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Methods for Effective Online Testing in Real-Time Bidding

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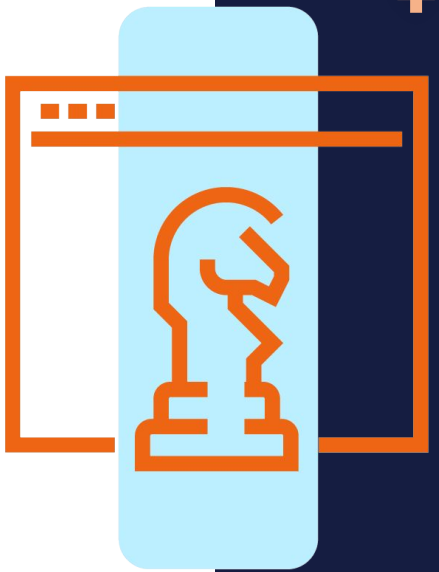
Intro

- Zemanta, an Outbrain Company
- Real-Time Bidding (RTB)
- We are one of the bidders

Zemanta™
an Outbrain Company

Online Advertising

- The past:
  - direct publisher and advertiser deals
  - paid upfront for rental like billboards
  - more expensive upfront
  - only big advertisers
  - no guarantees about users



Online Advertising

- The present:
  - use of middlemen
  - programmatic buying of ad space
  - real-time auctions
  - single placements
  - more accessible

RTB

- More auctions than stock exchanges
- Allows for targeted buying
- Basic participants:
  - Advertiser
  - Demand-side platforms (DSP)
  - Ad exchange
  - Supply-side platforms (SSP)
  - Publisher

RTB Diagram

- This process takes place on every page load
- Takes less than 100ms
- most people don't even know it exists

Image Cropping Optimization

- Provided images don't always fit
- Solution: Cropping
- Crops alter the image
- We have millions of images
- Picking the best option is subjective

Statistics to the Rescue

- Can we make it objective?
- Find the combinations that work best on average
- Leverage statistics
- Online tests come to mind

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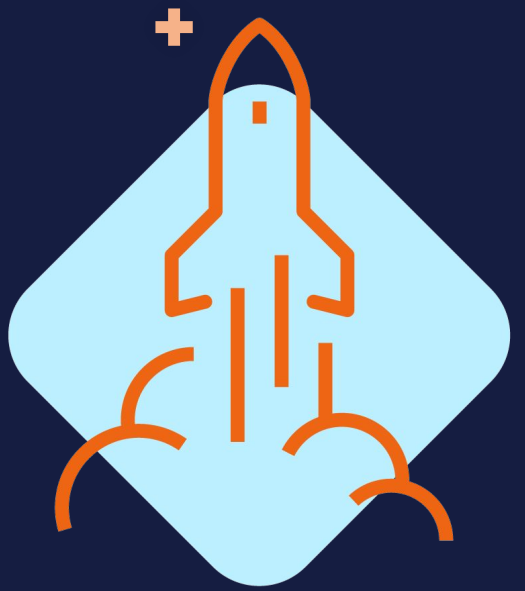
Testing

- Code testing <> online tests
  - making sure your implementations work
  - making sure your ideas work
- Code testing is important but limited
- Online tests provide a framework for gauging the performance of your features
- Test as you fly.
- Test as close to the production as possible

