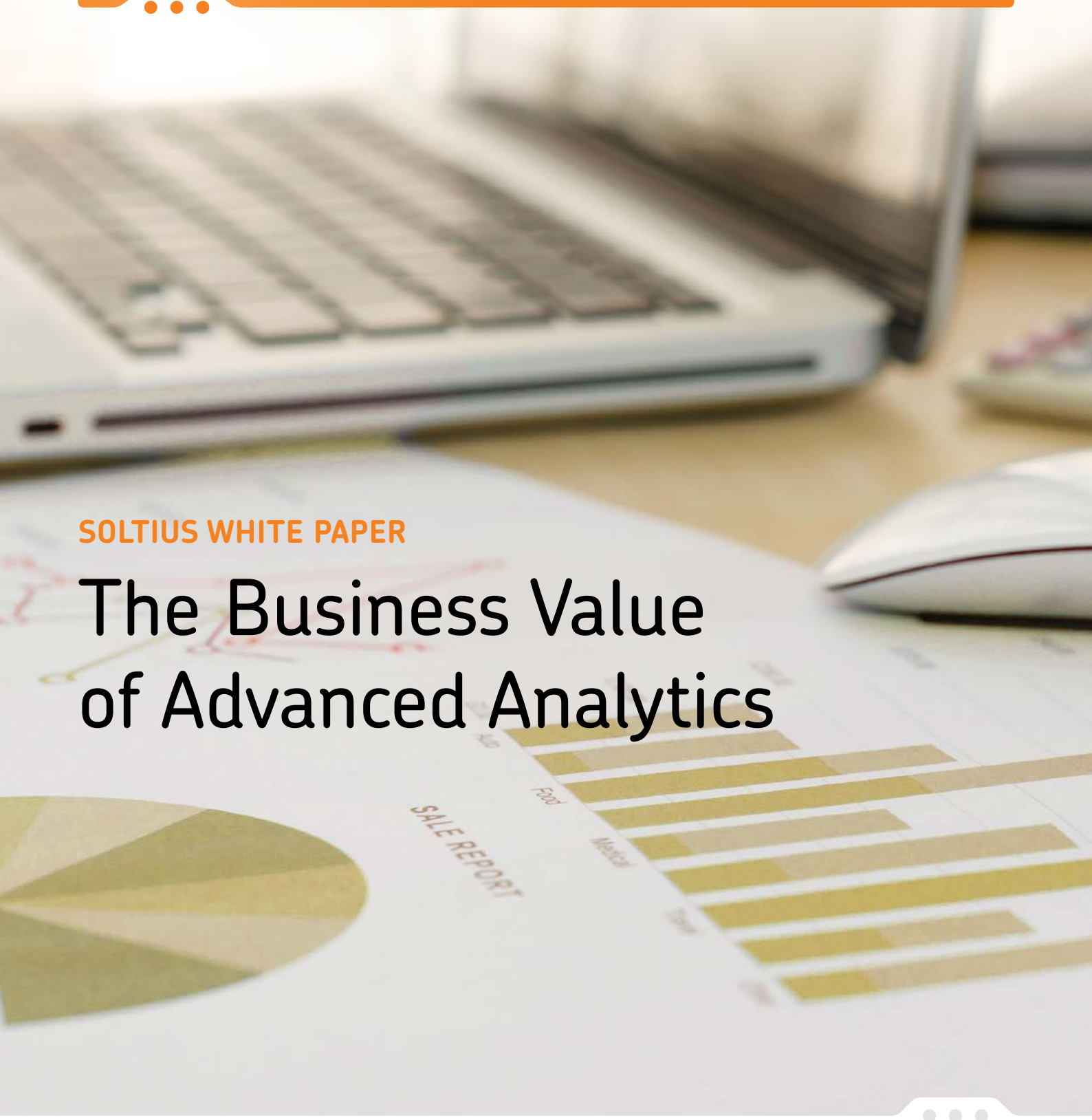
SAP ANALYTICS

ADVANCED ANALYTICS



SOLTIUS WHITE PAPER

The Business Value of Advanced Analytics

SAP Gold Partner

NEW ZEALAND'S MOST TRUSTED SAP PROVIDER

soltius

SAP ANALYTICS

ADVANCED ANALYTICS

There is no doubt that modern businesses are complex beasts. As the world continues to progress and evolve, doing business well is only going to become more complicated. In this white paper, Dr Andrew Peterson, Principal Data Scientist at Soltius, presents a business case for advanced analytics. He examines cognitive biases commonly seen in business and details the role that advanced analytics can play in overcoming them.

Cognitive biases, which affect us all, have been studied extensively for decades by psychologists and behavioural economists such as the late Amos Tversky and Nobel laureate Daniel Kahneman. These biases, and importantly, the simplifying heuristics that drive them, usually serve us well because they help us cope effectively with the complexities of every-day life. However they evolved during a time when people lived much simpler lives.

In today's fast-paced and highly complex world, these heuristics and biases can be profoundly counterproductive. This is particularly true when we need to make complex decisions that require evaluating many different criteria at one time, which is often the case for even routine business decisions. In essence, these biases are a manifestation of the limited ability of the human brain to access and process information. Curiously, they are much easier to spot in others than in ourselves – a tendency which is itself a cognitive bias known as the blind spot bias.

In today's fast-paced and highly complex world, these heuristics and biases can be profoundly counterproductive.

One important effect of our simplifying heuristics and cognitive biases is that they can seriously limit our ability to make objective and rational decisions in today's increasingly complex business environment. Advanced analytics provides one of the most powerful collections of tools and methodologies available today, that can help us maintain objectivity when it is needed most. In achieving this, advanced analytics serves two important functions:

- First, it helps us minimise the influence of our cognitive biases by translating important parts of the decision-making process into the objective language of mathematics (where mathematics is understood to be objective in a practical sense, if not a philosophical one).
- Second, it provides an efficient and effective framework for understanding and reducing complexity.

EXAMPLES OF COMPLEXITY IN BUSINESS

