American Century Investments®

Meet Your New ROBO-ANALYST

Scaling Investment Decisions with Artificial Intelligence

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DISCIPLINED EQUITY

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Executive Summary

The quarterly earnings conference call is highly choreographed. Corporate executives frame financial results and future expectations in a positive light while investment analysts question those carefully parsed statements, attempt to read between the lines, and use the new information to update their views of the company. A silent listener has recently joined these discussions, a newcomer that without asking a single question is able to digest every word, take meticulous notes and quickly generate a detailed report. Meet your new Robo-Analyst.

Artificial intelligence (AI) is changing the investment management industry and helping investors make better decisions. The emergence of the Robo-Analyst on conference calls is just one example of this larger trend and signifies a natural evolution and convergence of data, technology and investment competition. Thousands of conference calls occur worldwide every quarter, and even the most accomplished analysts have finite capacity to absorb and process information consistently and systematically. It would take one person more than 700 days—24 hours a day—to listen to a year's worth of earnings calls.

In this paper, we'll explain how AI enables investors to detect meaningful relationships across volumes of increasingly complex data sources. We will go under the hood of American Century Investments' Robo-Analyst, detailing how it leverages natural language processing (NLP) and psycholinguistics to analyze the nuanced speaking patterns of conference call participants that may signal underlying challenges within the company.

Key Takeaways

Focus on the Investment Problem First

While it's tempting to jump right into the latest technology or exotic new data source, focusing on the investment problem first establishes a sound economic foundation and improves model transparency. Investment teams are most successful when working side by side with technologists toward a solution that is both economically sound and thoughtfully implemented.

A Machine Is Only as Intelligent as The Data It Learns From

Sourcing additional data is often more effective than building a more elaborate model. The more comprehensive the training data, the more generalized the machine will process new events, thereby mitigating common pitfalls like overfitting. Harnessing more varied data is especially critical to equity investing as information relevant to valuations spreads beyond traditional financial statements.

See Through Corporate Speak

A management team's lack of candor and the quality of its communication can have meaningful and predictable impacts on future price movements. Powered by AI, the Robo-Analyst is designed to read between the lines like a discerning human. The machine is trained to listen for omission, spin, obfuscation, and blame as indicators that management may be misrepresenting underlying challenges.

Humans and Machines Are Complementary Forces

Human analysts are skilled at scrutinizing a small set of companies while the Robo-Analyst can systematically apply its objective and unique insights across thousands of companies at a time. We believe teams that harness the benefits of both are well-positioned in a highly competitive landscape.

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Scaling Investment Decisions with Artificial Intelligence

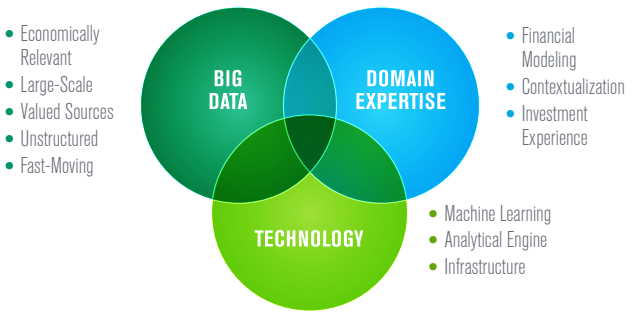
Brave New World: Equity Investing in the Age of AI

The application of artificial intelligence (AI) to investment management is filled with opportunity and risk. Stock prices are volatile and respond to a litany of factors, only a few of which have some predictability. In the vernacular, stock prices are said to have a low signal-to-noise ratio, which means it's harder to discern whether a piece of data is meaningful or simply noise. This attribute makes predicting stock prices a much different challenge than applications such as spotting anomalies in a medical image or differentiating between cats and dogs in a smartphone's photo library.

Successful AI-powered investing is built on three key tenets: Big Data, technology, and domain expertise. See **Figure 1**. Data and technology work in tandem to power machine intelligence, but they are arrows without a target in the absence of investment-specific insight. It requires domain expertise to train models on economically meaningful and highly contextualized inputs. For example, short-horizon models have significantly different return drivers than long-horizon models. Since computer scientists alone aren't equipped to address such nuances, machine learning implementations require multi-disciplinary expertise.

