Predictive Analytics + Constrained Optimization = Efficient Marketing

Paul Maiste, President, Lityx
www.lityx.com | Maiste@lityx.com
March 18, 2015
INFORMS New York
Predictive modeling has become more mainstream in the last 5 years as companies add more advanced capabilities to their analytic tool sets. There has also been more talk about incorporating concepts related to optimization (constrained or unconstrained) into business decision making. There is no argument that each can be quite powerful in their own right.

In this presentation, the speaker will take it to the next level: combining predictive models, predictive optimization, and constrained optimization techniques to provide tools that allow marketers to make optimal decisions and dramatically improve efficiency.
Agenda

- Background
- Predictive Optimization Models
- Constrained Optimization
- Case Studies
  - Prospect Offer Optimization
  - Print Media Targeting Optimization
  - Retail Direct Mail Targeting Optimization
- Wrap Up
Lityx Background

- Lityx is an analytic solutions and services firm with a proprietary cloud-based predictive modeling and optimization platform LityxIQ.

- We apply deep expertise in complex analytic solutions with a focus on applications in marketing analytics and customer relationship management.
Gartner framed analytic progression as the move forward from Information to Optimization.
Analytic Progression

Gartner framed analytic progression as the move forward from Information to Optimization.

- **Descriptive Analytics**
- **Diagnostic Analytics**
- **Predictive Analytics**
- **Prescriptive Analytics**

- **What Happened?**
- **Why Did It Happen?**
- **How Can We Make It Happen?**

- **Low Complexity**
- **High Complexity**
- **Low Business Value**
- **High Business Value**

Gartner framed analytic progression as the move forward from Information to Optimization.
Generic Concept

- Separate techniques work together
- We can’t forget the executonal piece of it (scoring/implementation)
- The global problem (optimal marketing) is solved with the combination
Where does Optimization appear in this approach?

- Predictive models are naturally an optimization process (nothing new here).
- “Predictive Optimization Models” incorporate marketing tactics into the predictive model inputs.
  - Offer type
  - Offer value
  - Discounts
  - Messaging, sequencing
  - Channel
- Constrained Optimization incorporates hard constraints into the overall solution
  - Business or marketing constraints
  - Contractual constraints
  - Channel constraints
A couple of predictive optimization modeling examples
Offer Optimization

Expected Customer Profitability = FUNCTION OF
- Transaction History
- Loyalty
- Demographics
- Modeled Behaviors
- Marketing Levers
- Marketing Costs

Offer Elasticity Curves

Modeled Behaviors
- Response Rate
- Spend/Value

Marketing Levers
- Offer Type
- Offer Value

Optimal offer is Offer 1 at 21% discount
Offer Optimization and Elasticity Curves

**Customer ID 15601**
Optimal Offer: DISCOUNT, Optimal Amount: $100

**Customer ID 36415**
Optimal Offer: DISCOUNT, Optimal Amount: $75

**Customer ID 45773**
Optimal Offer: MILES, Optimal Amount: $0

**Customer ID 107925**
Optimal Offer: HOTEL CREDIT, Optimal Amount: $250
### Last Two Months Activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Not targeted in last two months</th>
<th>Targeted two months ago</th>
<th>Targeted last month</th>
<th>Targeted both of last two months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not targeted in last two months ago</td>
<td>0.905</td>
<td>0.629</td>
<td>0.528</td>
<td>0.489</td>
</tr>
<tr>
<td>Targeted two months ago</td>
<td>0.796</td>
<td>0.644</td>
<td>0.593</td>
<td>0.480</td>
</tr>
<tr>
<td>Targeted last month</td>
<td>0.606</td>
<td>0.564</td>
<td>0.469</td>
<td>0.402</td>
</tr>
<tr>
<td>Targeted both of last two months ago</td>
<td>0.361</td>
<td>0.543</td>
<td>0.515</td>
<td>0.390</td>
</tr>
</tbody>
</table>

- **Cells show average observed response rates**
- **More “Freshness”**
- **Note:** Gray = low sample size

---

We can incorporate cadence into our predictive optimization model.

Recency and frequency can be categorized in a number of different ways.
What about constraints?
Constraints make the overall problem harder to solve, and (even worse) give a less than globally optimal solution.

But we need to account for them.

Number and complexity of constraints determine the solution approach.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Constraints</th>
<th>Solution</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1 (total budget)</td>
<td>Rank order all</td>
<td>Overall marketing budget</td>
</tr>
<tr>
<td>1 (channel)</td>
<td>1 (total budget)</td>
<td>Rank order by dim</td>
<td>Marketing budget by channel</td>
</tr>
<tr>
<td>1 (channel)</td>
<td>2 (channel budget)</td>
<td>Rank order by dim</td>
<td>Channel max spend and min spend</td>
</tr>
<tr>
<td>2+</td>
<td>2+</td>
<td>Harder! Need tools</td>
<td>Channel max spend with product min performance + more</td>
</tr>
</tbody>
</table>
In our offer optimization example, if there was a policy to never offer more than $100, we would not realize global optimality.
Case Study 1

Prospect Offer Optimization
We want to maximize
• Expected profitability OR
• Response rate OR
• Expected revenue

We have predictive optimization models that predict
• Spend by prospect
• Response rate by prospect

