The Big Picture

- Number of Internet Users
  - 2.5 Billion
- Size of Online Advertising Market
  - ~$80 Billion
Online Advertising Strategies

- **Display Advertising**
  - Text, logos, photographs, banners, etc

- **Methods**
  - Behavioral Targeting
  - Contextual Advertising
Behavioral Targeting

Figure 1: Behavioral Targeting.
Online Advertising Strategies

- Target Variables
  - Impressions
  - Click Through Ratio
  - Conversions
Conversion Optimization

- **Definition of a conversion**
  - Interaction with Advertiser web page beyond casual content view or website visit defined by the advertiser
  - Varies from advertiser to advertiser

- **Tracking**
  - Conversion Pixels
  - Javascript code embedded in the landing page
Problem Definition

- Conversions are rare events
  - Less available data
- User Profiles are highly dimensional
- Volatile
  - Cookie Churn
  - Variability in User interests
  - Temporal effects
Our Approach

- Relies on two sources of info
  - Campaign Metadata
    - Ad creative
    - Landing Page
  - Seed Users
    - users who have converted or viewed ads for the advertiser in the past
Our Approach

- Campaign Metadata allows for sharing of targeting knowledge across campaigns
  - Global Component

- Show how seed set can be used to capture the campaign-specific targeting constraints
  - Local Component

- Provide several modeling techniques for combining the two sets of information
User Representation

- Queries:
  - lady gaga
  - ipad
  - harry potter
  - angry birds

- Page Views:
  - facebook.com
  - music.yahoo.com
  - blockbuster.com
  - youtube.com

- Ad views/clicks:
  - arcade games
  - download itunes
  - overstock ipads
  - buy ipad now

Text extraction leads to User feature vector.
Campaign Metadata

- Campaign
  - Creative 1
  - Creative 2
  - Creative 3
  - other campaigns
- Seed users
  - Conversion
Modeling Techniques

- Linear-SVM

\[ \sum_{u,c} \max(0, 1 - y_{u,c} \cdot f(x_u, z_c, c)) \]

- Logistic Regression

\[ \sum_{u,c} \log(1 + \exp(-y_{u,c} \cdot f(x_u, z_c, c))) \]

- Naive Bayes
Modeling Features

- **Local**
  - Utilized all 3 of the modeling methods

- **Global**
  - Merge-based Global Model
    - Combine all users with all campaign data to learn features
    - No info about a user's interaction with a given campaign

\[
\operatorname{argmin}_{\beta_c} \sum_{u \in C} L(x_u, y_{u,c}, \beta_c) + \lambda_c \| \beta_c \|_p
\]

\[
f_c(x_u) = x' \beta
\]
Modeling Features

- Global Model
  - Interaction-based Global Model
    - Similar to merge-based but takes into account interactions

\[
\min_D \sum_{u,c} L(y_{u,c}, x_u'Dz_c + x'_u\beta) + \lambda(\lVert D \rVert_p + \lVert \beta \rVert_p)
\]

- Global + Local Models

\[
\min_D \sum_{u,c} L(y_{u,c}, X'_u Dz_c + x'_u\beta_g + x'_u\beta_c) \\
+ \lambda \lVert D \rVert_p + \lambda \lVert \beta_g \rVert_p + \sum_c \lambda_c \lVert \beta_c \rVert_p
\]
Dataset Description

- Logs covering a period of 4 weeks
- Over 300,000 Users
  - Assign binary labels to them indicating whether they converted or not
- Campaigns contain varying numbers of conversions/week
  - 10-20 per week to thousands per week
- Over 15,000 creatives
Evaluation Metric

- **Receiver Operating Characteristic (ROC)**
  - True positives vs False positives

- **Area Under Curve (AUC)**
  - Probability that audience selection method gives a high score to a random positive example than a random negative example
  - Higher AUC --> Good
Performance of Models

Figure 4: Performance comparison of SVM, Logistic and Naive-Bayes based local models.
Figure 5: Effect of the regularization constant on SVM models.
Figure 6: Performance evaluation of the local models for different number of positives (x) in the seed set. Note that for the small campaigns the maximum number of conversions is $x = 540$ in our dataset.
Performance by Campaigns

Small Campaigns

Large Campaigns
Conclusions

- Leveraged user profiles and campaign metadata to predict conversions
- Used actual data from ad network to evaluate and verify our approach
- Extendable modeling approach towards other target metrics