FIGURE 1

AI-Powered Investment Processes Draw on Multi-Disciplinary Expertise



Source: American Century Investments.

Data and Technology Arms Race

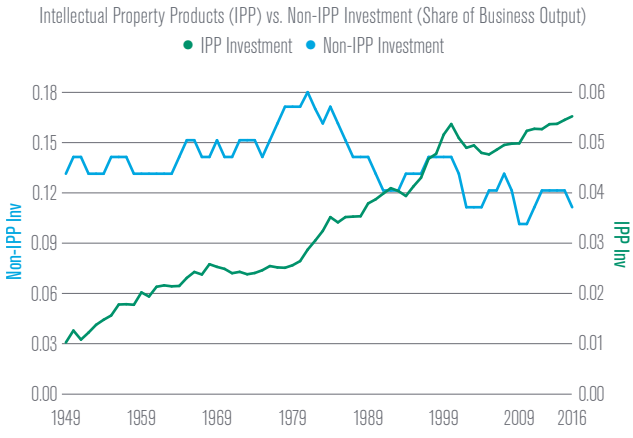
In a 2009 paper titled *The Unreasonable Effectiveness of Data*, Google scientists concluded "invariably, simple models and a lot of data trump more elaborate models based on less data."[1] This was a simple, yet important, observation: A machine is only as smart as the data it learns from. Just as you should not trust a driverless car that trains on the same roads every day, you should be wary of investment strategies employing complex models in the absence of varied data sources. In the noisy world of stock prices, this strategy is a recipe for overfitting. A complex model trained on noisy data likely performs well in a historic simulation but is ill-prepared to incorporate new and unexpected inputs.

Harnessing more varied data is especially relevant to equity investing. Consider the challenge of determining a company's appropriate valuation at a time when the level of corporate investment in intangible capital is rising at a historic rate. See **Figure 2**. Placing a value on such intangibles as research and development, patents, information systems, brand recognition, media content, and business processes is critical, but the value they create is not fully captured in traditional accounting statements.[2] We're experiencing a generational shift in the availability of information that may be relevant for such valuations, but asset managers must develop tools to integrate traditional accounting metrics with new data sources if they intend to accurately project the future value of a company.

To handle the growth of alternative data sources, platforms should seamlessly integrate with the rapidly evolving open-source community where cutting-edge techniques in data manipulation, natural language processing, and statistical learning are available to everyone. Teams that leverage cloud-based computing services to power computationally intensive algorithms are likely to explore data in ways that in-house infrastructure won't allow.

FIGURE 2

Investors Are Turning to Alternative Data Sources to Establish Valuations as Investment in Intellectual Property Rises



Source: St. Louis Federal Reserve Economic Database. Data as of 12/31/2016.

[1] "The Unreasonable Effectiveness of Data." Alon Halevy, Peter Norvig, and Fernando Pereira. Published by the IEEE Computer Society, March/April 2009.

[2] "Time to Change Your Investment Model." Feng Gu and Baruch Lev. *Financial Analysts Journal*, Volume 73 Number 4, 2017.

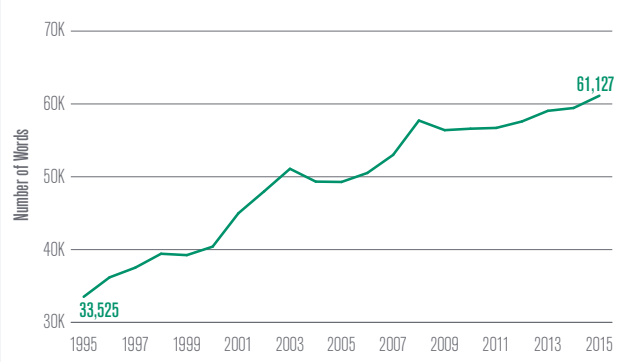
Swimming in Data

Investment managers are engaged in a highly competitive arms race to acquire new data sources. Consequently, alternative data providers have proliferated over the last 20 years, creating a host of new challenges. Even if you find an economically sensible source, the contents can be unwieldy and highly unstructured. Uncovering signals among this noise requires targeted algorithms and strategic technology decisions.

