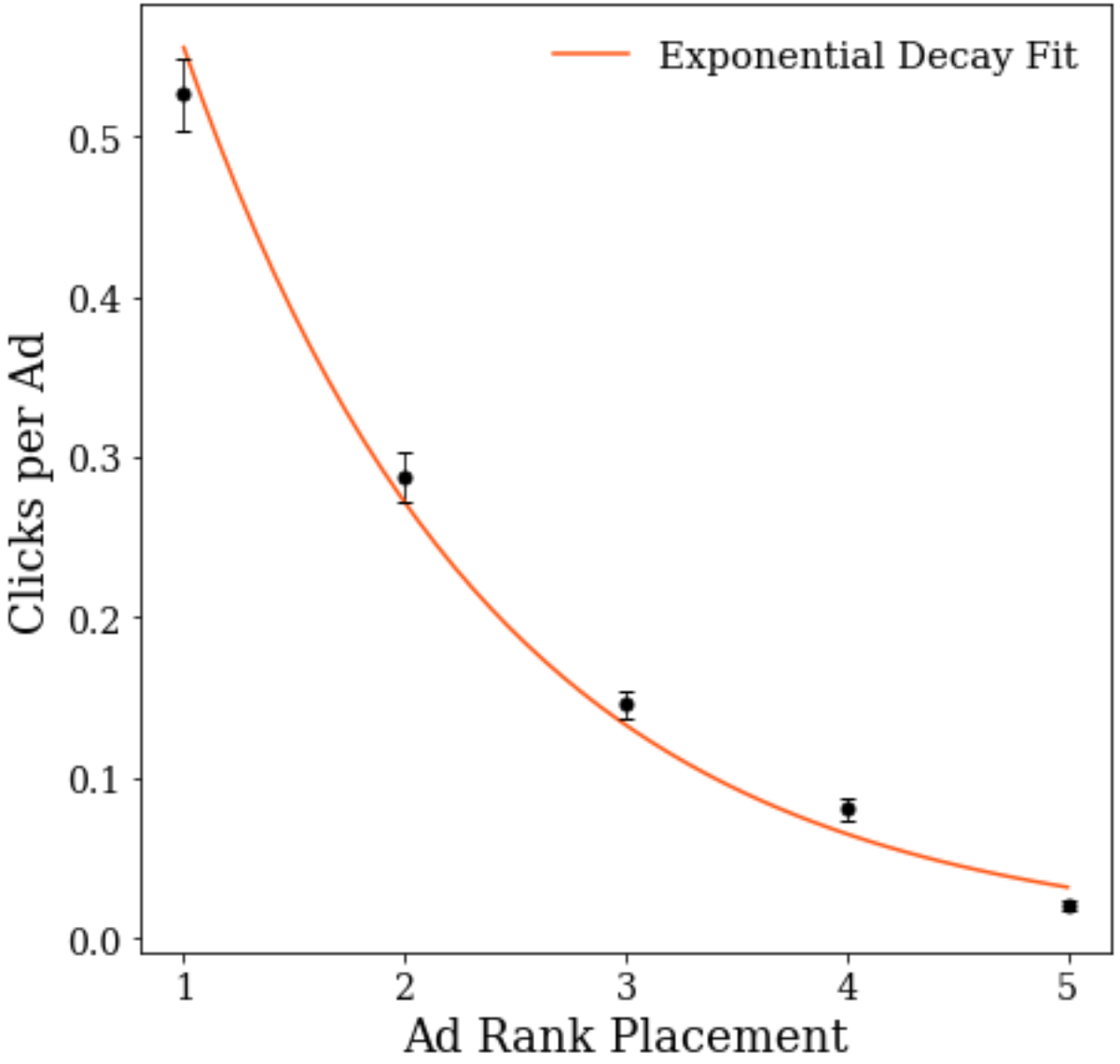
