TFC FINANCIAL
The Financial Counselors

ARTIFICIAL INTELLIGENCE

ABSTRACT

- Ideas (technologies) that seem unthinkable to a present generation often become conventional with time. Artificial Intelligence (AI), the idea that computers will eventually replicate humans as sensory beings is one such outlandish assertion. In the personal financial services arena, and investment decision-making process and portfolio management context, AI must contend with the inconvenient statistical truth that investment returns tend to revert to the mean; as well as what neural scientists and behaviorists have been studying in recent times (i.e., how to map and profile unique individual emotional patterns).

- Since a robust macro-econometric model must monitor and map as many as 2,000-3,000 dependent variables, but cannot incorporate the "soft" inputs of sentiment (behavior), policy and geopolitics, over the longer term won't reversion-to-the-mean (less fees) be the best of the results one could expect?

- In today's and the future online "robo" revolutionary world, what will be the impact of interactive AI-driven decision programs on the RIA-offered personal financial advisory business (profession)?

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ARTIFICIAL INTELLIGENCE IN OUR LIVES

(From Google to Hands-Off Parking and Minds-Off-Driving to Robo-Investing and Big Brother; a liberal arts major's view of burgeoning AI developments)

[On an iPhone somewhere, the user is asked in a computer monotone: "How can I help you?" User answers . . . "Siri, how long can a Caucasian male aged 81 years, with a college degree and in good health, expect to live?" And Siri replies, "Here's what I found . . . Try the Life-Expectancy Calculator at www . . ."]

At the Los Angeles Airport Marriott Residence Inn Hotel standing next to the registration desk is a three-foot-high R2-D2-like robot on rollers with bluish eyes blinking. As the writer and his wife enter the elevator heading to their eighth floor room, "Wally the Butler" (as he/she/it introduces itself) follows, electronically selects the seventh floor, and announces it is delivering toothpaste and extra facecloths to a guest's room. It also suggests that if we would like coffee from the lobby Starbucks, it would be happy to fetch it for us. As we depart the next morning for our flight home, Wally is dutifully standing at the hotel check-out desk, and remembering our name, wishes us a safe flight.

In almost any direction one turns today, some form of computer-based information processing technology intrudes, whether to the individual knowingly or not. Artificial Intelligence (AI) has already transformed our lives. From the punch-card-driven mainframes of the 1960s to the voice-activated instantaneous cell phone response applications of today, the elusive era of brutish computers armed with chips (number-crunching power is now doubling every 2.5 years according to Intel) designed to facilitate algorithms that replicate the way the human brain processes information, is said to be finally at hand. Whether during a Google search, or while conversing with Siri on an iPhone, Amazon's Echo, or Nuance's Dragon v15 deep learning speech engine, or tracking your travel when using your EZPass on the Massachusetts Turnpike, various forms of artificial intelligence programs are at work behind the computerized voice or screen.

Broadly speaking, AI is the branch of computer science that attempts to model the mind and the process by which it attempts to solve problems, make choices, or resolve conflicts. The ultimate goal for a specific AI application is to replicate the thinking pattern of a sensitive human expert in a selected domain. It would appear that the global age of AI is now at hand; or is it?

What is AI Anyway, and How Pervasive Is It in Our Lives Already?

As indicated, AI is broadly the use of software with logic devised, and code written, to approximate human cognitive reasoning patterns. Whether to recognize images, schedule meetings, process human speech, drive autonomous vehicles, or help doctors and other

professionals make diagnoses and remedial decisions, it can be thought of as " . . . a rational agent that perceives its environment and takes actions that maximize its chances of success at some goal . . ."* Computers have been used for decades to increase automation tasks and efficiency. Until early in this decade, AI programming has been mostly driven by rules-based (i.e., "if-then") tools of logic and programming language. But as AI enters the real time mainstream, humans and machines are expected to collaborate in new ways, on ever-more sophisticated assignments. Such inferential reasoning electronic machines will be able to take on more complex tasks entirely on their own, particularly when repetitive routines are the mode. In perhaps its worst manifestation, personal information-gathering, aggregation and profiling in both corporate and governmental applications, Big Brother (back to Orwell's future) may be closer to reality than one thinks.