Consider 10-Ks, which have ballooned in size since the 1990s.[3] The enormity of the data, coupled with increasingly and sometimes intentionally complex language, makes it challenging for investors to find meaning in the filings. There is a distinct advantage, however, for asset managers that successfully identify subtle, but salient, changes across thousands of documents.

FIGURE 3

The Explosion of Information in 10-Ks and Other Filings Challenges Investors to Find Meaning in the Data



Source: Loughran and McDonald. Data from 1/1/1995 to 12/31/2015.

Navigating the Data Deluge: Start with the Investment Problem

Narrowing the scope of data requires a keen economic sense of what you seek to uncover. We advise teams to start with the investment problem, evaluate the data sources second, and only then begin to explore the appropriate methodology. An investment-first discipline provides a foundation from which to build (and return to) as data sources and technologies evolve. In this framework, it's critical that investment management and technology teams collaborate toward an economically sound and thoughtfully implemented solution.

Putting AI to Work: Decoding Corporate Speak

As we noted at the outset of this paper, the emergence of the Robo-Analyst on conference calls is just one example of how investors can use AI to detect meaningful relationships across large bodies of increasingly complex data. Listen to a quarterly earnings conference call, and you quickly realize that someone is trying to sell you something. AI is particularly effective in sifting through transcripts of such calls and uncovering subtle, but important, changes in language.

[3]Software Repository for Accounting and Finance, University of Notre Dame. Data from 1/1/1995-12/31/2015.

Here's an exchange from Starbuck's first-quarter conference call on April 26, 2018:

> "…First, **comps improved to a strong 3%** in the second half of the year. While **we believe we will hit the 3% mark** in the third quarter, we recognize year-over-year comparison requires progress across our initiatives to reach this level. **These initiatives give us even greater optimism** for the fourth quarter…"
>
> SCOTT MAW, CFO, STARBUCKS

> "Just **first a clarification**, Scott. I wanted to **make sure I understood your commentary** around the third-quarter comps. I think you mentioned that you expect it to be plus 3%, despite the tougher comparisons, but I **wasn't sure how to interpret that** in light of your comment about the initiatives needing to work. So if you could **clarify that,** that would be great."
>
> DAVID TARANTINO, ANALYST, ROBERT W. BAIRD & CO., INC

Behold, the cat and mouse game of quarterly conference calls, where analysts are as much truth-seeking detectives as finance professionals. Communication from executives is predictably skewed to project the company in the best possible light. Management is selling listeners unbridled optimism and confidence. Should analysts buy it?

We have years of empirical evidence suggesting that management's candor is not only a reflection of its leadership values, but a meaningful signal about the underlying health of the company. The quality of communication from management affects the way investors digest and act on information, which affects near-term price movements in meaningful and predictable ways. Longer-term, poor communication patterns may also raise questions about corporate governance and result in a loss of investors' trust.

We based an early iteration of our model largely on management sentiment as a means to extract the content and tone of the call. The model had strong performance despite only capturing what was said, not how it was said. We wanted the Robo-Analyst to think more like a discerning human who could read between the lines. For example, what if management is exaggerating? What if company executives are telling the truth, but excluding important details?

Four Signs of Deception

We started our research by asking *What language patterns suggest deception?* We didn't find the answer in traditional financial literature. The roots of this question are grounded in disciplines like psychology and computational linguistics. For example, the following passage came from a series in criminology:

> "The best solution [for the deceiver] therefore could be to give a statement that provides the observer with as little lie-catching opportunities as possible. Liars could achieve this by using general, non-specific language."
>
> ALDERT VRIJ, 2008
> Wiley Series in the Psychology of Crime, Policing, and Law[4]

[4]Detecting Lies and Deceit: Pitfalls and Opportunities. Aldert Vrij. Copyright 2008. John Wiley & Sons, Ltd.