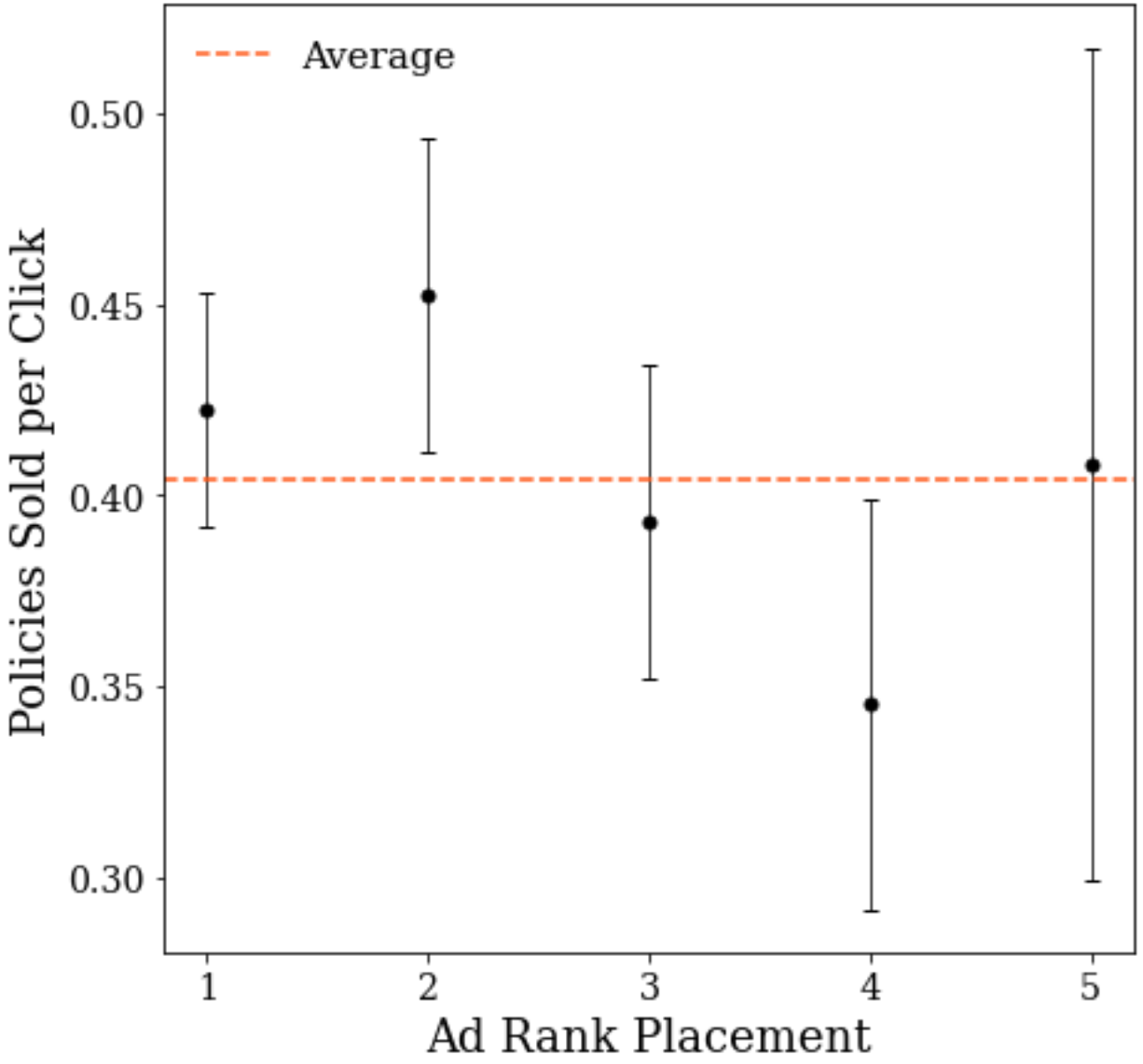


