Grocery pricing and forecasting

Machine learning with a human touch

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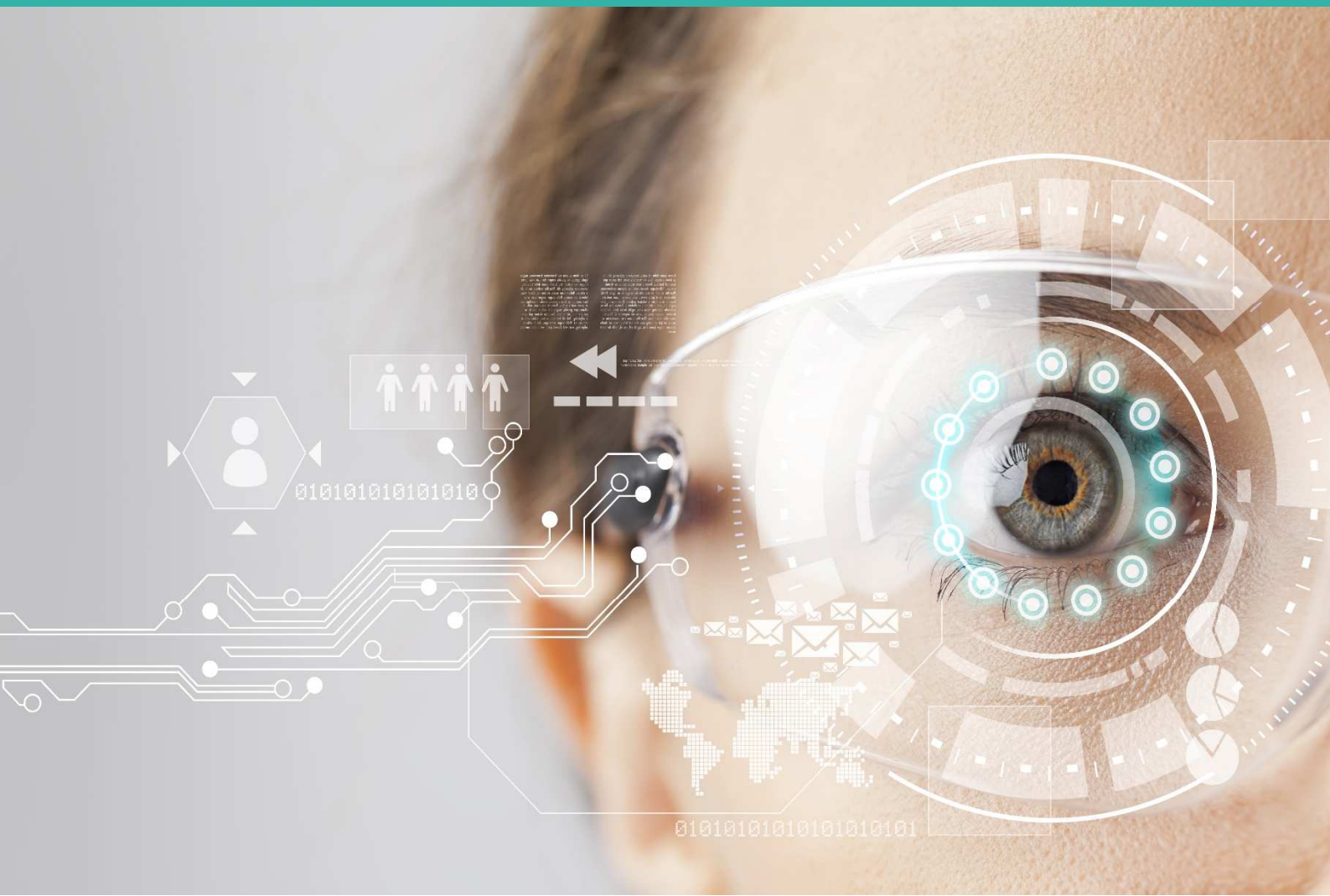
evo PRICING



Five simple but profitable grocery retail questions

1. At the end of each season, month or week, do you often observe a large gap between expected and actual demand?
2. Are your price points entirely grounded on client insight and business objectives, or rather tactically based on costs, competition and previous seasons?
3. Do you invest significantly in promotions and temporary price reductions to clear excess inventory?
4. Are your sales forecasts leaving substantial margin value on the table?
5. Last, but not least – can you accurately measure the answers to these questions in a way that can systematically guide your future trading decisions?

