WHAT IS UPLIFT MODELING?

INTRODUCTION

Refinance your mortgage now
Lower your rate

Donald W. McCormack
Austin, TX

Loan Number Ending in:

Dear Donald W. McCormack,

As a responsible homeowner, you meet the preliminary criteria to refinance to a new, low-rate mortgage from Chase that may save you money. You can even use your refinance to consolidate higher interest credit cards and loans.

Here's an estimate of how much you could lower your rate if you refinance your mortgage balance with Chase.* But note, rates change daily—call now to get the lowest available rate.

<table>
<thead>
<tr>
<th>Your current rate</th>
<th>Estimated new rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.500% (3.580% APR)</td>
</tr>
</tbody>
</table>

APR shown is estimated as of 04/29/13 and may vary as rates change daily. This APR includes the borrower paying approximately 1 point at closing, which is generally 1% of the loan amount (ask us about other rates and point options). See reverse side for important program information.

Stop by your local branch, or call 1-866-744-3521, or visit us at chase.com/RefiWithChase. But remember, you do need to act now because rates change daily.
What is Uplift Modeling?

**INTRODUCTION**

1. Collect data on possible target recipients
2. Apply treatment to target population
3. Find $X$ that optimizes $P(Y = 1)$ or $\hat{Y}$

But does this predict treatment success?

What about those who respond in the absence of the treatment?

And those who don’t respond because of the treatment?
WHAT IS UPLIFT MODELING?

INTRODUCTION

How much more likely am I to respond in the presence of a treatment?

Responds to treatment

<table>
<thead>
<tr>
<th>Yes</th>
<th>Sure Thing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Persuadable</td>
</tr>
</tbody>
</table>

Responds without treatment

<table>
<thead>
<tr>
<th>Yes</th>
<th>Do Not Disturb</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>Lost Cause</td>
</tr>
</tbody>
</table>

Siegel, E. (2013)
WHAT IS UPLIFT MODELING?  INTRODUCTION

Randomized, phase III trial of panitumumab with infusional fluorouracil, leucovorin, and oxaliplatin (FOLFOX4) versus FOLFOX4 alone as first-line treatment in patients with previously untreated metastatic colorectal cancer: the PRIME study.


Centre René Gauducheau, Nantes, France. jy-douillard@nantes.fnclcc.fr

Abstract

PURPOSE: Panitumumab, a fully human anti-epidermal growth factor receptor (EGFR) monoclonal antibody that improves progression-free survival (PFS), is approved as monotherapy for patients with chemotherapy-refractory metastatic colorectal cancer (mCRC). The Panitumumab Randomized Trial in Combination With Chemotherapy for Metastatic Colorectal Cancer to Determine Efficacy (PRIME) was designed to evaluate the efficacy and safety of panitumumab plus infusional fluorouracil, leucovorin, and oxaliplatin (FOLFOX4) versus FOLFOX4 alone as initial treatment for mCRC.

PATIENTS AND METHODS: In this multicenter, phase III trial, patients with no prior chemotherapy for mCRC, Eastern Cooperative Oncology Group performance status of 0 to 2, and available tissue for biomarker testing were randomly assigned 1:1 to receive panitumumab-FOLFOX4 versus FOLFOX4. The primary end point was PFS; overall survival (OS) was a secondary end point. Results were prospectively analyzed on an intent-to-treat basis by tumor KRAS status.

RESULTS: KRAS results were available for 93% of the 1,183 patients randomly assigned. In the wild-type (WT) KRAS stratum, panitumumab-FOLFOX4 significantly improved PFS compared with FOLFOX4 (median PFS, 9.6 vs 6.0 months, respectively; hazard ratio [HR], 0.60; 95% CI, 0.66 to 0.97; P = .02). A nonsignificant increase in OS was also observed for panitumumab-FOLFOX4 versus FOLFOX4 (median OS, 23.9 vs 19.9 months, respectively; HR, 0.83; 95% CI, 0.67 to 1.02; P = .072). In the mutant KRAS stratum, PFS was significantly reduced in the panitumumab-FOLFOX4 arm versus the FOLFOX4 arm (HR, 1.23; 95% CI, 1.04 to 1.42; P = .02), and median OS was 15.5 months versus 19.3 months, respectively (HR, 1.24; 95% CI, 0.98 to 1.57; P = .066). Adverse event rates were generally comparable across arms with the exception of toxicities known to be associated with anti-EGFR therapy.

CONCLUSION: This study demonstrated that panitumumab-FOLFOX4 was well tolerated and significantly improved PFS in patients with WT KRAS tumors and underscores the importance of KRAS testing for patients with mCRC.
WHAT IS UPLIFT MODELING?