The Problem – Vertical Search Advertising

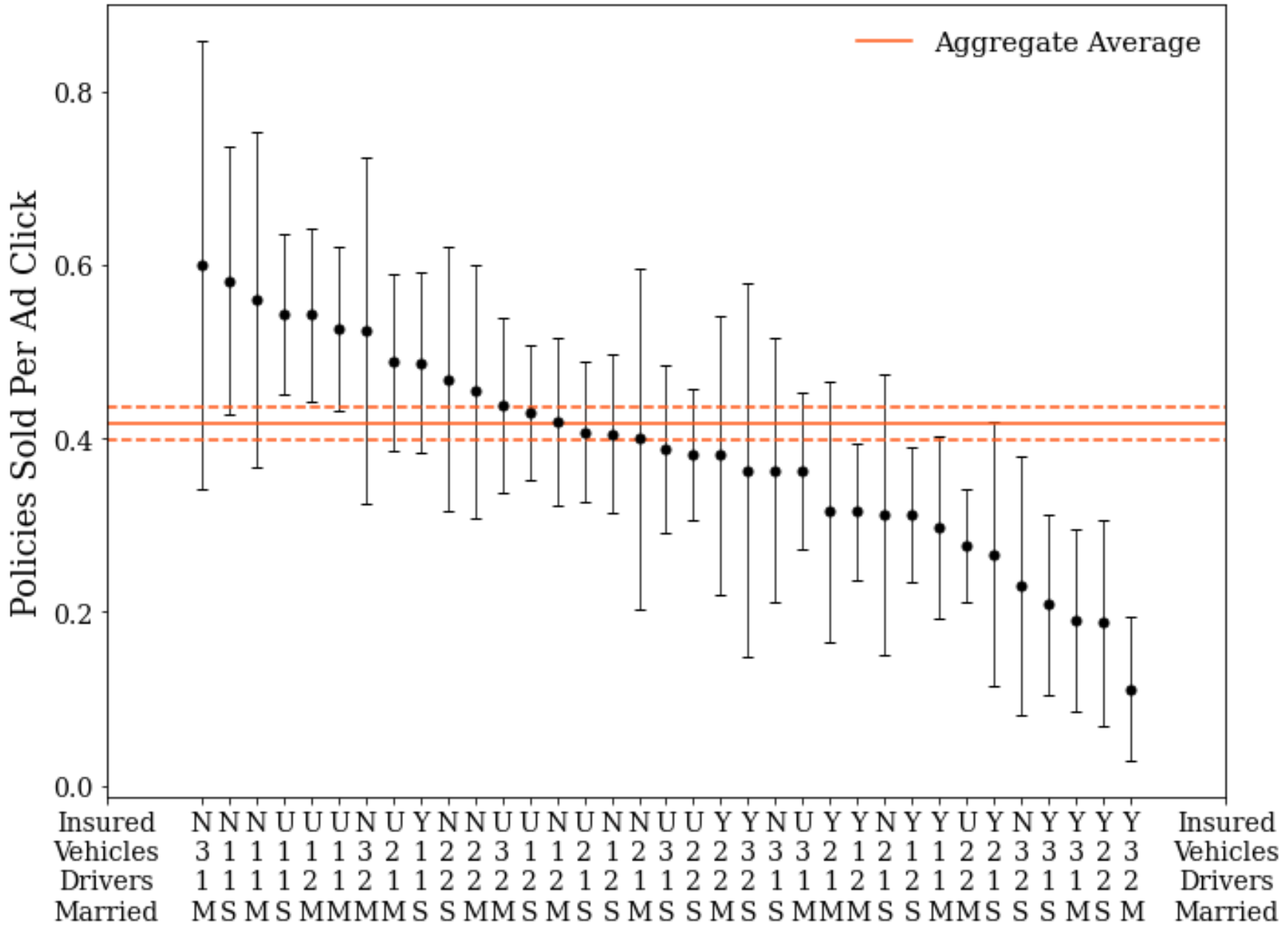
- Customers self-report various pieces of information about themselves into a website and are then shown ads from 5 different insurance companies
- Companies bid based on the customer's information, and the customer is shown ads in rank order of the companies' bids
  - Companies are only charged for bids if the customer actually clicks on their ad
- Acme Insurance has been utilizing a flat $10 bidding strategy and has a data set of 10,000 previously shown ads, including whether each ad was clicked on and subsequently produced a policy sale
- Acme would like us to optimize their bidding strategy such that it costs as little as possible to obtain new customers, while ensuring that for every 10,000 ads shown they expect to sell 400 new policies