Most people have a general understanding of what "complexity" means, but some may not be aware that there is a long-established field of scientific research focussed on defining and understanding complex systems. Under the guise of various names such as Complexity Theory or Complex Systems Analysis, researchers have identified several characteristics that are common to complex systems. Interestingly, many of these characteristics are also found in most medium to large enterprises. We will explore some of the key features of complex systems with examples of where those features can be found in a modern enterprise, but first we need to be clear that modern enterprises (both private and public, for profit and not for profit) are, in fact, systems.

There are numerous definitions of what a "system" is, but in general terms they all suggest that a system is a collection of interdependent and interacting parts that collectively constitute some form of "whole" or "entity". Importantly, the parts interact by passing either material, energy, or information among each other. Each part serves a purpose in the functioning of the whole, and that purpose is often to transform their inputs into an output that is required by the next part of the system. A perfect example of a system that everyone is familiar with is their own body. We all have inputs and outputs, and the transformation of the inputs by different organs and cells enables us to do the things that we often take for granted every day.

So almost by definition, the larger a business or enterprise is, the more complex it will be.

Similarly, a modern enterprise is an entity with various inputs that are transformed in one way or another by its interconnected parts to produce an output, such as a final product or service.

So, what are the features that distinguish a complex system from other simpler systems and how do those features relate to a modern business or enterprise? The most obvious defining feature of a complex system is the sheer number of components (inputs, parts, interconnections, outputs, etc.). As the name suggests, complex systems will likely have many interconnected parts that may transform many different inputs into many different outputs, which is exactly what large modern enterprises do. So almost by definition, the larger a business or enterprise is, the more complex it will be. There are also less obvious causes of increased business complexity that include external factors such as foreign trade agreements, increasing regulatory compliance requirements, multiple currencies and exchange rates, international offices and geographically distributed management and operational functions, etc.