AI works better in context-limited, defined domains where the challenge is carefully delineated. However, as we know, human behavior is highly variable, depending on the individual's personal psychological profile and the circumstances of a particular incident. But circumstances can vary, the law of unintended consequences seems always to lead to outcomes and situations that are different each time, and the human experience continually confronts occurrences requiring creative responses to new combinations of events. Today, using leading-edge cameras and imaging technology, AI algorithms can assist law enforcement authorities with non-invasive DUI discovery techniques. In such confined domain space, reading facial expression patterns and corneal configuration may reveal an individual's state of inebriation, but can an online "robo" personal financial planning and/or investment program for an individual investor divine a truly uniquely personal investment portfolio for a financial advisor or online user? Can such technology be a substitute for in-person advisory services in which the human connection is the driving combination behind conclusions which emerge as uniquely personal?

Where is AI Headed?

If AI's paramount goal is programming, data aggregation and analysis that solves problems, makes decisions and/or resolves conflicts replicating how the human brain operates, then the hoped-for state-of-the-art and its capabilities are still a long way from realization. Neurologists are just beginning to understand the brain's physiology, and geneticists have only relatively recently successfully mapped the complete human genome. Complicating the problem is that Behaviorists, during the past 25 years, have learned that the classical economic model of "rational expectations," in which individuals always optimize personal financial resources, is flawed. Until science unlocks the secrets of how to account for, and remove (or include), emotional impulses in the human mental process equation, computer scientists will continue to have difficulty devising processing logic that learns from its own experience the way individuals

*Wikipedia

do. "Artificial emotional intelligence" is today where aeronautical science was perhaps in the 1930s. Today's AI applications might be likened to the "smart calculators" of the late 1960s.

AI implementations today are to be found in robotics, attempts to leverage Big Data aggregation and sorting tasks, optimize internet search engine performance, scan, interpret, and parse text language (e.g., comparing the language in successive Federal Reserve Bank bimonthly policy statements), as well as assist in narrow-context decision-making tasks. "Operating in the background (of which most users are unaware) narrowly defined AI algorithms have automated many user routines in shopping, net browsing, driving, manufacturing, flying, education, and healthcare, enhancing user experience and ultimately redefining the rules of how business is done."*

As we know, most humans tend to learn from experience, particularly from repeated exposure to the same routine and resulting outcomes, and react by modifying future personal behavior accordingly. In its ultimate state, AI's objective is to build algorithms that learn from its observations and modify future processing results; "machine-learning" aimed at training a system to sift through a vast quantity of data to discern a pattern which might be predictive of a future outcome is one such anticipated application.

But if the ultimate objective of AI is to exactly replicate human cognition, then AI may never realize that hoped-for, ideal state. Learning from experience and inferential reasoning in unexpected, spontaneously occurring situations are particularly human capabilities. The human psyche is influenced daily by the variety of experiences it continuously confronts and to which it adjusts dynamically in real time. The decision-making environment and emotional framework within which humans decide how to act is loaded with an almost infinite number of dependent variables. "Singularity," "Synchronicity"#, the era of "Super Intelligence" in which human cognition, true wisdom and machine behavior are identical, remains well off into the future.

But computer scientists have had to confront what is termed "NP-complete" problems@ suggesting that there are some complexities, equations, in computer applications which simply are not resolvable. Landon Clay's Institute is offering a US $1.0 million award to anyone who develops a formal proof solving the NP-complete dilemma. Such intractable problems are rife in attempting to model human behavior where one of the soft inputs is *sentiment*. Sentiment, of course, however defined, must be both measured, some form of aggregation agreed to, and then quantified for inclusion in the algorithm being developed. Enter, as well, chaos theory; attempting to identify, track and predict outcomes from an initial combination of randomly

*Nassib Chamoun
#Raymond Kurzweil, *The Singularity Is Near: When Humans Transcend Biology*, 2006
@Wikipedia " . . . the most notable characteristic of NP-complete problems is that no fast solution to them is known . . ."

selected starting points, all of which come to bear in the sociologic context and compound the challenge to replicate. The list of hurdles creators of AI algorithms must contend with is formidable to say the least. In the global financial market domain, for instance, in the macroeconomic context, how can machine-learning algorithms ever expect to disaggregate the full menu of meaningful variables required to encompass an actionable macroeconomic framework if the logic cannot incorporate the soft variables of investor sentiment (i.e., emotion and behavior), government policy (i.e., political compromise) and geopolitics (conflict and diplomacy)?