Constraints
• Limits on total amount of offers
• Limits on freebies (e.g., hotel rooms capacity constraints)
• Experimental testing and cross-decile sampling
• Segment level marketing plan
## Data View

<table>
<thead>
<tr>
<th>Geog</th>
<th>HotelOffer</th>
<th>Id</th>
<th>ResponseScore</th>
<th>ValueScore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>101073</td>
<td>0.03</td>
<td>80.11</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>102564</td>
<td>0.03</td>
<td>116.48</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>103982</td>
<td>0.02</td>
<td>201.97</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857611</td>
<td>0.02</td>
<td>232.05</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857614</td>
<td>0.02</td>
<td>201.97</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857615</td>
<td>0.06</td>
<td>223.82</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857616</td>
<td>0.09</td>
<td>96.20</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857619</td>
<td>0.03</td>
<td>472.58</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857620</td>
<td>0.03</td>
<td>233.81</td>
</tr>
<tr>
<td>Middle</td>
<td>HOTEL_ANYDAY1</td>
<td>1857622</td>
<td>0.14</td>
<td>116.46</td>
</tr>
<tr>
<td>Middle</td>
<td>HOTEL_ANYDAY1</td>
<td>1857641</td>
<td>0.11</td>
<td>191.20</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857643</td>
<td>0.02</td>
<td>304.97</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857645</td>
<td>0.11</td>
<td>4.87</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857649</td>
<td>0.03</td>
<td>255.83</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857650</td>
<td>0.06</td>
<td>353.81</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857652</td>
<td>0.07</td>
<td>217.39</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857653</td>
<td>0.02</td>
<td>100.92</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857655</td>
<td>0.03</td>
<td>255.83</td>
</tr>
<tr>
<td>Outer</td>
<td>HOTEL_ANYDAY1</td>
<td>1857660</td>
<td>0.03</td>
<td>215.81</td>
</tr>
</tbody>
</table>
Outputs

Number to Contact by Offer

Budget by Offer
For this industry, prospects are placed into an offer matrix for marketing execution.

<table>
<thead>
<tr>
<th>Predicted Value</th>
<th>High Offer Value</th>
<th>Low Offer Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Offer 1</td>
<td>Offer 2</td>
</tr>
<tr>
<td>Predicted Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$75</td>
<td>3506</td>
<td>3962</td>
</tr>
<tr>
<td>$75-299</td>
<td>5556</td>
<td>4572</td>
</tr>
<tr>
<td>$300-749</td>
<td>1642</td>
<td>384</td>
</tr>
<tr>
<td>$750+</td>
<td>475</td>
<td>12</td>
</tr>
</tbody>
</table>
Print Media Targeting Optimization
(Cadence)
Print Media Targeting Problem

- **Multiple Channels**
  - Newspaper inserts
  - Shared mail (multiple programs)

- **Many choices**
  - 30,000+ zip codes
  - 60,000+ targeting zones

- **Many constraints**

- **Predictive optimization models** predict zip-level response rate given prior history, cadence, demographics

- **Decision**
  - On a monthly basis, how do we best allocate our fixed budget? (i.e., what zips/zones should be targeted)
It's a complex process

Dynamic Data (Processed Monthly)
- Zip/zone targeting history (cadence)
- Historical response rates
- Census and Geodemographic data at Zip level

Static Models (updated approx yearly)
- Predictive Model of Newspaper Zone Response Rates
- Predictive Model of Shared Mail Zone Response Rates

Scoring
- Aggregation of program/zip level actual historical response rates
- Prediction of Response Rates at Zone Level

Final Optimization Result
- Ranked Zone List - Ordered by Decreasing Expected CPO

Mathematical Optimization Model

Somewhat Static Data (yearly)
- Media Data
  - Zip/zone maps
  - CPM
  - Circulation
- Business Rules and Constraints
  - Minimum insert restrictions
  - Fixed setup costs
  - Target/Do not target rules
- Marketing constraints
  - Cross-channel budget min/max percent
  - Max papers
  - Restricted papers
The constraint list covers a wide variety of metrics, dimensions, and business rules.

Without these accounted for, the problem could not be solved to the satisfaction of the business.
Outputs
Case Study 3

Retail Direct Mail Targeting Optimization
Maximize overall response rate

Each prospect has a predictive model score based on:

- Demographics (age, income, education)
- Location (distance, drivetime to closest store)
- Appended behaviors (credit card usage, internet usage)

Constraints

- Meet store minimum quantity needs
- Cross-decile testing and metrics
- Prior times targeted
  - Cadence is (currently) controlled in this case study through constraints – not incorporated yet into a modeling paradigm.
Outputs

Mail Qty by Decile

Mail Qty by Prior Times Targeted

Mail Qty by Store Location
Implementing modeling and constraints has helped generate incremental sales consistently since the program began mid-July 2014.
Future Objectives

➢ Incorporate predictive optimization modeling
  • Cadence / prior contacts
  • Direct mail package/message
    o What is optimal way to communicate with each prospect?
Putting it all together raises overall complexity

But the reward can be significant
  - Improve key business metrics
  - Ease of marketing execution

Tools can help
Questions

Paul Maiste
maiste@lityx.com
www.lityx.com