Ultimately, we identified four key signals that consistently stand out across a variety of contexts – from children lying to their parents to C-suite executives placating an angry board:

1 OMISSION
Failure to Disclose Key Details
Management teams that avoid details or key figures may be withholding relevant information from the investment public. For example, an airline company that disclosed revenue per available seat mile last quarter but avoided that disclosure this quarter.

2 SPIN
Exaggeration and Overly Scripted Language
Corporate executives are typically enthusiastic during conference calls, but our model negatively views abnormal levels of corporate spin, especially in the face of analyst uncertainty and questioning.

3 OBFUSCATION
Overly Complicated Storytelling
Amid underlying business challenges, management tends to avoid the simple story. Hand-waving and complex language to simple questions often signal obfuscation.

4 BLAME
Deflection of Responsibility
Management communication exhibits evidence of self-attribution bias – ascribing success to internal factors and failure to external forces. Language patterns in the spirit of "bad luck," "challenging environments," and "unexpected situations," are not uncommon excuses, but in many contexts they're not good ones. Management is either covering up real business issues or doesn't understand them.

The Robo-Analyst in Action: Examining a Company in Transition

Let's return to Starbucks' April 2018 conference call for a closer look at the Robo-Analyst in action. Once a growth darling, posting consistent year-over-year sales gains, Starbucks is beginning to look like a company entering its maturation phase. While having three Starbucks within 10 minutes of the office is convenient, it's hard to ignore the pressures of cannibalization on same-store-sales. The company also faces the pressure of an increasingly crowded coffee market, including cheaper options from fast-casual restaurants and the differentiated draw of local gourmet cafes.

It's in these moments of transition, while underlying fundamentals begin to shift behind the scenes, that management feels the most pressure to maintain its year-over-year growth story. The Robo-Analyst picked up on these patterns, identifying clear signs of manipulation over the course of the call. For example, **Figure 4** demonstrates a sharp divergence in tone, or sentiment, toward the end of the call. The management team's tone became more positive as they may have been attempting to end on a good note, a clear indication of "spin." At the same time, the tone of analysts on the call decreased/flattened. **Figure 5** shows the increase in our four deception indicators when comparing the April 2018 call with the April 2017 call. As shown in **Figure 6**, Starbucks calls exhibited a gradual decline in tone relative to industry peers. The decline seems clear from this conveniently quantifiable vantage point, but from one carefully scripted call to the next, these shifts were subtle, making them more difficult for the average listener to detect.

While the analysis of conference calls alone would never drive our model to buy or sell a stock, subtle shifts in communication patterns, combined with a variety of complementary indicators reveal meaningful, price-predictive information. In the case of Starbucks, we found confirming warning signals from short sellers, deteriorating momentum overseas, and questionable earnings sustainability that reinforced the Robo-Analyst's interpretation of the call.

Less than two months after CFO Scott Maw said, "We believe we will hit the 3% mark in the third quarter," Starbucks issued negative guidance. Management stated the company would fall well short of that 3% same-store-sales figure, which is exactly the sticking point many analysts questioned on the original call, but never acted on. It was only after the company issued this business update that analysts lowered their outlooks. Over the next 10 days, the stock dropped more than 15% as investors became increasingly skeptical of the company's long-term growth prospects. In all, 25 of the 27 analysts covering Starbucks subsequently lowered their earnings projection.[5]

[5]I/B/E/S Consensus Estimates.