Ad Rank Placement Drives Clicks, Not Sales



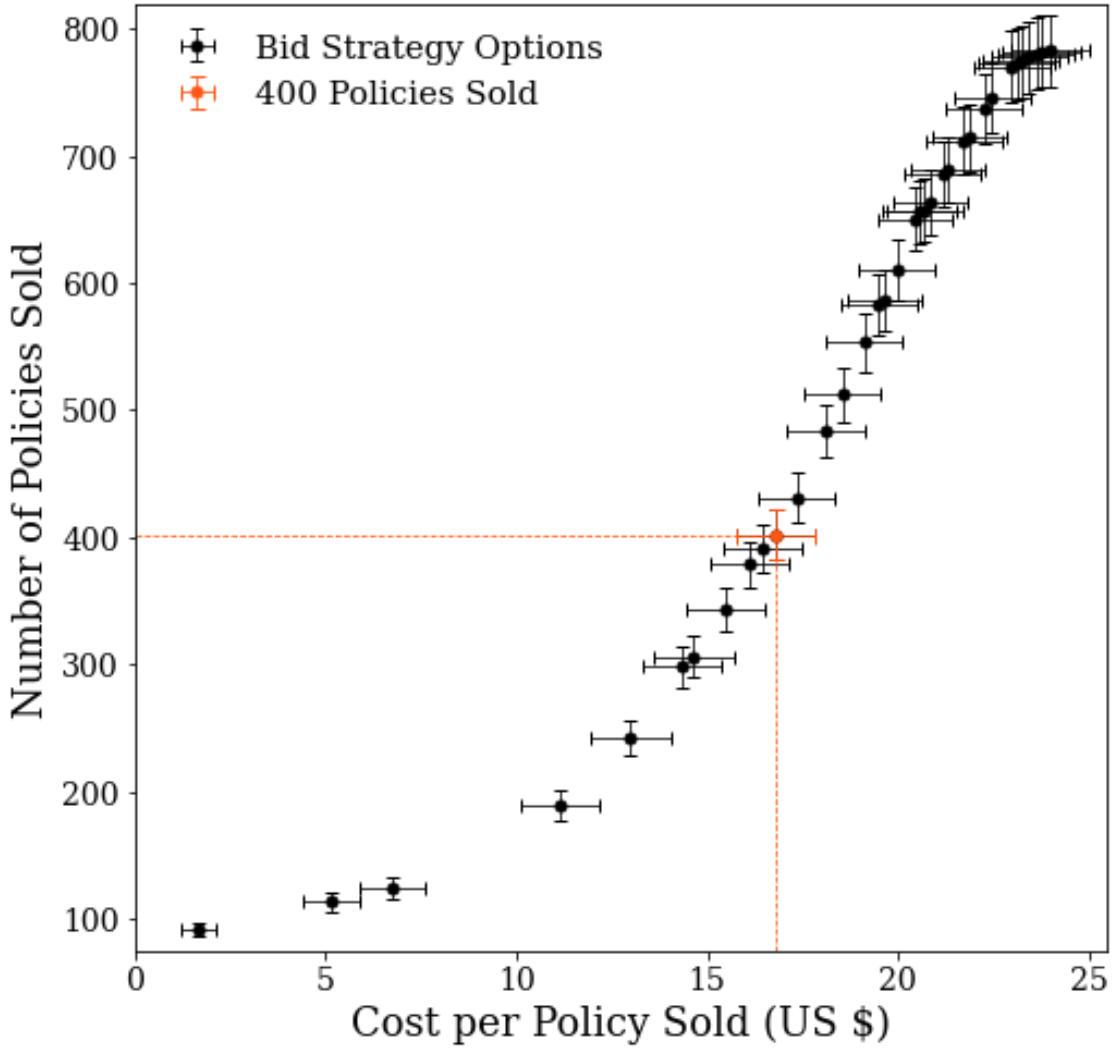


Critical Customers – Who's Buying Policies?



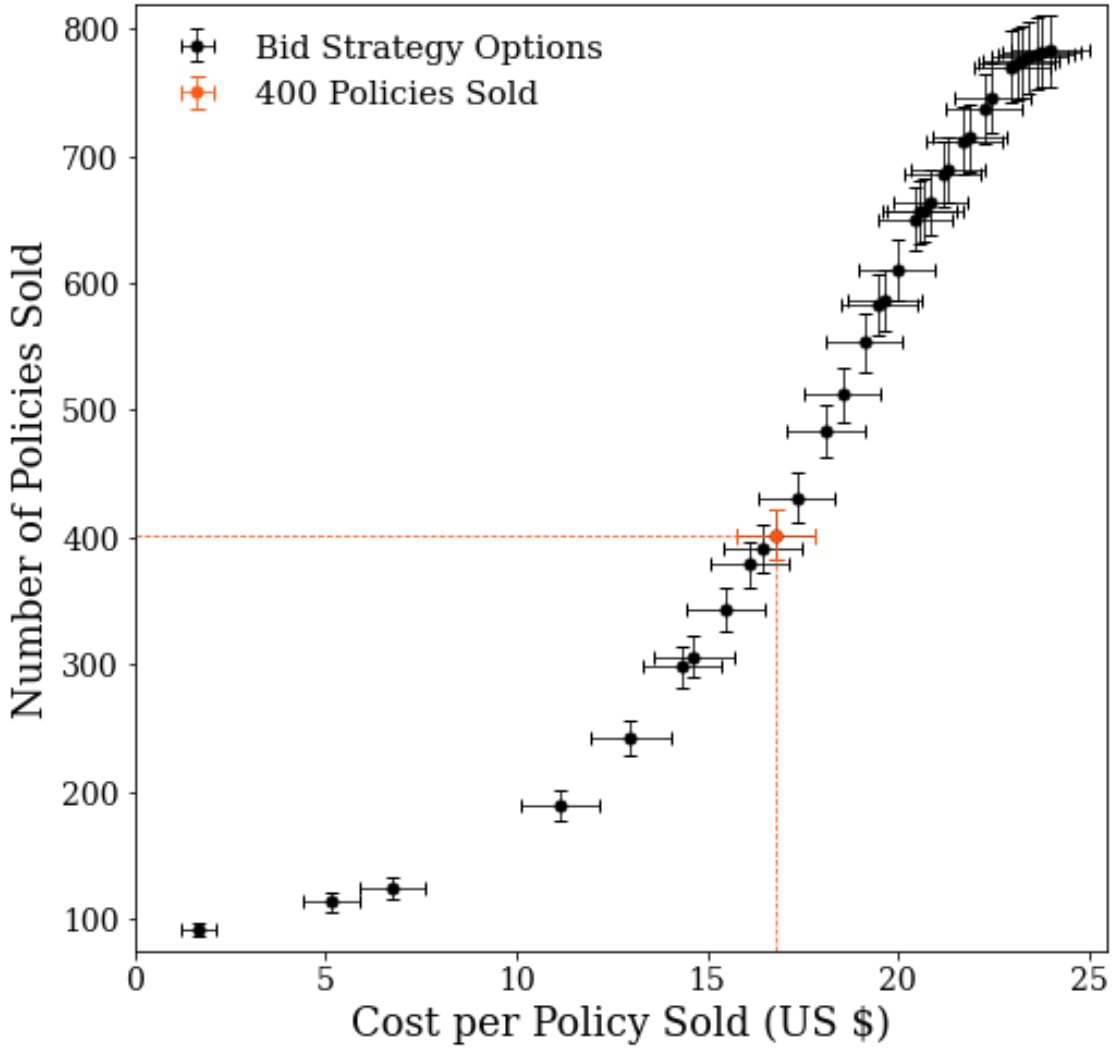
Simplest Strategy – Targeted Minimum Bids