A new alliance between big data and human intuition

Few industries are as brutal as retail: hyper-competitive, multi-channel markets; complex global sourcing; wide ranges with strong links across products, categories and competitors; high sales volatility with strong macro and micro seasonality.

In this context, managers are called to place bets a whole season, or perhaps months in advance. Promotions and markdowns – double-edged swords – can help reduce waste and clear excess stock, but at a cost: reduced profits, and increased complexity of demand and impact monitoring.

In any case, at the end of the year, most of the margin is earned – or lost – depending on the gap between expected and actual demand. To keep abreast of markets changing faster and faster, new approaches are required to achieve the maximum potential impact on profitability.

Today, the latest generation of big data algorithms is capable of simultaneously optimising prices and assortment, growing profits and reducing unsold inventory.

Thanks to new methods of data analysis informed by human intuition, the traditional grocery retail challenge can finally be solved: the right amount of product in stock at the right time and price in every store.

This white paper looks at the ways retailers can improve forecast accuracy and price / promotion decisions. Fixing each of these areas can produce powerful standalone results but, when managed together, the synergy is unstoppable.

Machine learning: like a Sat Nav, but for managers

New, revolutionary algorithms allow computers to learn from data even without pre-set, hard-coded rules, automating processes and dramatically improving forecast and pricing accuracy: up to 90 percent reduction in stock-outs and wasted inventory, and 5 percentage points growth in margins or even more (for example, net margins increasing from 15 to 21 percent of revenues).

But what exactly powers this new approach? A simple recipe: big data, human intuition and lots of applied mathematics. Historical sales, weather and geographical locations, but also web and social presence are used by data scientists to create more accurate sales forecasts, serving the manager much like a Sat Nav aides the driver.

Unlike traditional software, new methods based on big data are able to collect, analyse and manage hundreds of parameters at a much more granular level than previously possible in Excel, establishing the effects of each parameter on each SKU (product) for every store on a daily basis. However, only select few retailers, today, are able to leverage data to build successful models, simulations and forecasts.

Machine learning respects logistical constraints, such as supplier delivery times and minimum or maximum quantity per order, reducing extra administrative work for stores and headquarters. These solutions integrate and feed into existing planning systems in a more flexible way and are therefore faster to implement.

There is no requirement for special investments on new resources, rather freeing time for other more value-adding activities. Machine learning solutions rapidly adapt to the specific objectives of management, such as maximising margins, market share, reducing unsold stock, or simultaneously optimising a mix of KPIs.

Machine learning in action: a practical example

The logic behind machine learning can successfully be applied to grocery retail processes such as pricing and replenishment management. This practical example starts with a replenishment use case, then expands to pricing/promotions.

Let us consider a particular product in a given store and week: for example, “1 ripe avocado”, shop "Oxford Street", week of September 28.

In Figure 1, the X-axis shows the store inventory, in number of pieces; the bar chart (left Y axis) represents the probability of selling the X-th piece, for example the third if X = 3; and the line chart (right Y axis) shows the expected number of pieces sold in total, at different levels of inventory.

Intuitively, the more avocados in stock, the lower the probability of selling them all: in this example, it is almost certain that the first avocado will be sold, but already a little less likely for the second, and in turn even less so for the third etc.

However, with a larger inventory the expected sales grow, albeit with an ever-smaller increase as the maximum sales potential is reached, in this case of ~7 pieces. Each additional piece in stock adds some probability of selling more, but clearly there is a trade-off.

