Market Design in Display Advertising

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Growing Older, and Adjusting to the Dark

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How well do you see at night? If you’re over 50, probably not as well as you think, no matter how many carrots you eat. The typical 50-year-old driver needs twice as much light to see as well after dark as a 30-year-old. Yet few of us compensate adequately for the reduction in nighttime acuity that occurs in the aging eye.
Display Advertising

- Contracts purchased in advance
- Typically guarantee number of impressions
- Set types of eligible opportunities
  - 30-40 year old males
  - Californians on auto pages
- Supply random
- Excess sold on spot market
- Two main problems
  - Cream-skimming
  - Orphan categories
Objective Function Requirements

- Flexibility in serving
- Spot revenue
- Insuring quality of booked campaigns
- Risk of under and over delivery
- Handling orphan inventory categories
- Scarcity pricing
Objective Function

\[
\min \Phi = \gamma \left\{ \frac{1}{2} \sum_j V^j Y^j \sum_{i \in B^j} \frac{\sum_{k \in B^j} x_k x_i}{x_k} \left\{ \frac{x_i}{\sum_{k \in B^j} x_k} - \frac{y^j_i}{Y^j} \right\}^2 \right\} - \sum_i [r_i z_i] \]

\[
x_i \geq \sum_{j \mid i \in B^j} y^j_i \quad \quad Y^j = \sum_{i \in B^j} y^j_i
\]

- \( Y^j \): Requested demand for contract \( j \)
- \( B^j \): Eligible impressions for contract \( j \)
- \( x_i \): Available supply for impression \( i \)
- \( r_i \): Opportunity cost for impression \( i \)
- \( z_i \): Slack for impression \( i \)
- \( y^j_i \): Amount of impression \( i \) supply allocated to contract \( j \)
Objective Function

\[ \min \Phi = \gamma \left\{ \frac{1}{2} \sum_{j} Y^j \sum_{i \in B_j} \left( \frac{\sum_{k \in B_j} x_k}{x_i} \right) - \sum_{i} [r_i z_i] \right\} \]

\[ x_i \geq \sum_{j \mid i \in B_j} y^j_i \]

\[ Y^j = \sum_{i \in B_j} y^j_i \]

\[ y^j_i : \text{Amount of impression i supply allocated to contract j} \]

Yj: Requested demand for contract j
Bj: Eligible impressions for contract j
xi: Available supply for impression i
ri: Opportunity cost for impression i
zi: Slack for impression i
Theorem

- There is an implementation using randomized bidding into exchanges.
- Distribution of bids is uniform.
- Bidding distributions do not depend on type of inventory.
- Bidding distributions have closed forms.
- Can approximate without pricing orphaned categories!
Key Innovations

• Entire system designed to meet overall objective
• Fine-grained targeting
  – Forecasting, admission control and serving
• Integrated pricing and allocation
  – Price based on expected allocation
• Business knobs control all trade-offs

• Inventory allocation across guaranteed and spot demand
  – Unified marketplace
• User modeling

Addresses Current Problems

Forward Looking Innovations
Thank you!