- **Main Idea:** Save on ad costs by bidding $0.01 for customers that are unlikely to purchase a policy after clicking on an ad
- $10 bids are still submitted for customers that are likely to purchase a policy
- Cuts the cost per policy sold from $23.98 to $16.79, a savings of just under 30%



Simplest Strategy – Targeted Minimum Bids

- Only assumptions for this strategy are that customer demographics and competitor bid strategies will remain the same
- Also provides a range of options if Acme would rather aim for a different number of policies sold
- Only capable of building strategies that can sell up to about 783 policies, the total sales for a flat $10 bid strategy



Building a Variable Bidding Model

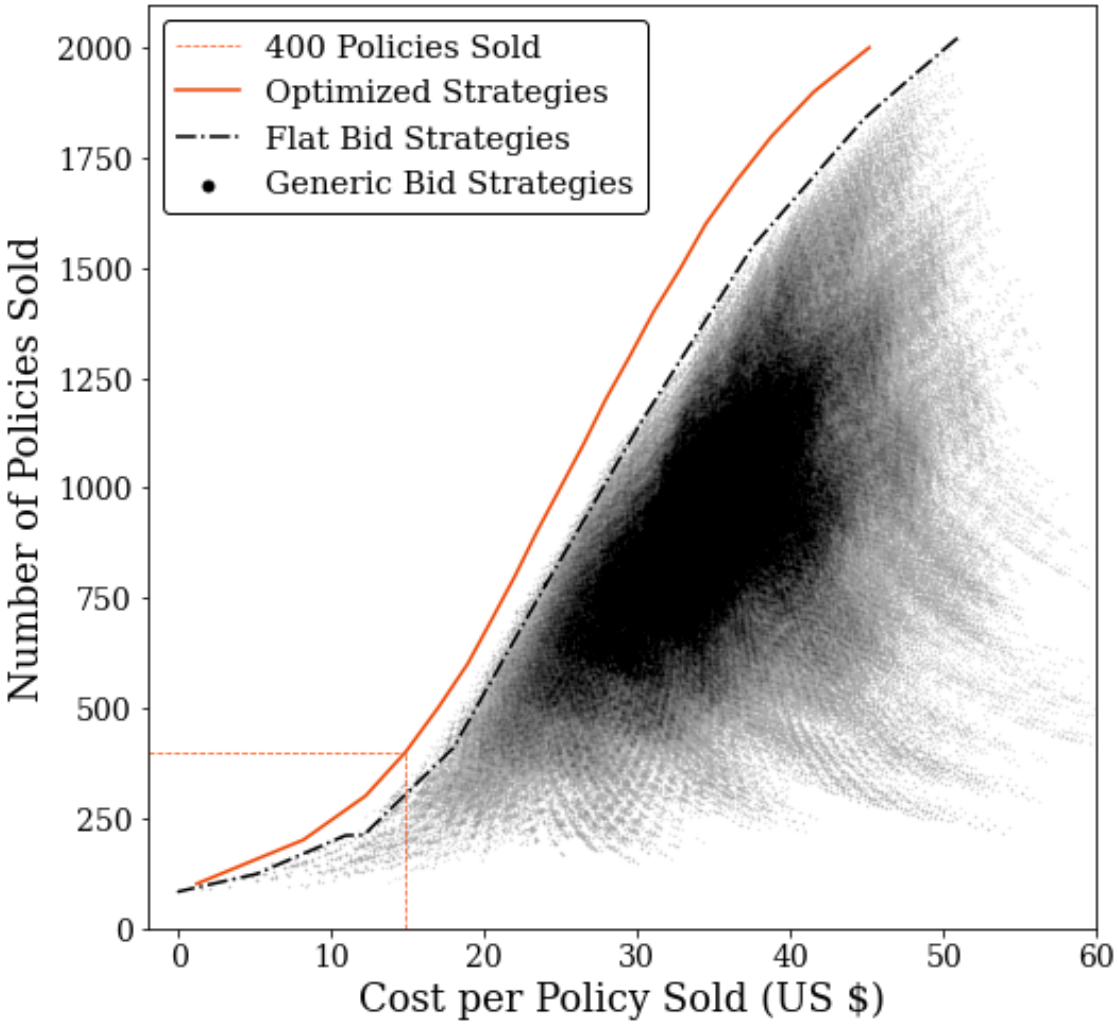
- Since Acme utilized a flat $10 bid strategy for the ads in this data set, we cannot directly estimate how changing bids will shift the expected rank
- We can, however, build a reasonable model around the assumption that increasing a bid by $2.50 would shift the expected display ranks for a given ad up one slot
- That is, if a $10 bid produced 150 rank 3 ads and 50 rank 4 ads for a given customer demographic, this model assumes that increasing the bid to $12.50 would yield 150 rank 2 ads and 50 rank 3 ads
  - And vice versa for decreasing the bid by $2.50 worsening the expected ranks
- In the real world we would talk with the marketing team to get a better estimate for the average cost to move up an ad rank, but for the purposes of this challenge $2.50 is a natural scale for the problem