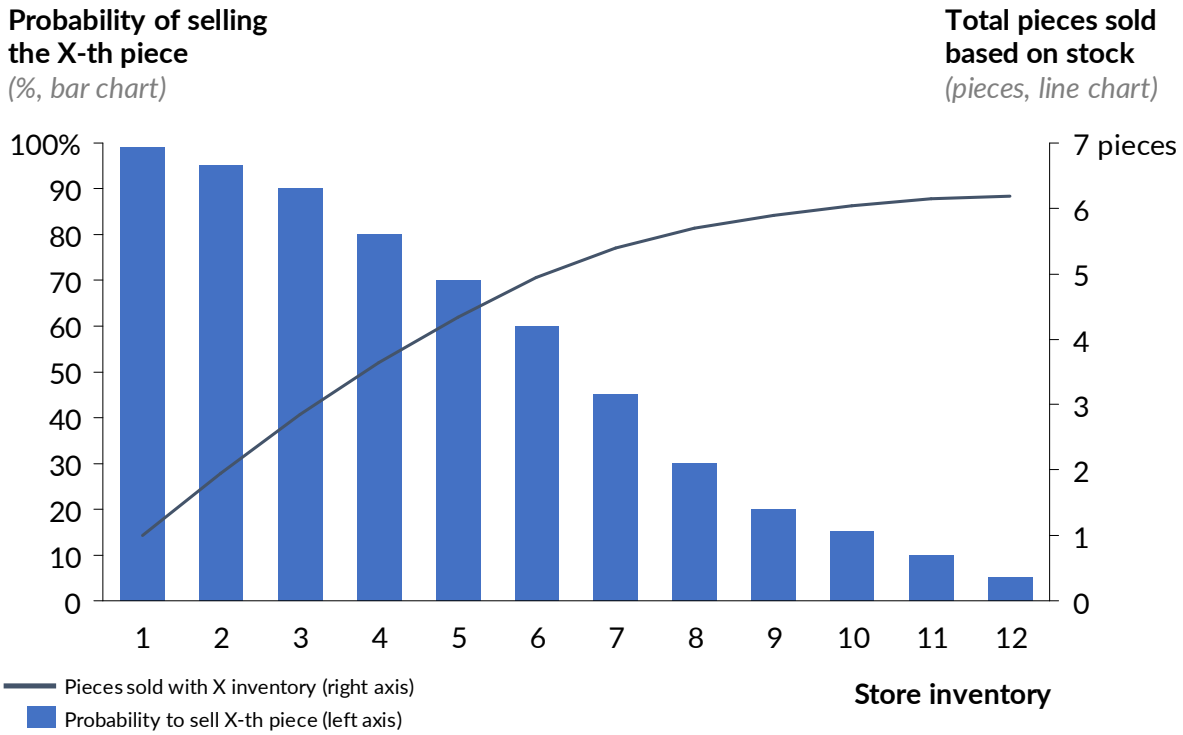


Figure 1: Sales forecast based on store inventory

Armed with these data, the machine learning automatically calculates the expected value of revenues and costs at each level of stock, taking into account potential losses from stock-outs and unsold inventory, and the extra discounts that may be needed to clear it.

Figure 2: Optimal inventory level to maximise expected profits

Figure 2 shows how the algorithm identified the optimum inventory level of 7 pieces for this store, assuming a list price of £0.95 per avocado, an average "baseline"

discount of 5%, and a cost of £0.35 per piece – in the (common) case of choosing to maximise profits, rather than for example market share or margins net of cost of unsold. These would lead to different solutions, but based on the same approach.

And what if a customer wanted to purchase the eight avocado? The store would lose revenues, because the product would be sold out. Therefore, the algorithm assesses the likelihood that customers will choose to substitute this with other similar products, e.g. other fruits or vegetables; but also, as we will see in the next section, the sales-prices link: for example, considering what would happen increasing the selling price (or reducing the discounts), or doing so just when, for example, the first 4 or 6 pieces are sold in that store.

The main benefit of these new machine learning-based systems is that they are fully based on the customer's perspective, rather than solely on historical sales, or costs, or competition: for example, exploiting the entire potential of those "invisible" sales that are missing from the historical data-set due to stock-outs.