This list of difficult-to-surmount obstacles would seem to give rise to the quandary defined in one of Zeno's dichotomy paradoxes: ". . . every leap will take us halfway to our goal without ever reaching it." In a universe of unbounded inputs and resulting computerized outcomes, can AI ever be expected to achieve the goal of developing algorithms that think like humans and solve broad-scale, machine-learning problems?

Orwell was Right (The Struggle for AI's Soul)

Stealthily , unnoticed to the public; as if a conspiracy among neurologist, psychologists, computer scientists, chip manufacturers, and internet providers, AI has been evolving as a technology (i.e., computer logic generation and programing techniques) which could impact one's freedom of movement, choice, and even the exercise of free will generally! In George Orwell's ***1984***, the reader is warned of ever-present cameras monitoring movement, thought control police checking citizen attitude profiles, and Big Brother always watching for apostate conduct. The sense of helplessness before the power of Orwell's version of ever-present overwhelming technology is palpable in the principal character of Winston Smith. Although Orwell in the early 1950s surely knew nothing of the future of computing, nor had any sense of how the internet would unfold, his concerns intuitively were prescient and on point. Today, already, privacy issues abound, and the concerns are not only limited to government and corporate intrusions. As information processing technology becomes more innovative and human-like, the advent of the dystopian world Orwell foresaw is moving closer to reality.

Ethical Issues (Biased and Discriminating Algorithms)

As AI algorithms with time inevitably move toward replicating human cognitive patterns of conduct, and more closely resemble systems that are capable of inferential reasoning, the greater the concern becomes about who has sponsored the design of the algorithm, and by what moral or ethical compass the logic is directed (FBI vs. Apple). Ideally, an AI algorithm should be expected to not disadvantage any party when grinding through to a concluding outcome. An optimist might ignore the prospect that AI technology could be used for nefarious purposes. But as Einstein and his associates came to realize during World War II when unleashing the atom, the unintended consequences could, and did, have world-shattering potential. So also could AI technology in the wrong hands. An innate rising sense of distrust of

this technology is already possible to detect. Reining in algorithms that distinguish and disadvantage will increasingly be a challenge which all societies will face.

This concern has not gone unnoticed in Silicon Valley, around Kendall and Harvard Squares in Cambridge, and elsewhere in the scientific community of the Western developed world. Technological futurists are well into how to ward off what Stephen Hawking, when referring to the AI ethics issue, has termed a " . . . technological catastrophe vastly exceeding the human sort." The immediate issue is with the development of autonomous weapons tasked with various missions to kill! And with the accelerating convergence of instantaneous computer processing, more productive and responsive learning algorithms, as well as expanding usage throughout an exponentially growing list of applications, keeping the AI genie in the bottle in an interconnected online world becomes a not terribly optimistic and almost impossible undertaking.

Drawing up, gaining universal acceptance, and enforcing ethical rules for AI research, development and applications, never mind global enforcement, would seem almost an insurmountable, possibly quixotic, chore. Will Vladimir Putin, or the Iranian mullahs, abide by rules of conduct aiming to control the ethical behavior of such programming?

Nonetheless, such a movement is underway at Stanford, MIT, Harvard, and the University of Texas, and elsewhere, all aimed at drafting a catechism for AI technical development while "keeping society in the loop." An initial report from Stanford titled "Artificial Intelligence and Life in 2030"* argues it will be difficult to regulate the development of AI in that ". . . the risks and considerations are very different in different domains . . ."

Underway also are two separate Silicon Valley firm-sponsored efforts which aim to set societal and best practice norms for AI research. Google, Facebook, Amazon, IBM, and Microsoft are joining forces to define conduct standards and advance public understanding. The program, "Partnership on Artificial Intelligence to Benefit People" (Partnership on AI) will tackle ". . . issues of fairness and inclusivity, transparency, privacy, trustworthiness . . ." The other effort, "Open AI" . . . is a non-profit artificial intelligence research company . . . formed by the peripatetic Elon Musk. Its mission as stated, ". . . is to build safe AI and ensure AI's benefits are as widely and evenly distributed as possible." No doubt the mid-October, two segment AI piece on "60 Minutes" was in part attributable to Partnership on AI's PR efforts.