Feedback loops are another defining feature of complex systems. The concept of feedback loops and how they are named can be a little confusing at first, but two simple examples help illustrate them quite clearly. The first is the piercing screech caused by placing a microphone too close to its amplifier's speaker. This is an example of positive feedback in which the output of a system reinforces its input through some form of loop. In this case, the signal from the microphone is amplified (reinforced) by the amplifier and this amplified sound is 'fed back' to the microphone causing further amplification of the sound. Importantly, positive feedback does not refer to the direction of change (up or down), rather, it refers to a mechanism that reinforces the current direction of change irrespective of what that direction is. If the feedback loop cannot be controlled in some way, the system can run out of control, potentially leading to very unpleasant results. In contrast, controlling room temperature with a thermostat is an example of negative feedback. If the room gets too cold, the heat turns on, but if the room gets too hot, the cooling turns on. Negative feedback counteracts changes in the system and tends to stabilise it – for better or for worse.

Modern enterprises are full of positive and negative feedback loops. A simple example of a positive feedback loop is when a company reinvests profits to fund growth in other profitable ventures, which leads to even further profit to reinvest. An example of negative feedback is the inertia or resistance that a company may experience among its staff when attempting to implement a major change initiative. In this case, the management team gives a directive for the enterprise to change. This directive for change becomes the input to the social and behavioural component of the business. People generally resist change due to a variety of factors including cognitive biases such as the status quo bias and system justification, and this behaviour will tend to counteract the change required by the management team.

The next defining characteristic of complex systems we will consider is nonlinearity. The simplest way to think about nonlinearity is that the output of a system or one of its components is not proportional to its input. In a linear system, the output will always be proportional to the input. In a nonlinear system, for every step change in the system's input, its output can be much greater, much smaller, or there could even be no change at all. Compounding interest is a simple example of a nonlinear system. Given sufficient time, money will accumulate at an ever increasing rate, resulting in the familiar exponential growth curve. Compounding interest is also an example of positive feedback, and in many situations, feedback loops can lead to nonlinearities. But nonlinearities do not depend on feedback loops – some systems or system components can be inherently nonlinear, even in the absence of feedback loops. Another example of a nonlinearity that can have profound impact on some businesses is the way that messages conveying customer sentiment can spread through social networks.

If you count the number of people every hour who respond in some way to certain types of social media messages and then plot those numbers against time, you will often see a strong upwards curve in the number of people responding but the curve will eventually drop off – sometimes slowly and sometimes quite rapidly. The reason for the upwards curve, or nonlinearity, is quite intuitive. If every person who receives the message quickly passes it on to two or more different people, then the total number of people receiving the message will increase exponentially until the network is saturated or people begin to lose interest in that topic. At that point, the number of people responding will begin to drop[1].

There are other defining features of complex systems such as time lags and system memory that can also be found in large enterprises, but we won't discuss them here in the interest of brevity. However, there is one last feature of these systems we will discuss, and this feature is arguably the ultimate defining characteristic of complex systems. This feature is system stability, or perhaps more importantly, system instability. Depending on the specific characteristics, or state, of a complex system, its history, and its inputs at a given point in time, the system could either be stable and capable of recovering from even large perturbations, or it could be very unstable, in which case even a small perturbation could cause the system to either oscillate, fluctuate wildly, or even crash. It's even possible for a complex system to rapidly switch among these states (stable, cyclical, unstable, etc.) due to changes in external or internal conditions. Such changes in system state may appear to occur for no apparent reason and catch us by surprise, giving these systems the appearance of being erratic and unpredictable. In fact, this type of system behaviour should be expected, even if it is difficult to predict.

In a nonlinear system, for every step change in the system's input, its output can be much greater, much smaller, or there could even be no change at all.

[1] There is a large body of academic research on the spread of information through social networks and the simplified scenario described here is provided purely for illustration.

