Leveraging Big Data More Effectively for Better Informed Predictions and Insights

Since its first travel and hospitality assignment for United Airlines in 1930, Booz Allen Hamilton, a leading strategy and technology consulting firm, has completed hundreds of successful engagements for clients in the travel and hospitality industry. We provide deep functional knowledge spanning strategy, organization, marketing, operations technology, and analytics. Our Decision Analytics Center of Excellence employs data science, modeling and simulation, operations research, and quantitative analysis to deliver data-driven solutions that improve performance, optimize flows, and help stakeholders understand what and when events are likely to occur.

Booz Allen combines technical excellence with a core understanding of the travel and hospitality industry to solve problems in:

+ Big Data Mining and Data Architecture
+ Competitive Analysis and Wargaming
+ Customer Analytics and Marketing
+ Demand Modeling and Forecasting
+ Legislative and Regulatory Analysis
+ Loyalty Program Analytics
+ Performance Benchmarking
+ Pricing and Revenue Management
+ Promotional Campaign Design
+ Resource Optimization
+ Risk Modeling
+ Technology Deployment and Evaluation

Booz Allen helps organizations solve these industry-specific challenges using data science processes, tools, and techniques—transforming complex data into insights, and ultimately actions. Data science supports and encourages shifting between deductive, hypothesis-based reasoning and inductive, pattern-based reasoning.

A fundamental change from traditional analysis approaches, data science allows organizations to build capabilities over time, tackling increasingly complex analytic goals, while achieving success on the path to data science maturity.

Key Benefits of Data Science

Research suggests that even simple algorithms applied to complete datasets are more useful than complex algorithms applied to samples and extracts. Booz Allen is driving the paradigm shift toward cloud-enabled data science by providing a cloud “insight-engine,” built on simple turnkey solutions applied to full datasets.

Booz Allen’s Data Analytics capabilities provide a framework to collect and optimize large datasets, baseline and improve performance, understand how and why unique events occur, and simulate the impact of changes. Potential benefits and applications in the travel and hospitality industry include:

+ Design and deployment of optimal promotional campaigns
  - Given a desired objective, what are the optimal promotional attributes? (e.g., how do we better sustain our top tier customers?)
  - Measure impact of campaigns more accurately (e.g., how do different incentives, marketing, and media contribute to performance)?
  - Given a promotion, which loyalty members will be most influenced?

+ Development of customer-level understanding and “predictive personalization”
  - Which customers have the greatest and least potential for upsell or ancillary spend?
  - Define new customer segments (clusters) based on behavior (e.g., response to marketing), not merely demographics
  - Inform precise marketing/media decisions (e.g., digital marketing and direct mail) and large-scale marketing/media decisions (based on bottom-up aggregation) to drive more profitable advertising
  - Employ pattern recognition to identify guests who book stays together, to inform proactive marketing for group travel

+ Identification of key drivers for revenue management and oversell opportunities
  - How can individual property booking curves be built into the revenue management system?
  - What is an individual customer’s likelihood of a booking cancellation or no-show?

+ Identification of facility planning needs for construction/acquisition/sale of properties
  - What is the ROI of a property facelift/refurbishment? How much incremental revenue will be generated?
  - Given location attributes, where will a new property be most successful?
  - Identify features (combinations thereof) of properties that will yield the greatest increase in revenue per available room (RevPAR)?
Case Study: Evaluating Promotional Campaign Effectiveness with Probabilistic Analysis

Hotels, airlines, travel agencies and their marketing agencies typically use traditional statistical approaches to attribute revenues to a specific promotion or advertising campaign. Traditionally, return on investment (ROI) is calculated by constructing a linear regression model to conduct top-down comparisons of the aggregated behavior of hotel guests who received the promotion with another control group of customers who did not. Under these circumstances, the traditional method of linear modeling is likely to under- or overestimate the ROI of promotional campaigns because of differences in churn rate between the treatment and control groups. In addition, for some public promotions, no control groups are available because the campaigns are global (all guests are treated).

**OUR CHALLENGE**

A leading hotel chain engaged Booz Allen to develop a model that accurately captures the many dimensions that drive customer decisions and consequently predict individual impacts driven by promotional campaign offers. Booz Allen developed a probabilistic Bayesian Network model to estimating the aggregated ROI of individual campaigns. In particular, the Bayesian model can be used to learn individual attributes of guests that drive their personal incremental revenue. This presents a robust alternative to the traditional approach of comparing a treatment cohort to a control cohort. Using comprehensive data science tools and tradecraft, our team of experts developed a model that is more accurate in calculating true promotional ROI, even in the absence of a control group.