Just as there is an infinite variety in human cognitive patterns, psychological profiles, and applications to be replicated, guaranteeing freedom of expression while protecting privacy rights needs to underlie an effort to codify any rules of AI development conduct. Some sense of common ground in the Western world might be gained in this challenge, but represented at the

*Stanford, One Hundred Year Study on Artificial Intelligence (AI100), 2014

global negotiating table will be a vastly different set of going-in philosophical principles in totalitarian, autocratic, Eastern Asiatic societies.

Can a Robot Be Taught to Section a Grapefruit?

Computer programmed robots have taken over automobile production lines in Detroit and throughout the rest of the developed world. Vastly improving quality control, the jobs undertaken by these automatons are performed within a precisely constrained domain. Nothing more or less is expected from these machine-driven repetitive routines than a perfect weld or a screw placed in a designated hole and turned to its optimal torque setting. The individual who once functioned in this role has been replaced; and, of course, has needed to reinvent his/her occupation. But today the same car production line robot, or any present more sophisticated AI algorithm for that matter, given the variety of shapes and sizes it comes in, would be hard pressed to learn the very human skill of sectioning a grapefruit for your breakfast table. But such applications are not too far off in the indeterminable future.

AI-programmed interaction on the internet between an Amazon customer and Amazon's search engine is more broadly constrained. As Amazon's AI algorithms, or Google's inquiry and search activity, continually learn from a given user's questions and choices, and build their AI-assembled user profiles, the user's evermore robust file will, in turn, prompt pop-up ads on subsequent online encounters, and generate targeted, unsolicited e-mails focused on the customer's indicated interest, age, socioeconomic status, location, and any number of other variables the big data-sifting algorithms have been developed to gather and track. In the individual setting, these personal data parsing systems represent the state-of-the-art of applied consumer AI applications today. In soon-to-be driverless cars, remote medical diagnostic and treatment techniques, analytical tools to develop and measure the effectiveness of government policy initiatives, and AI applications for the U.S. Defense Department which delegate to inferential machines the decisions to kill, the future looms. The challenge ahead would, it seems, to be ". . . how to keep society in the loop" as the inevitable, inexorable evolution of AI unfolds and promises to further intrude.

"A Financial Planner with Nerves of Silicon"

In October 1985 this assertion headed a *Business Week* article describing a pioneering AI program developed during the heady early days of AI's first wave when the technology was thought to be a new era in computing. It was an early effort in Cambridge to create an expert system replicating this writer's and collaborators' approach to comprehensive personal financial planning. According to *Business Week*, our effort produced "Plan Power. . . one of the most complex 'expert systems' ever built . . ."* *Forbes*, in its December 30, 1985 edition, "Deus ex Machina," described our PlanPower (a 6,600 "what-if-rules-based" expert system) as ". . . featuring audited analytical and accounting methodologies, along with computational tax-

**Business Week*, McGraw Hill, October 7, 1985

planning formulas and unique asset class allocation strategies to provide a planner with an optimized framework to interact with clients . . . *and simulates the thinking patterns of a human expert . . .*" In the mid-1980s, AI's prospects were thought to be limitless, but in *Globe* columnist Scott Kirsner's more recent words, ". . . technology moves blindingly fast—except when it doesn't."#

PlanPower was a $40 million write-off for a major Hartford insurer for a number of reasons, not the least of which was frustratingly slow computer speed, but just as importantly a lack of understanding of elemental individual behavioral heuristics on the part of both intended planner-user (i.e., insurance agent) and client. It goes without saying that in today's IT world, computing power has yielded the instantaneous response times required to remove the hardware speed issue holding back AI in the mid-1980s, but replicating human cognition and the soft inputs of emotion, government policy and geopolitical events still have not been achieved. Neurologists today suggest that a fuller understanding the brain's physiology remains an elusive goal. Further, for all the reasons cited earlier in this article, expecting dramatic breakthroughs in such broad and all-encompassing domains as comprehensive personal and individual financial planning and investment portfolio management would seem beyond reach presently.