Customers reveal, through their observed behaviour, all their own complex assessments, and these can be “surveyed” by retail management in real time using automated systems, just like a car driver can use a navigation system connected to the Internet to assess real-time traffic and optimise driving decisions accordingly.

Prices and promotions: the leverage to grow sales and profits

Prices, and even more so promotions, are the lifeblood of grocery retailing.

It is easy to see promotions as a negative – but when they are managed in combination with effective price targets, and clear messaging, they may contribute to both higher volumes and profits, while strengthening the proposition to the customer.

Unfortunately, most of the promotions are less deliberate than they could – planned poorly, executed without enthusiasm, and not systematically evaluated or adequately measured in terms of impact. As a result, an astonishing 59% of grocery promotions destroy shareholder value, i.e. losing margin through the combination of the cost of price reduction (and communication) and the loss of opportunity of greater profit.

A structured approach to pricing and promotions can however be based on a systematic understanding of how these factors influence demand: if a price reduction generated significant sales and margin growth, then this might be implemented together with larger product shipments (and/or correspondingly higher planned volumes); but if a price increase did not affect significantly the demand for a specific product, then it would likely lead to greater profits.

Figure 3 shows the impact of increasing the average discount from 5% (Figure 1), up to 15%: higher probability of selling more pieces. The larger impact is at 6-9 pieces of stock, i.e. where expected sales started to "approach potential" in Figure 1.

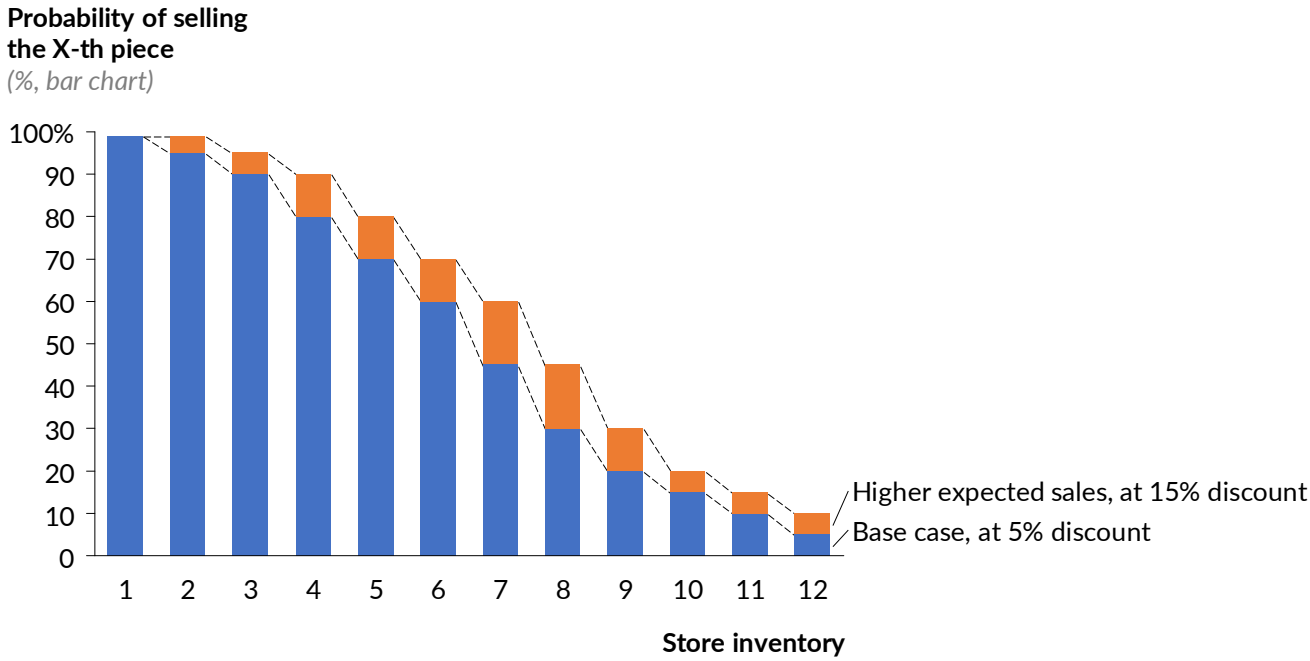


Figure 3: Impact of higher discount on sales

However, this impact is not uniform across inventory levels: traditional elasticity-based analysis fails to deliver value for grocery retailers, even when used correctly!