The probabilistic promotional analysis that Booz Allen implemented with its client is an industry-first in an area that is fervently discussed across the travel and hospitality sector. All of the machine learning and data science capabilities that we developed are software- and platform-agnostic, so they can be readily tailored for specific client needs that may include mining historical data, developing predictive models, and forecasting uncertain outcomes.

**OUR APPROACH**

Employing a number of machine-learning techniques, millions of records from multiple, disparate data sets were analyzed. These datasets included a detailed transaction history for each hotel guest for years prior to, during, and after the promotion, hotel property attributes such as location, brand, and occupancy rate, as well as specific promotional attributes. In order to calculate individualized returns, Booz Allen focused on three key elements:

1. **Initial Data Mining**
   - What insights about tendencies in guest behaviors can be mined from joining the multiple, disparate datasets?

2. **Prediction of Probability Registration**
   - Who in the control group would be likely to have registered for the promotion if offered?
   - What is the probability that they would do so?

3. **Prediction of Customer Behavior**
   - How would a hotel guest in the treatment group have responded if not offered the promotion? How would a hotel guest in the control group have responded if offered the promotion?

The Booz Allen team constructed Bayesian Belief Networks and employed batch inference to isolate the impact of the promotional offer on driving expected incremental nights for individual participants, simulating how they would behave with and without promotion. Expected incremental nights were summed across all participants with positive return to find the total impact of the campaign on qualifying nights during the promotion. Finally, the traditional approach was replicated using a linear model to determine expected number of nights due to promotion. Incremental nights were monetized using each individual guest’s median room rate, using his or her stay history.
Over the course of this engagement, Booz Allen employed a suite of analytics and visualization tools to provide a customized data science offering for our client. By combining cutting-edge big data technology, advanced statistical and probabilistic techniques, and our travel and hospitality market expertise, we were able to implement solutions to explore the data, develop predictive probabilistic models, and visualize the powerful results therein.

**OUR RESULTS**

Booz Allen’s probabilistic approach was found to estimate promotional ROI—without the use of a control group—to within 15 percent of estimates that leverage control groups. The inclusion of a control group in the promotional design carries a significant opportunity cost, typically up to 50 percent of the promotion’s overall ROI. The bottom-up approach enables ROI estimation for hypothetical customers (or promotional attributes) for which no complete look-alikes exist. Using the Bayesian approach enables:

- Accurate campaign ROI assessment without the need to include costly control groups
- Optimal campaigns design given the ability to estimate the promotional attributes that are likely to drive the greatest incremental spend in a hypothetical deployment
- Efficient audience selection given the model’s individualized estimates, reducing the risk of marketing “spam” that prompts costly unsubscriptions

**Driving Innovation**

For clients that seek a thought partner in tackling their toughest challenges, Booz Allen is proud of its cadre of highly regarded functional specialists and travel and hospitality industry experts. With a rich history of advising the most senior leaders in industry and government, Booz Allen has the resources and experience to meet those needs.

Combining the firm’s unparalleled experience in cloud computing, big data analytics, and machine learning with its established travel and hospitality expertise is our unique value proposition. Our broad experience with clients across the commercial and government space enables Booz Allen to bring the most highly skilled and knowledgeable staff in the industry to any client engagement to solve the tough problems faced in today’s challenging environment. See our ideas in action at boozallen.com/data-science.

---

Booz Allen employs Bayesian Belief Networks to identify relationships between factors and conduct probabilistic “what-if” analysis for nearly limitless scenarios.

The probabilistic bottom-up approach enables ROI estimation for each and every customer, facilitating optimized campaign design and audience selection.

**About Booz Allen**

Booz Allen Hamilton has been at the forefront of strategy and technology consulting for 100 years. Today, the firm provides services primarily to the US government in defense, intelligence, and civil markets, and to major corporations and not-for-profit organizations. Booz Allen helps clients achieve success today and address future needs by applying functional expertise spanning consulting, analytics, mission operations, technology, systems development, cybersecurity, engineering, and innovation to design, develop, and implement solutions.

Booz Allen is headquartered in McLean, Virginia, employs more than 22,000 people, and had revenue of $5.48 billion for the 12 months ended March 31, 2014. In 2014, Booz Allen celebrates its 100th anniversary year. To learn more, visit www.boozallen.com. (NYSE: BAH)

**For more information contact**

<table>
<thead>
<tr>
<th>Alex Cosmas</th>
<th>Cenk Tunasar, PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief Scientist</td>
<td>Principal</td>
</tr>
<tr>
<td><a href="mailto:cosmas_alex@bah.com">cosmas_alex@bah.com</a></td>
<td><a href="mailto:tunasar_cenk@bah.com">tunasar_cenk@bah.com</a></td>
</tr>
<tr>
<td>617-428-4472</td>
<td>703-377-7961</td>
</tr>
</tbody>
</table>