Analyzing Starbucks' Communication Patterns

FIGURE 4

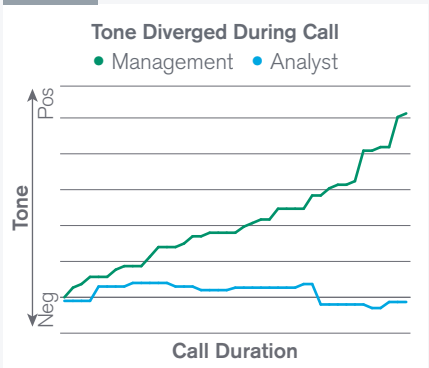


FIGURE 5

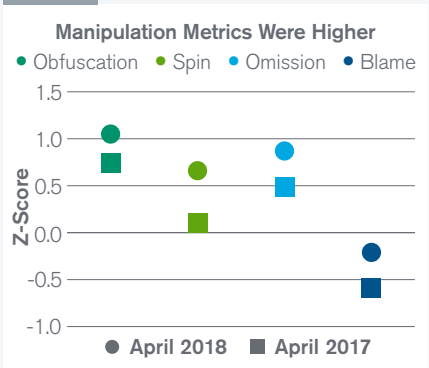
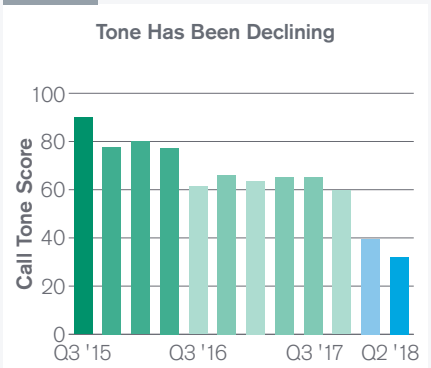


FIGURE 6



Source: American Century Investments analysis and Thomson Reuters, April 26, 2018.

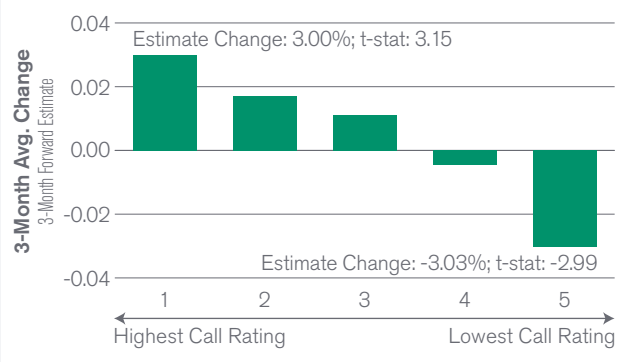
The real power of the Robo-Analyst comes from being unleashed on thousands of calls simultaneously.

The Proof Is in the Data

The Starbucks example illustrates the value of being able to predict sales-side analyst estimate revisions before they happen. To validate the efficacy of our model in this context and on a broader scale, we decomposed the model's conference call ratings into quintiles. The highest rated calls are represented by the top 20% and the lowest rated calls by the bottom 20%. **Figure 7** shows that across the Russell 3000 All-Cap US Equity Universe, companies with the highest rated calls predicted an average 3% increase in analyst estimate revisions (with a statistically significant t-stat of 3.15). Companies with the lowest rated calls predicted -3% decreases in revisions (with a significant t-stat of -2.99). Based on this data, we can conclude that the lower our Robo-Analyst rates a company's call, the more likely the firm will see analyst downgrades in the future.

FIGURE 7

Lower Call Ratings Indicate Greater Likelihood of Future Analyst Downgrades



Source: American Century Investments. Data from 1/31/2006-7/30/2018.

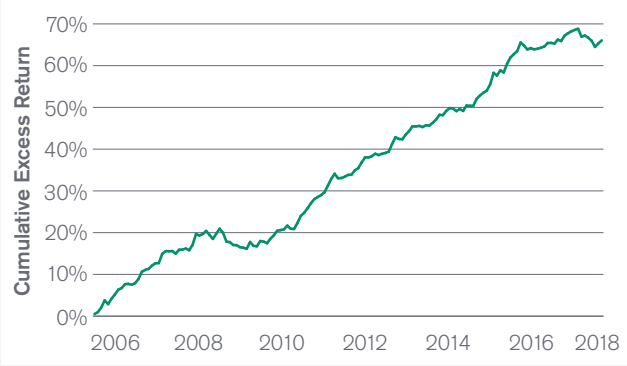
This ancillary testing helped ensure that our AI-powered model is robust and firmly grounded in sound economic principles. It "illuminated the AI black box" by providing a better understanding of the model's economic sensibilities and demonstrated the mechanism by which the model predicts stock returns. Testing also confirmed we weren't overfitting the model to the training data. Stock returns are noisy and challenging to predict, so models validated solely on returns risk reaching spurious conclusions.