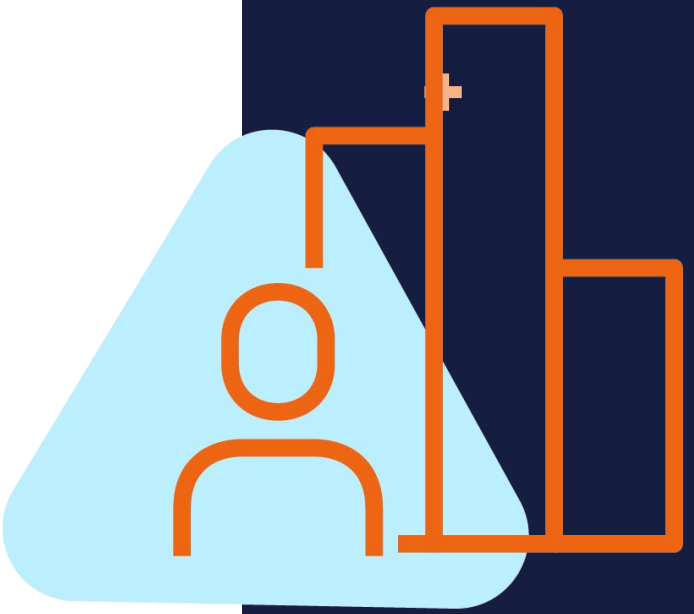


Leveraging Online Tests

- Outside factors impact performance
- Testing online in production
- Truly actionable results
- There is some due diligence before going online

Online tests

- Data hungry
- Zemanta processes 1.5+ mil requests per second
- Online tests can be cheaper than developing an elaborate simulation environment
- Data-driven decision and development
- Gaining traction in the industry



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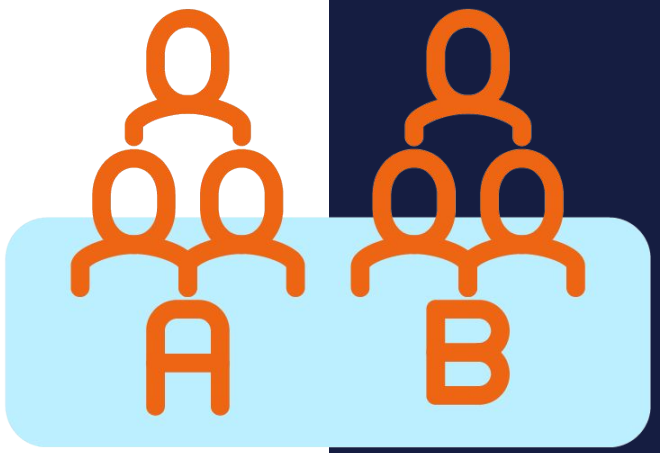
A/B Tests

- ❑ Probably the most common
- ❑ Start with a hypothesis
- ❑ Pick a KPI as statistical variable
- ❑ Calculate needed examples
- ❑ Split traffic between groups uniformly
- ❑ Analyse results with a statistical test

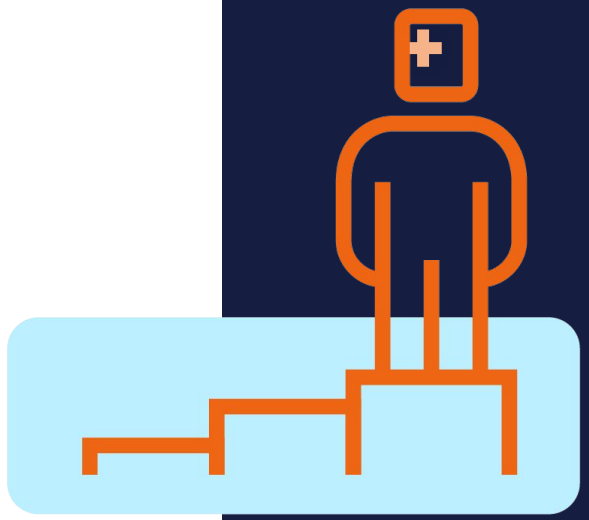


Can We A/B Test?

- Comparing similar distributions => large pool of examples
- 1.5+ Million opportunities per second
- Trying to optimize millions of images
- Hard deadlines
- Average overall business results

Multi-Armed Bandits

- Define the test as a MAB problem
- Allocation of limited resources between competing choice to maximize expected gain
- Exploit-explore tradeoff
- Different strategies