The crucial question is: what happens to profits with the higher discount?

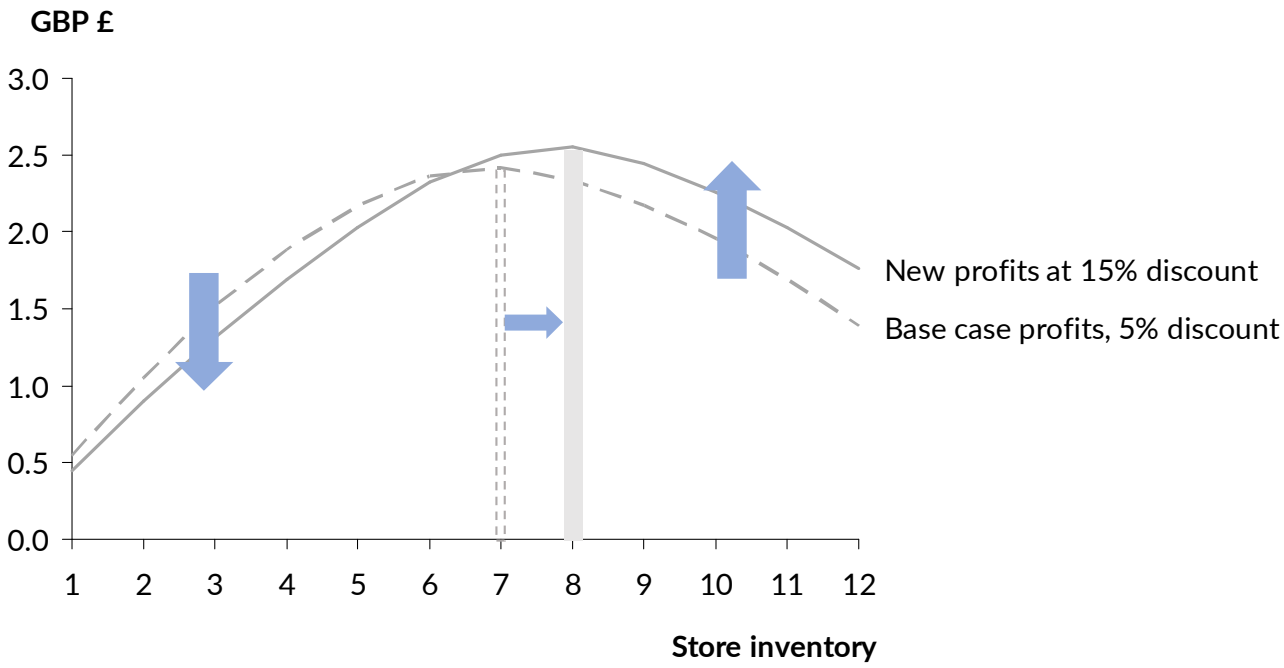


Figure 4: Impact of higher discount on profits

Figure 4 shows some typical impacts.

- The higher discount enables more sales, and therefore the optimum inventory level grows from 7 to 8 pieces
- At low levels of stock (up to ~6 pieces), the promotion destroys value: for this reason, the promotional strategy should always be firmly anchored in an integrated planning, distribution, logistics and replenishment process
- Finally, the optimal profits are now higher than at the lower discount.

When factoring in the "cost of not selling", it is sometimes desirable to discount selectively, but in a smart and targeted manner.

Human intuition as the "soul" of machine learning: case study

For decades, grocery retailers have extrapolated future demand from historical sales, underestimating their forecasts – for example due to the impact of stock outs; therefore failing to fully capture the potential, unmet demand.

New tools accurately predict how each factor influences demand, so they can simultaneously optimise pricing and range, based on the trade-off between the risk of stock-outs and the cost of unsold goods.