Lastly, we wanted to measure the model's ability to predict returns. As shown in **Figure 8**, we charted the cumulative excess returns of a monthly-rebalanced portfolio that is long the Russell 3000 Index companies with highest rated calls (top 20%) and short the companies with the lowest rated calls (bottom 20%). In a simulation run from January 2006 to July 2018, this strategy returned over 65%. The annualized return of 5.25% with 2.90% risk produced an Information Ratio of 1.81. We believe this test confirms that our Robo-Analyst extracts meaningful information that's relevant to valuations but has yet to be priced-in by the broader market.

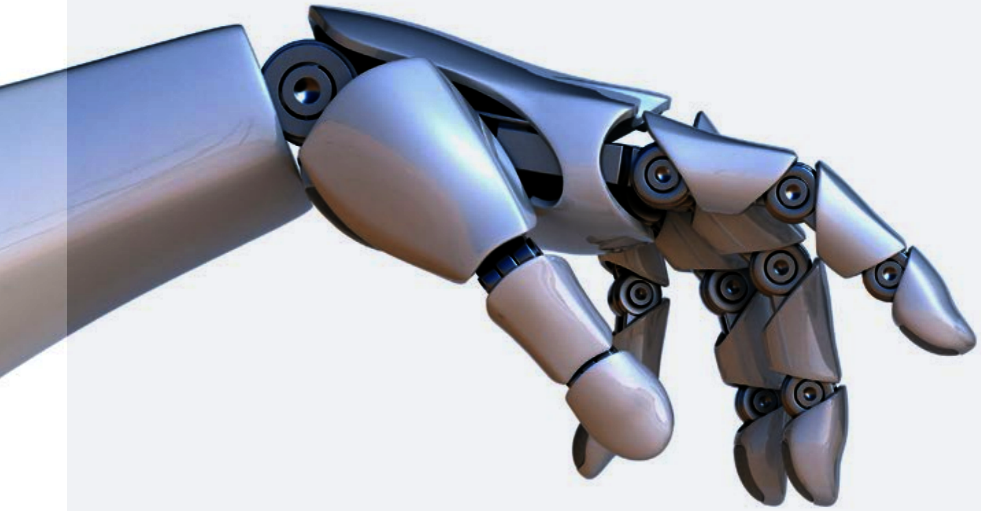
While our analysis of the Starbucks calls demonstrates how the Robo-Analyst might think about a single name, its real power comes from being unleashed on thousands of conference calls simultaneously. More than 140 million words are spoken during conference calls every year. A well-trained machine can parse these conversations in seconds, simultaneously comparing a company to its own call history and to its industry peers, detecting subtle variations in language. We believe this combination of scale, speed, and objective precision enable the machine to get ahead of the broader market.

FIGURE 8

Companies with Higher Call Ratings Generated Higher Returns



Source: American Century Investments. Data from 1/31/2006-7/30-2018..



Conclusion

Humans and Machines Are Complementary Forces

Like many other data-driven algorithms, the Robo-Analyst model benefits from its unbiased approach and immense scale. Some human analysts may be more skilled at analyzing a small set of companies, but the machine can systematically apply its objective insights across thousands at one time.

Neither humans nor machines are perfect, so we view these two stock-picking perspectives—the discerning human analyst and the trained, data-driven Robo-Analyst—as complementary forces. In the highly competitive landscape of investment management, teams that leverage the benefits of both humans and machines may be best positioned for success.

American Century Investments®

1958
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OUR SOLE FOCUS IS INVESTMENT MANAGEMENT

181 INVESTMENT PROFESSIONALS
TOTAL as of 9/30/2018.

19 YEARS OF EXPERIENCE
AVERAGE as of 9/30/2018.

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$172b
ASSETS UNDER MANAGEMENT
as of 9/30/2018.

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