Difficulties of this Approach

- There are 9 natural bid prices in this model
  - Move ads up 1, 2, 3, or 4 slots
  - Stay the same
  - Move ads down 1, 2, 3, or 4 slots
- Since there are 35 unique customer demographic combinations present in this data set, there are 9^{35} possible bid strategies to consider
- It is unfeasible to write code that can search all of these possible options on a reasonable timescale
- Need to optimize efficiently!

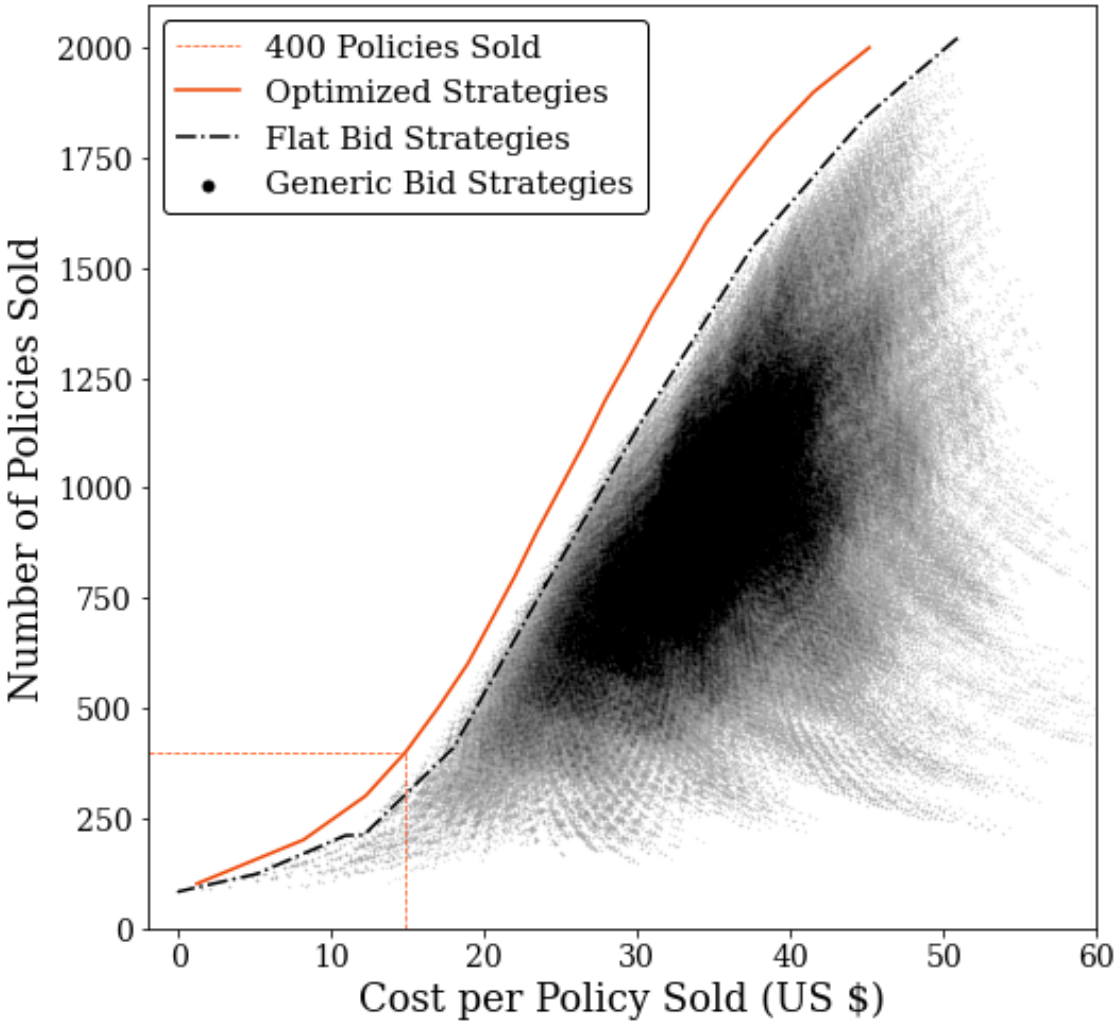
Optimizing the Variable Bid Model

- We can compress the effective size of the parameter space by combining similar features and ignoring those with minimal impact
  - 35 parameter combinations compressed to 7
- Surprisingly, flat bid strategies are close to the optimal approach
  - Easy-to-calculate starting point for optimization
- Optimized strategies can then be found using a series of random walks
  - First in the compressed parameter space, and then in the full 35 combination space



Utilizing the Variable Bid Model

- Effectiveness of this model is entirely dependent on the accuracy of our assumption that increasing a bid by $2.50 will shift an ad's expected display ranks one slot
  - Could determine this directly with intentional experimentation in future ad campaigns
- If our assumption holds, we can obtain 400 policy sales at a cost per policy of $14.85
  - 38% savings compared to flat $10 bids
  - 11% savings compared to targeted minimum bids
- Very generalizable, allowing Acme to choose strategies efficiently targeting anywhere from less than 100 to upwards of 2000 policy sales



Practical Recommendations

- If Acme Insurance's only goal for the next ad campaign is to obtain 400 policy sales as cheaply as possible, they should probably utilize our targeted minimum bid strategy
  - The uncertainty in the underpinning pricing assumption of the variable bid model makes it somewhat risky for a relatively small projected 11% savings
- If instead Acme Insurance wants to focus on achieving more sales, then using the optimized variable bid strategies becomes more compelling
  - Targeted minimum bid strategies achieve smaller and smaller savings as sales goals increase, and they are incapable of achieving sales of 800 policies or more
- In either case, it would likely be a worthwhile investment to include an experimental component in the next ad campaign to directly study how changing bid prices impact an ad's display rank