Epsilon Greedy MAB

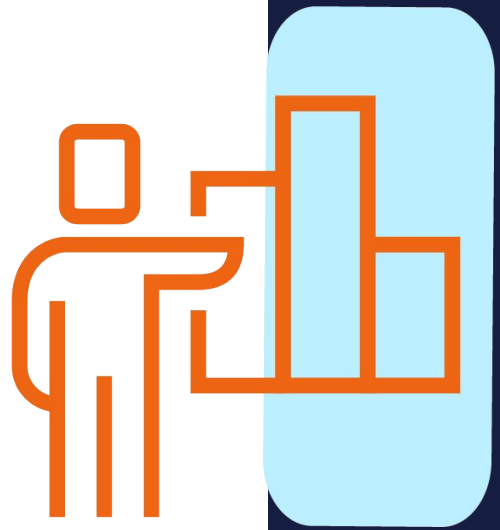
- Frequentist approach
- Separate traffic into explore and exploit
- Explore traffic uniformly distributed across bandits and measure their performance
- Apply best bandit on exploit traffic
- Reap rewards sooner
- Has some downsides

Thompson Sampling

- Bayesian approach
- Set priors for bandits and sample them
- Pick best bandit based on sampled results
- Update priors and repeat
- Can start uniformly and converge to the best bandit
- Has some downsides as well

MAB not the solution you were looking for

- ❑ We have to trust our code
- ❑ Hard to report exact lifts
- ❑ Changes in user experience
- ❑ Workarounds



Hard Constraints

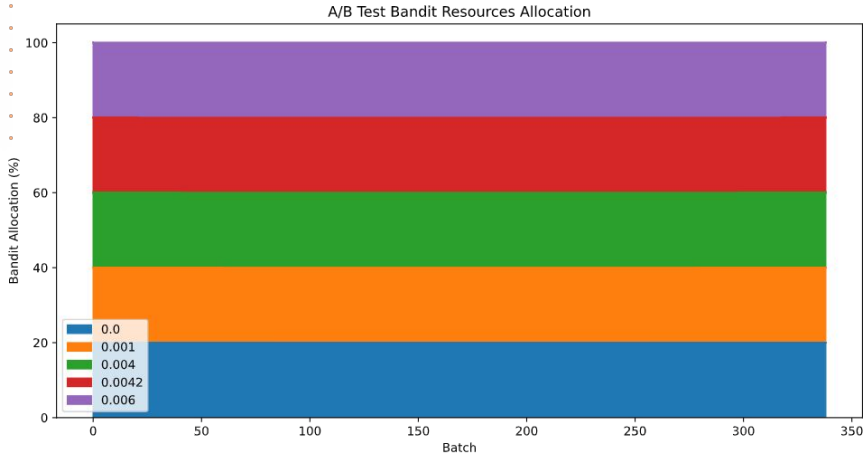
- 100 ms per request
- Sharded net of bidder nodes spread worldwide
- Central data store
- Sampling is an expensive operation