How Might AI Play Out in the Future Personal Financial Services Environment?

Jason Zweig, in a recent *Wall Street Journal* column, "An Investing Idea for the Near Future,"* contends that AI-based platforms effectively program themselves to analyze data and solve problems. He further asserts that "Backed by artificial intelligence, a human advisor should be better able to prevent a change in emotions or circumstances from knocking you off track to meet your goals." As a decision support tool, Zweig's contention may hold up, but AI remains a fair distance from the time when algorithms can broadly replicate human thinking patterns, particularly in such full-bodied domains as personal finance and global financial market behavior. *At best such programs remain decision support tools, not decision-making techniques.*

A futuristic application of AI in the field of personal financial advisory services might have a Registered Investor Advisor's (RIA) client submitting to an fMRI brain scan analysis while the client puts his/her head in the tunnel and responds to 20 questions framed to elicit the client's response to various investment risk situations. This would be supplemented by a genome map uncovering the client's DNA pattern and hereditary propensity to take, or avoid, risk. The resulting data aggregation would then be parsed through an AI-based natural language generation program that crafts a client-specific investment policy statement (IPS).

#"Watch Out: The AI Bulls Are Running Again," *Boston Globe*, July 7, 2016
**Wall Street Journal*, September 10-11, 2016, p. B-1.

Armed with such information (never mind the inherent privacy issues in the genome map), the financial advisor could then provide a blueprint for the client to achieve financial independence. But the weakness in this picture is that the profile has been compiled in an essentially stress-free setting. Attitudes about risk are situation-dependent and are not consistent. Financial market circumstances shift daily, if not in nanosecond timeframes, and whereas the human brain can sometimes handle and balance all these inputs and variables, programming computers to deal with this almost infinite dynamic and interactive range of the dependent variables in this equation is not in the AI technology cards presently. Nor, if neurologists and computer scientists are pushed to opine honestly, is it likely to occur in the near future.

Can AI-Based Portfolio Management Algorithms Improve Individual Investor Account Performance?

The individual investor, indeed investors generally, is/are caught in a difficult-to-solve equation. In an attempt to earn a real return on capital at risk, each finds him/herself locked in a zero-sum game contested on a mean-reversion playing field. It's a global competition in which yesterday's winning strategy becomes today's conventional wisdom adopted by individuals and professionals alike. Relying on past results, what in retrospect seems the obvious best formula for future success quickly becomes inundated with overwhelming amounts of cash and loses currency. What produced yesterday's alpha (excess return) becomes today's beta (systematic risk). It is a game where behavioral biases, hubris and over-confidence trumps rational expectations, a domain which is both wide ranging and fraught with unintended consequences; not, one might infer, fertile territory for AI applications.

In today's low investment return expectation environment, traditional active management (i.e., individual stock-picking, attempting to generate excess return vs. a financial market benchmark) is being questioned and under the cost-cutting microscope. Since the mid-1970s, Jack Bogle, when commenting on active management approaches, has maintained, "The most important of these rules is . . . the eternal law of reversion to the mean (RTM) in the financial markets."*

In a mean-reversion (less fees) universe, where the top of the heap for short periods of time is defined by the likes of Peter Lynch, George Soros, John Paulson, Ray Dalio, and David Swensen, can knowledge-based AI program logic, and algorithms, add excess return to the *average investor's* portfolio performance results when yesterday's alpha is today's beta? Since a robust macro-econometric model must track and map as many as 2,000-3,000 dependent variables, and even then cannot incorporate the "soft" inputs of sentiment (behavior), government policy and geopolitics, over the longer term in the portfolio management context, won't reversion-to-the-mean (less fees) results necessarily be the outcome? Even at

*John C. Bogle, *The Clash of the Cultures: Investment vs. Speculation*.

exponentially greater computing speeds, escape from a mean reversion result (less fees) would statistically seem not possible.