Despite the significant progress in the automated analysis methods, human intuition – within an appropriately structured process – continues to play an important role. "Offline" can still "beat online", and the human manager can still "drive" better than the machine alone, at least certainly in the world of grocery.

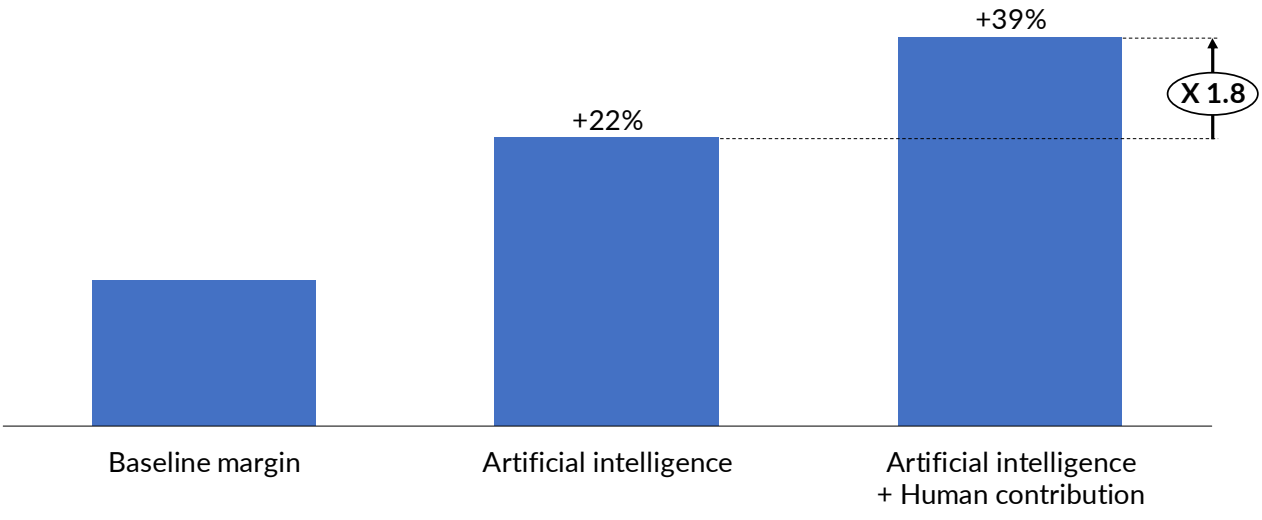


Figure 5: Margin benefit (case study, grocery category leader)

Figure 5 summarises the results of a case study on a UK grocery category leader; Evo Pricing supported a 22% margin increase, a benefit increased even further – more than 1.8 times – thanks to the Human contribution of management.

About Evo Pricing

Our exciting formula: Success = Data x Artificial Intelligence x Human intuition.

Our world-class, but also simple to use, predictive tools help our clients achieve extraordinary results and sustain them over time, with weekly updates and monthly in-depth reviews on top of a distinctive “unlimited support” delivery model.

Our story starts in 2009, when our founder Fabrizio Fantini, while jointly pursuing his Pricing PhD and Harvard MBA, discovered new algorithms that could outperform even the most complex and expensive commercial pricing systems.

On top of analytical excellence, we deliver a distinctive business model: value creation crucially also depends on the people side of the equation, as our founder learnt in his 10 years consulting for global CEOs at McKinsey. Therefore, our algorithms build on human intuition, instead of aiming to replace it.

And so, our unique Evo Pricing approach was born.

Software powered by artificial intelligence, developed in partnership with the very best academics globally, building a new man/machine alliance on top of proven machine learning successes.

Today we have 2 offices (London, Turin) and 120 man-years experience across engineers, data scientists, academics and business experts who all share a common goal: better management decisions, every day.

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Further reading:

1. http://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/the-age-of-analytics-competing-in-a-data-driven-world
2. http://www.hbs.edu/faculty/Publication%20Files/kris%20Analytics%20for%20an%20Online%20Retailer_6ef5f3e6-48e7-4923-a2d4-607d3a3d943c.pdf
3. https://hbr.org/2016/05/where-predictive-analytics-is-having-the-biggest-impact