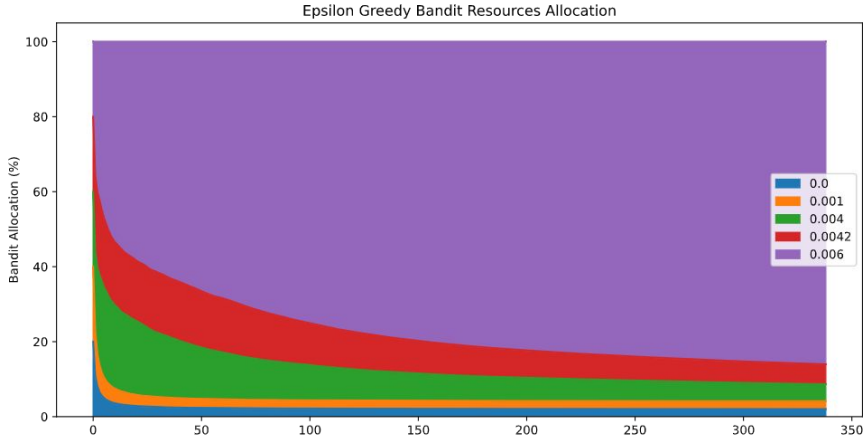
MAB Going Online

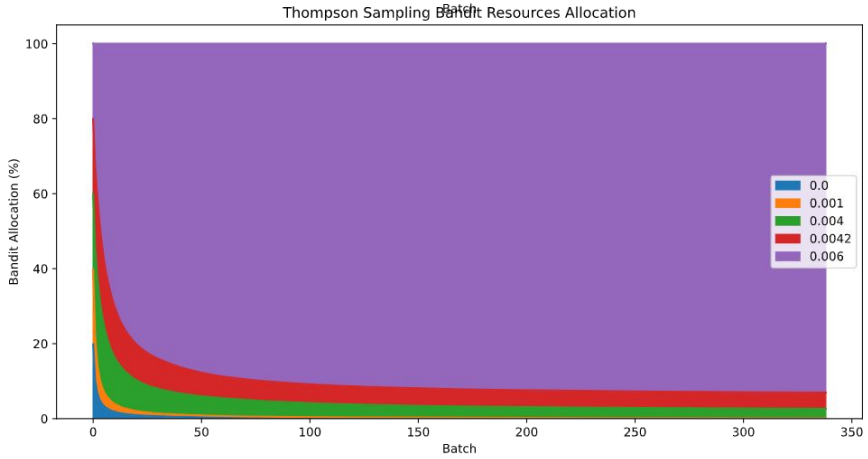
- Workaround: batching
- Periodically
  - get data and update priors
  - sample prior distributions
  - create weights for bandits
  - pull weights into bidders
- Weighted lottery while bidding

Simulations

- Simple simulation environment
- Results are based on plugged in numbers
- Code available on GitHub