• Uplift modeling attempts to:
  • Determine the conditions associated with those most affected by the treatment.
  • Quantify the incremental benefit of applying a treatment over not applying a treatment.
  • Identify the proportion of the target population for which a treatment is profitable.
• AKA: incremental response modeling, net lift modeling, true lift modeling, differential value modeling, impact modeling.
• Related to: Structural Mean Models and Differential Prediction.
WHAT IS UPLIFT MODELING?

WHERE IT CAN BE USED

• Marketing & Advertising
  • Cross-sell (Fries with that burger?) and Up-sell (Super-size that?)
  • Retention
  • Content (Blue background or white?) and channel selection (e-mail or phone call?)
• Personalized Medicine
• Other
  • Risk
  • Voter targeting
WHAT IS UPLIFT MODELING?

HOW IS IT DIFFERENT?

• Typical predictive models

\[ P(Y = 1|X,T = 1) \quad \text{OR} \quad f(Y|X,T = 1) \]

• Uplift models

\[ P(Y = 1|X,T = 1) - P(Y = 1|X,T = 0) \quad \text{OR} \quad f(Y|X,T = 1) - f(Y|X,T = 0) \]

\[ f(Y|g(X,T)), \text{ e.g., } E(Y = \tilde{\beta}X + \phi T + \tilde{\phi}XT) \]
WHAT IS UPLIFT MODELING?

Collect data on possible target recipients

Treatment

\[ f(Y|X, T = 1) \]

Control

\[ f(Y|X, T = 0) \]

\[ f(Y|X, T = 1) - f(Y|X, T = 0) \]
WHAT IS UPLIFT MODELING?

HOW IS IT IMPLEMENTED?

- Trees (Radcliffe & Surry)
- Logistic Regression (Lo)
- Naïve Bayes (Larsen)
- Neural Networks (Lo)
- Inductive Logic Programming (ILP - Nassif)
WHAT IS UPLIFT MODELING?

HOW IS IT IMPLEMENTED?

- Commercial Software
  - Portrait Uplift (Pitney Bowes)
  - Enterprise Miner 7.1, JMP Pro 11 (SAS)
  - InfiniteInsight (KXEN)
- Freeware
  - Aleph (ILP)
  - R (SimpleNet)
WHAT IS UPLIFT MODELING?

CHALLENGES

• Model implementation – One or two?
• Variable Selection
• Splitting and pruning criteria (trees)
• Multilevel treatments
• Multiplicative models
• Treatment – Marketing promotion incentive mailed to 4500 customers
• Response – Purchase made in promotional period (1/0), sales ($)
• Predictors – 32 measuring a number of customer characteristics such as tenure, incentive club membership level, online ordering history, etc.
WHAT IS UPLIFT MODELING?

EXAMPLE

- Two model logistic regression approach used.
- Sixteen variables selected based on net information value.

\[
NWOE_i = \log \left( \frac{P_T(X = x_i \mid Y = 1) P_C(X = x_i \mid Y = 0)}{P_C(X = x_i \mid Y = 1) P_T(X = x_i \mid Y = 0)} \right)
\]

\[
NIV = \sum_i \left[ P_T(X = x_i \mid Y = 1) P_C(X = x_i \mid Y = 0) - P_C(X = x_i \mid Y = 1) P_T(X = x_i \mid Y = 0) \right] NWOE_i
\]
WHAT IS UPLIFT MODELING?

EXAMPLE
WHAT IS UPLIFT MODELING?

EXAMPLE

*Table:*

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Avg Incremental Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$52.10</td>
</tr>
<tr>
<td>20</td>
<td>$17.19</td>
</tr>
<tr>
<td>30</td>
<td>$14.58</td>
</tr>
<tr>
<td>40</td>
<td>$11.41</td>
</tr>
<tr>
<td>50</td>
<td>$8.09</td>
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<tr>
<td>60</td>
<td>$4.23</td>
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<tr>
<td>70</td>
<td>$0.67</td>
</tr>
<tr>
<td>80</td>
<td>($3.08)</td>
</tr>
<tr>
<td>90</td>
<td>($6.46)</td>
</tr>
<tr>
<td>100</td>
<td>($30.40)</td>
</tr>
</tbody>
</table>
**WHAT IS UPLIFT MODELING?**

**REFERENCES**

- Siegel, E. (2013). Persuasion by the Number (Chapter 7 in Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die). John Wiley & Sons, Hoboken, NJ.
WHAT IS UPLIFT MODELING?

ACKNOWLEDGEMENTS

• Victor Lo (Fidelity)