History is full of examples of large monolithic enterprises that were extremely stable and withstood all sorts of pressures and challenges for many decades, only to eventually fail and disappear because they were, perhaps, inherently too stable to adapt to changes in external conditions. Similarly, there are many more examples of start-up companies that had done everything 'right' for a handful of years only to implode and collapse. While it is impossible to say that all organisations which have suffered such failure did so because of their inherent complexity and resulting system dynamics, the general patterns are consistent with what we might expect based on complex systems theory.

EXAMPLES OF COGNITIVE BIAS IN BUSINESS

Wikipedia provides an extensive list of cognitive biases[2], all of which could conceivably affect the way people make important business decisions. The following is a list of five of these that have particular relevance to business decisions.

- **Hindsight bias:** Sometimes referred to as the "I knew it all along" effect, this is the tendency to see past events as being more predictable than they actually were at the time. This can lead to overconfidence in one's own judgement, which is itself another cognitive bias known as the overconfidence bias. Hindsight bias stems from our strong tendency to selectively recall information from memory that confirms what we now know to be true. This creates the illusion that we always knew what the outcome of an event would be, even if the outcome was demonstrably unknowable at the time. When unchecked, hindsight bias prevents us from learning from past experience and can lead us to believe we can accurately and reliably foresee outcomes, when in fact we can't.
- **Clustering illusion and illusory correlations:** These related biases, which are associated with our inability to accurately evaluate probabilities, are responsible for us seeing patterns and relationships that don't really exist, particularly in random data. A classic example is so called 'chartists' who claim to see distinct patterns in random stock prices. A vastly more relevant example is when an analyst reports a trend in an important business indictor such as sales or revenue and interprets it as being real and meaningful without correctly testing the likelihood that the change is simply an outcome of random variation and has, in fact, no business significance whatsoever. It is easy to appreciate the risk of making important decisions in this type of scenario, but it is done much more frequently than some may care to admit.

"..there are many more examples of start-up companies that had done everything 'right' for a handful of years only to implode and collapse".

- **Confirmation bias:** This is our tendency to place more value on information that confirms our preconceived opinion, point of view, or beliefs while placing disproportionately less value on information that contradicts it, irrespective of the accuracy or credibility of the contradictory information. If we are not aware of our innate tendency to do this, we may make catastrophic mistakes by biasing what we believe to be true over what may actually be true. When we think someone is being stubborn in the face of strong evidence, they have likely succumbed to confirmation bias without being aware of it.
- **Belief bias:** This bias is seen when we judge the validity of a logical argument based on the believability of its conclusion. This is particularly important when trying to optimise some aspect or component of an enterprise, which is a common and worthwhile objective. Belief bias is important in this scenario because the best solutions are sometimes counter intuitive and therefore difficult for many people to accept as correct.
- **Survivorship bias:** This is the tendency to focus on people or organisations that are successful or have 'survived' one or more events while ignoring all those that failed. We do this because the survivors are more visible than those that didn't survive or succeed. Focussing only on the survivors biases the information we make available to ourselves which can be catastrophic if we are trying to understand what the cause of survival or success is. The only way we can objectively evaluate the reasons for success or survival is to include those that didn't in our analysis. Doing so may reveal that success has more to do with chance than with anything else (e.g., right time, right place, right team, etc.).

[2] https://en.wikipedia.org/wiki/List_of_cognitive_biases

THE ROLE OF ADVANCED ANALYTICS IN OBJECTIVE DECISION MAKING

Cognitive biases and their simplifying heuristics are the evolutionary outcome of our brain's limited ability to deal with a complex world. But the world we live in today is far more complex and fast-paced than the world that existed when these traits evolved. Consequently, the undesirable effects that cognitive biases have on our ability to make objective decisions is compounded by the increased complexity we have created for ourselves today. Making matters worse, research has shown that most people can only hold somewhere between three and five distinct pieces of information in working memory at any one time. Simply put, the complexity of modern businesses and many of the decisions that need to be made to run them effectively far exceed our ability to acquire, retrieve, process, and synthesise information.