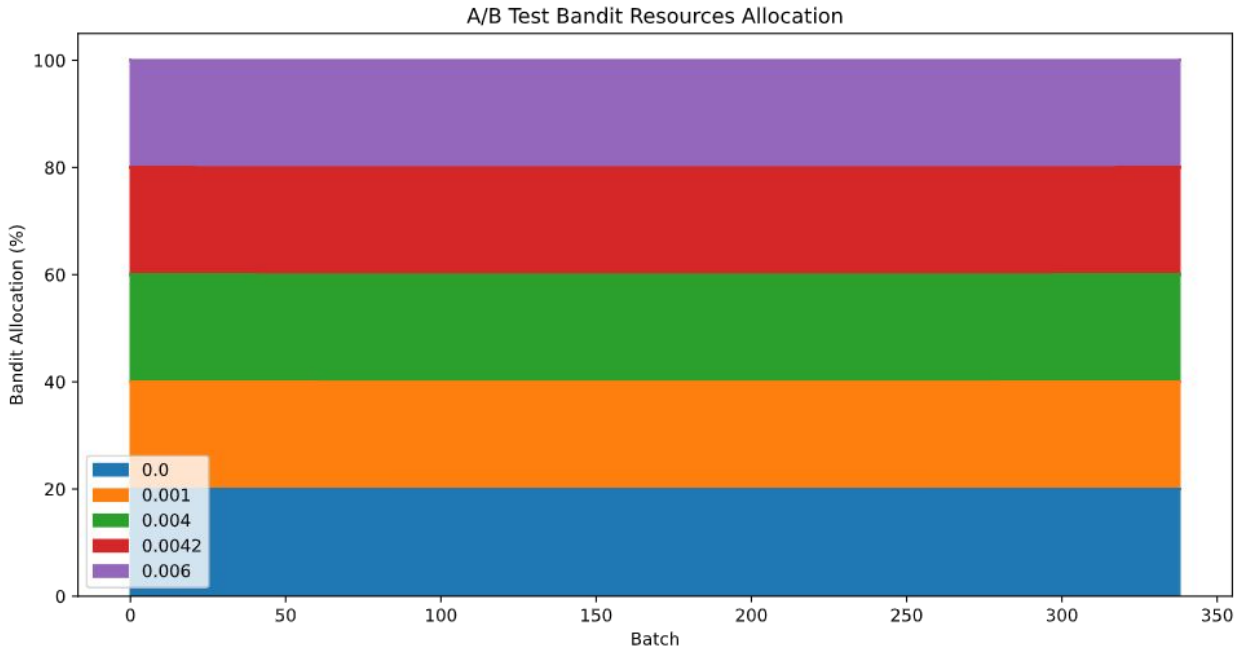






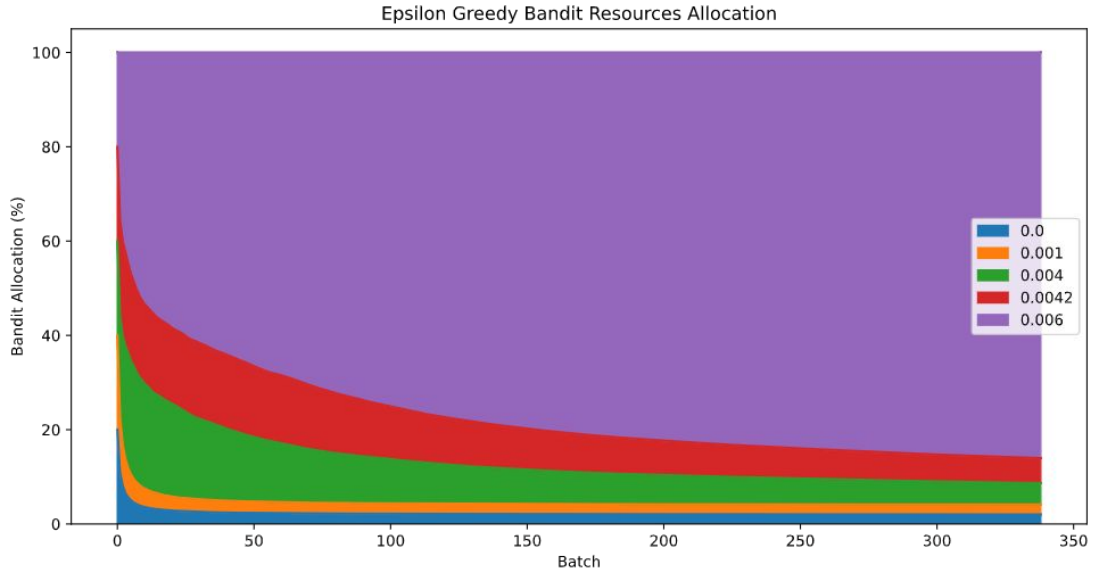
A/B Test Allocation

- Uniform allocation between bandits
- This is expected behaviour
- The plots are cumulative



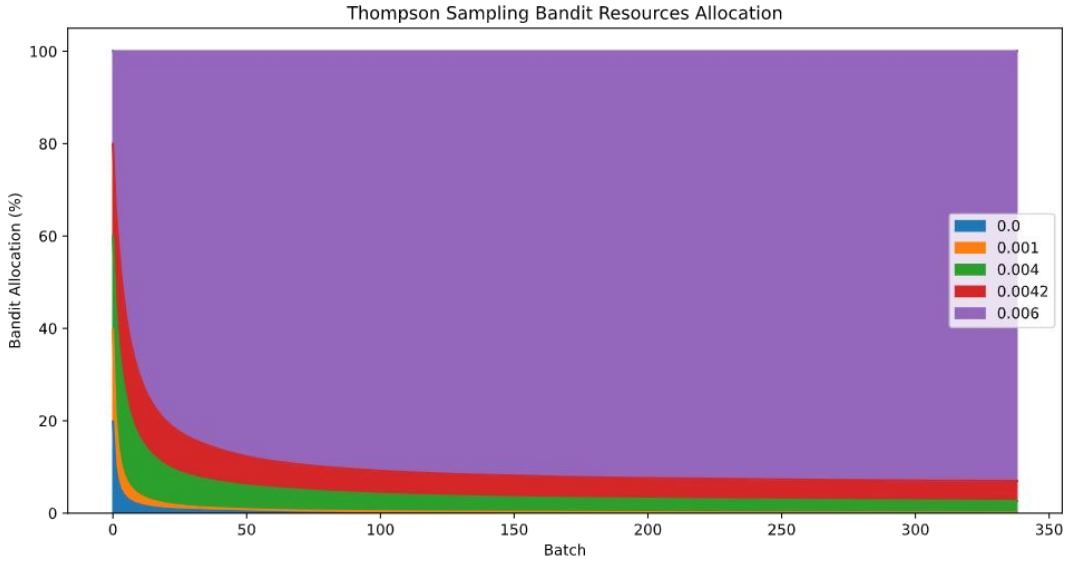
Epsilon Greedy Allocation

- The best bandit is a lot more prevalent
- Hard to decide which is best at the start
- Exploration continues till we stop the test
- There are some add-ons to the base strategy