In today's and future "robo" revolutionary online world, what will be the impact of AI-based online support programs on the RIA-offered personal financial advisory business (profession)? Can these online, "personalized" programs improve the odds for individual investors of achieving at least a mean reversion (less fees) investment return? Can the *Financial Times* (www.ft.com/funds) really help an investor ". . . invest in funds the smart way?" Even if sifting through an all-encompassing global financial market database, and an investor or his/her advisor could isolate useful predictive fact patterns will not ". . . both investors and their agents still fall prey to behavioral biases in interpreting what is happening, the handling of which will probably explain outcomes better than an underlying active management function itself."#

If mean reversion (less fees) investment return outcomes are the expected statistical norm, can an AI algorithm (purporting to learn from its own experience) ever be smarter, or make better decisions, than those who design its logic? And in attempting to find certainly in an uncertain, often irrationally, randomly behaving domain, in which the fuzzy math of chaos theory prevails such as the global financial markets, can an AI-driven "rational" decision-making process derive practical solutions? Can such an approach ever be expected to solve spontaneously occurring problems or react rationally (by whatever definition) to randomly arising situations requiring creative responses? How will AI deal with the law of unexpected consequences which always seems to be the unknown variable in most investment equations?

Meanwhile in the Investment Portfolio Managers' World*

Artificial intelligence is already in wide use among many investment managers and financial advisors. The current generation of AI includes algorithmic trading programs, quantitative investment strategies, analytical models for risk management and consumer-focused advice models that create risk-defined investment portfolios through an easy to use interface.

Algorithmic trading strategies systematically trade based on a mathematical model or other objective criteria, and make it possible to trade at a speed and frequency impossible for human traders. *Quantitative investment strategies* are systematic approaches that use quantifiable inputs to identify investment opportunities, and may be loosely defined to include smart beta, factor-based and quantitative alpha strategies.

#Financial Times, "Letters," Stuart Fowler, August 8, 2016
*Dan Kern, Chief Investment Strategist, TFC Financial Management

Technology advances have dramatically enhanced the *risk management* capabilities used by investment managers, but the room for arbitrage narrows as financial market modelling becomes more ubiquitous. Analytical models help investors to understand their risks, going beyond the basics of stock, sector and country weightings to assess a wide variety of factor sensitivities and explore a wide variety of "what if" scenarios. *"Robo-advisors"* offer online advice through a user interface, creating diversified portfolios aligned to an investor's risk tolerance and financial goals.

There are common themes visible in the current generation of AI-supported investment activities. Advances in computing power make it possible for machine-based systems to answer quantifiable questions faster than a human and to analyze multiple dimensions of a bounded problem. Despite the undeniable impact of AI on investments, human design remains the driving force. Algorithmic trading strategies are informed by technology, but designed by humans, as are quantitative investment strategies, risk models and robo-advice.

The ultimate leap forward is for AI to become adaptive technology capable of replacing the human element in design. It's unclear to us how close we are to that leap forward, though perhaps a window into the future is visible through innovative firms such as Palantir, a big data firm whose original clients were intelligence agencies and Kensho, a firm on the cutting edge of developing "what if" scenario analysis for investment firms.

Concluding Thoughts

It will be interesting to observe the inroads of AI into addressing harder to quantify questions involving more of a human connection. Human advisors spend much of their time helping clients balance between multiple, often-conflicting goals that have a financial element as well as heuristic and emotional elements. The emotional element, particularly if faced with a Black Swan event, is much harder to codify and capture for AI than the financial element, and typically requires trust, non-verbal insight and intuition to navigate. Current forms of AI are not yet equipped to incorporate the "human" element.

Another interesting dimension involves decision-making when outcomes are uncertain and subject to a high degree of randomness. Investing combines elements of luck and skill, and emotions play a significant part in explaining investment performance over short and intermediate periods of time. Is it possible for AI to fully replicate the wisdom of a Warren Buffett or George Soros, or the creativity of a Steve Jobs?

In the end, AI software logic must be translated into an array of numbers and interpreted through hard-wired circuitry. To expect such electronic processing to achieve sentience, at least in today's highly touted "global golden age of AI," would seem a stretch, and

not yet a major threat to the human condition.* The real challenge that AI poses for the personal financial advisory profession is not so much whether AI-based platforms will replace in-person rendered advice, but more importantly, can advisors learn to work with it in a complementary fashion , as the science evolves, thereby offering clients the best of both worlds.#

*BCA Special Report, "AI and Deep Learning," October 18, 2016
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