Fortunately, there are a number of ways we can minimise the negative impacts of complexity and cognitive biases on our ability to make objective business decisions. The first, and perhaps most useful, is to be consciously aware of these impacts and the potential consequences of ignoring them. A quick search on the internet for "cognitive biases" will reveal numerous sites with useful guidance on questions you can ask yourself to help identify if you, or your colleagues, are being unduly influenced by various biases. In terms of gaining awareness of how complex systems may respond to different situations, perhaps the most salient advice would be to expect the unexpected. In other words, when trying to evaluate the outcome of a decision or action (either internal or external to the business), it would be prudent to broaden the range of possible outcomes that are considered.

Advanced analytics is another approach to enhancing objectivity in business decisions. It is a toolset and a methodology that can be profoundly effective at minimising the negative impacts of complexity and cognitive bias. To be clear, advanced analytics is not a panacea, but when applied correctly to appropriate business scenarios, it is without doubt the best option available for ensuring the highest levels of objectivity that can be realistically hoped for. To explain why this is the case, we will briefly explore how advanced analytics helps reduce complexity to an understandable level, and then we will explore how it can help minimise the specific cognitive biases we discussed earlier. For the purpose of this discussion, we will not delve into the variety of different types of mathematical and statistical models that are used in advanced analytics, nor will we discuss different business application of these models. Instead, we will approach the topic from a general perspective that can be easily translated to virtually any business sector or application.

A principal way that advanced analytics can reduce complexity to an understandable level is by identifying which variables among many, possibly many hundreds, are the key drivers of a particular business process, function, or metric. In addition to identifying the key drivers, we can quantify each one's contribution to the metric of interest while aggregating the remaining variables so that their collective influence is not ignored. Advanced analytics also allows us to understand relationships among the driving variables and whether or not nonlinearities and feedback loops also exist. Being able to do this is important for at least two reasons:

- First, such relationships may represent business opportunities that can be readily capitalised.
- Second, quantifying these types of relationships enhances the accuracy and reliability of predictive models that may be used for business forecasting or for identifying new sales and revenue opportunities.

"A principal way that advanced analytics can reduce complexity to an understandable level is by identifying which variables among many, possibly many hundreds, are the key drivers of a particular business process, function, or metric".

In this context, a primary role of advanced analytics is to identify the key variables and relationships that matter. In effect, we can use it to sort the wheat from the chaff, enabling us to focus our attention and efforts on a small subset of factors that have demonstrable business effects or value.

Advanced analytics also helps us minimise the influence of cognitive biases on business decisions in a number of effective ways. With respect to hindsight bias, or the "I knew it all along" effect, advanced analytics can help us understand in detail just how predictable the outcome of certain types of events are before they occur. This gives us clarity and a degree of confidence regarding what types of business events are predictable and which ones aren't. It can also be used after an unexpected event has occurred to evaluate if it could have been predicted ahead of time. If analysis shows it could have been predicted, then we can incorporate that information into our business systems so that we aren't caught by surprise if it happens again.

Advanced analytics is particularly powerful for avoiding the effects of the clustering illusion and illusionary correlations. These biases, which lead us to see patterns in data that don't actually exist, can essentially be eliminated through the careful application of statistical methods that are designed specifically to differentiate between real patterns and illusory patterns in data. This is particularly important when trying to decide how to respond to trends and changes in business metrics. The analytics show us which patterns have substantive business meaning and which are essentially nothing but random variation, and hence contain no exploitable information.