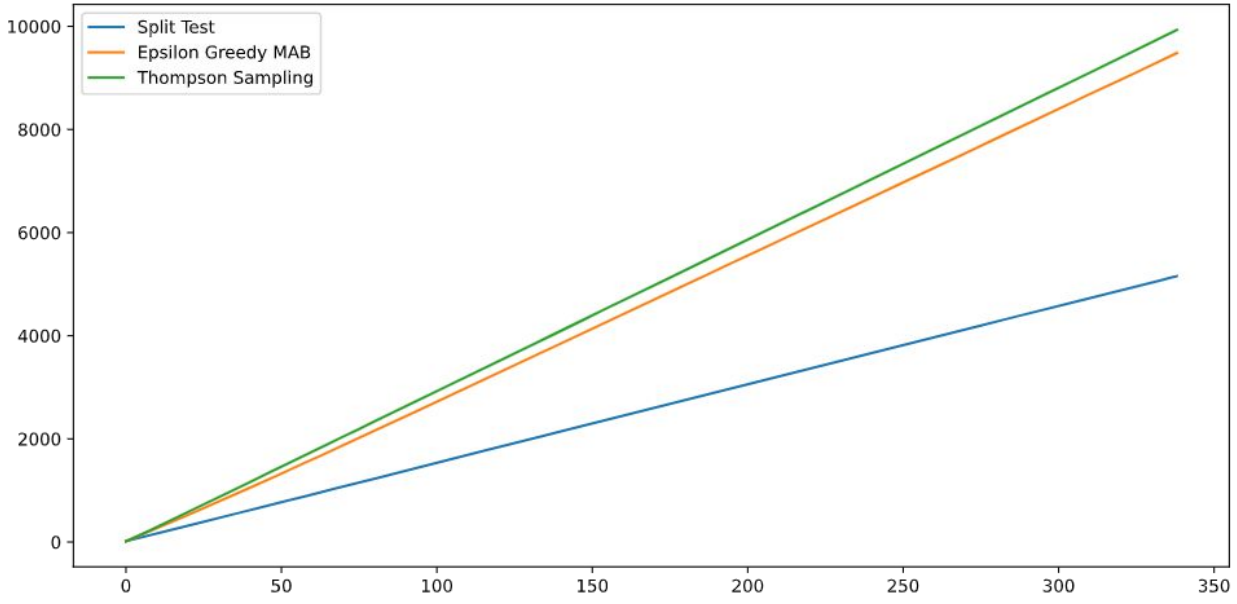
Thompson Sampling Allocation

- Best bandit is preferred again
- Bandits that aren't performing get omitted
- Somewhat better than Epsilon-greedy
- Also has some add-ons



Final Results

- Thompson sampling did perform best
- The margin between MAB methods is small
- MAB clearly outperformed A/B tests
- There are pros and cons to all methods
- You have to figure out which will work best

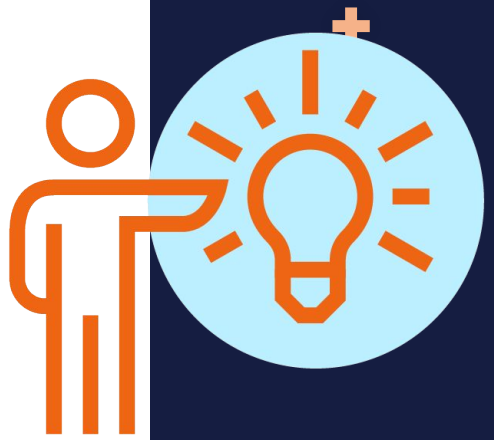


Final Optimization and Test

- Exploration and exploitation of crops is done by Thompson sampling
- The whole system gets tested in an A/B test
- We get both
  - the benefits of fast exploitation
  - knowing how well the new system works

Takeaways

- Online tests are great
- Small risks if done correctly
- There are different approaches to online testing, pick the one that suits your problem
- Scientific approach to development



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