The role that advanced analytics can play in avoiding confirmation bias is a little more slippery because it is not uncommon for inexperienced analysts to succumb to it. In this case it is the methodology of doing advanced analytics that can assist, rather than the use of specific types of statistical models. The methodology referred to is simply the scientific method of hypothesis-driven enquiry applied to data analysis, which some refer to as 'Data Science'. Regretfully, the term 'Data Science', which has only been in use for a few years now, is already used grossly out of context by many, simply because they ignore the 'science' in 'Data Science'. While it can be argued that this is a matter of opinion or semantics, language is important in order to avoid ambiguity and confusion. As long as the terms 'Data Science' and 'Data Scientist' are being used, they must imply the same level of scientific rigour applied to data analysis in business as any other domain of scientific enterprise. While it can also be argued that even the most rigorous application of the scientific method will still contain some degree of subjectivity simply because it is a human endeavour, it is the most objective methodology available to us at this time. Consequently, the correct application of advanced analytics using the scientific method is our best tactic for minimising the effects of not only confirmation bias in many types of important business decisions, but also other biases such as survivorship bias.

With respect to hindsight bias...advanced analytics can help us understand in detail just how predictable the outcome of certain types of events are before they occur.

The role that advanced analytics can play in overcoming belief bias has more to do with how advanced analytics is positioned and conducted within an organisation than it does on the specific tools that are used. In very general terms, overcoming this bias will depend on at least two factors:

- One is the ability of the analyst to communicate a story to a nontechnical audience in a convincing and compelling way so the audience will be able to see the logic in what may be a counterintuitive solution.
- The second factor is the cultural maturity of the organisation in terms of the use and acceptance of advanced analytics as a routine business methodology. In organisations that have low maturity in this area, it often becomes the responsibility of the champions and practitioners of advanced analytics to gently educate other stakeholders about the methodology and the value it provides. It needs to be understood that these organisations have embarked on a journey that will often take time, patience, and nurturing before the full value of advanced analytics becomes embedded in their cultural fabric. When it does, stakeholders are more likely to look at results that may appear counterintuitive with interest and curiosity instead of rejecting them in disbelief.

"...certain limitations in the way the human brain works can inhibit our abilities to make rational and objective decisions in the face of ever increasing complexity".

CONCLUSION

As the complexity and pace of business continues to increase, so does the need for decision makers at all levels to be rational and objective. We have seen some examples of how certain limitations in the way the human brain works can inhibit our abilities to make rational and objective decisions in the face of ever increasing complexity. And while it can be argued that it is impossible for anyone to be truly rational and objective, even just occasionally, we have also seen that there are effective ways of helping us improve the degree of rationality and objectivity in our business decisions. Conscious awareness of how our innate traits such as heuristics, cognitive biases, and limited working memory affect us is the first step. The next step is to implement strategies to help overcome those effects. For a wide cross section of common, high-value business scenarios, advanced analytics provides the best tools and methodology currently available for maximising objectivity in business decisions and processes. To be clear about the full business value of advanced analytics, we need to see it as a collective whole that not only helps empower organisations to achieve specific business objectives such as retaining customers and improving operational efficiency, but also as a powerful means for maximising objectivity in mission-critical business decisions.

DR. ANDREW PETERSON:

PRINCIPAL DATA SCIENTIST, SOLTIUS

EMAIL. andrew.peterson@soltius.co.nz

LINKEDIN. andrewpeterson0analytics

For more information on advanced and predictive analytics, visit www.soltius.co.nz/advanced-predictive-analytics or get in touch with Andrew today.

soltius

SOLTIUS NEW ZEALAND LIMITED

WEB: www.soltius.co.nz
EMAIL: info@soltius.co.nz

WELLINGTON OFFICE:

OFFICE: Level 1, 3 Queens Wharf, Wellington
MAIL: PO Box 25-385, Wellington 6146, New Zealand
PHONE: (+64 4) 472 1897
FAX: (+64 4) 472 8172

AUCKLAND OFFICE:

OFFICE: Level 1, 49 Main Highway, Ellerslie, Auckland
MAIL: PO Box 11-731, Ellerslie, Auckland 1542, New Zealand
PHONE: (+64 9) 571 7100
FAX: (+64 9) 571 7109