

## Human AI

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### Abstract

Finance is a key milestone for AI. Imagine coming back from vacation and talking to your virtual assistant about your investment portfolio and wondering how she does it, quarter after quarter, year after year. Managing money is the real test for human AI. It has to talk, it has to think, it has to have intuition and it has to make money. Despite the AI Game successes, there is no AI player with such capability today and it's unclear whether brain emulation under Strong AI is the preferred direction for achieving human AI. This paper uses a historical context to explain why it maybe time to denounce social systems, embrace system thinking, and explore simple ideas like computational linguistics to explore technologies that can teach computers to talk, think, assimilate knowledge and hence also manage money. Such technologies should set up the foundation for Web 4.0.

### Key Milestone

*-Underperformance:* John Bogle's 1951 [1] Princeton thesis questioning the mutual funds performance got reconfirmed by Samuelson's 1975 [2] "Challenge to Judgement". This led to the first institutional initiative that questioned mutual fund performance. But the story of under performance has gotten worse since then. Now it's the active managers, the hedge funds and even the pension funds which are punishing underperformance [3]. Rule based systems drive a sizable share of the industry today [4]. ETFs have gained ground, advisors have lost clout as investors herd into passive investing [5]. If this was not enough, near zero fees are making sure that Vanguard's movement is slowly killing the industry [6]. On the other side the surviving hedge funds are struggling, recklessly betting, losing money [7] (Valeant) and seem unable to come up with an effective differentiation [8] which can help the industry find its feet. If the industry leaders like BlackRock with an army of 28 PhDs fail to build smarter outperforming systems [9] (A third of their rule based systems outperformed last year), the industry has a problem. Trades that make a billion dollar gain and lose a few billion dollars have turned Finance into an adventure failing sport.

*-Stuck in the past:* Modern finance is stuck in a 60-year-old past and its disruption will lead its commoditization. It all starts with infighting but later reaches a Nash equilibrium [10], when it makes more sense to cooperate than compete. There is actually no clarity on what is ethical and what is not. After 20 years, it is common market knowledge that betting on big Size weighted market capitalization is inefficient. This led to the birth of smart beta [11]. You cannot simply keep telling the world to overweight a big Size company in your portfolio. John Bogle is wrong in doing [12] that and it does not need technology to challenge such opinions. Or even ask Robert Arnott how he could market the fundamental index and economic value for a decade and decide to eventually go the multi-factor way [13]. The stories of non-scientific methodologies are endless. [14]

Just like all natural systems the finance industry has got clustered behind big Size and small Size forgetting research papers that suggested the possibility that Size could be a proxy [15] and a host of other work by Boulding [16], Klien [17] and work of Ball and Brown [18], Bernard and Thomas [19] which explained information was hard to quantify as it drifts. The finance industry continues to ignore history as it continues to downsize in revenue. The history even goes back to Jules Regnault [20] but the industry continues to ardently hold on to the mast while the

ship has fallen apart. This is not a story about persistence but inability to adapt. This is why HMC firing its fund managers [21] and Marc Levin [22] support of rule-based passive systems suggest that the industry is late for change. The disruption has already happened, the firing has to catch up.

*-Circular Argument:* My argument vs. yours is not helping. [23] The Beta and Smart Beta are in conflict. [24] Behavioral finance cited behavior as reasons, while modern finance refuses to confirm the validity of the behavioral biases. The brief history of modern finance sees a stout defense of personal opinion while claiming the other view as wrong. “How did some of this stuff ever get published?” – Fama.[25] “End of behavioral finance” – Thaler. [26] “CAPM is CRAP” – Montier.[27] “Great Intellectual Fraud” – Taleb. [28] “Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?” – Shiller. [29] “Investing styles are like riding one horse until it tires” – John Bogle. [30] “Can the Market Add and Subtract?” - Lamont and Thaler. [31] There is a lack of coherence, confusion and a circular argument which does not bother the industry, even while it bleeds. Finance is suffering from the tragedy of commons.[32] It belongs to no one so there is no accountability. I remember a fund manager in India laughing about inside information. It did not matter to him because India was another world where global ethical norms could be flouted easily.

### **Ineffable Social Systems**

Finance relies on social systems, which by very nature are unstable and have threatened the existence of society more than AI. The history of economic crisis continues to be rich and vivid.

*-History:* Adam Smith highlighted the role of the human agent in economics. [33] Thomas Malthus talked about the dynamics of social economics. [34] The war between ‘Vices’ and ‘Virtues’. The evolution of social sciences focussed more on agents of change rather than the System encompassing the respective agents. So the ‘System’ has been less important than the agents. Consequently we assign more importance to the agent and the interactional and transactional information generated by these agents. This has made the society focus more on causality rather than understanding System behavior. Social systems were designed to systematize social behavior. Over the last 250 years, the inefficiency of social behavior and the inability to map it has brought out the limitations in economics and the modern finance which sprouted from it.

*-End of Behavioral Finance:* Despite Thaler’s overconfidence [35] behavioral funds failed to live up to their expectations [36]. Daniel Kahneman’s work on intuition though brilliant does not answer the more important question about why intuitive judgment does not conform to statistical principles. [37] The assumption that statistical principles are robust is at the heart of the behavioral finance. Removing that assumption puts the existence of behavioral finance into question. This is what the author explained in his version of “End of behavioral finance” (Pal, SSRN, 2013). Assuming the robustness of statistical laws and building a behavioral Nobel Prize winning subject matter would have been ok if there is no historical connection between psychology and statistics. John Rae’s intertemporal choices [38] explained the mathematical behavior of instant and delayed gratification [39]. Behavioral finance conveniently ignored it. Celebrating the partnership of Kahneman-Tversky [40] is fine till it limits itself to appreciate the psychological flaw in human thinking that the duo highlighted. The bigger question is why psychological behavior like many other natural characteristics fail to confirm statistically and could the statistical failure itself be a necessity for nature to function. It’s the inability to ask such questions that has kept the society (modern and behavioral finance) dependent on the social system. This is about to change as statistics gets ready to answer such questions and explain why human nature diverges from statistical laws.[41]

Despite the mathematics, we as a society have indulged with terms like Socionomics[42] and SocioPhysics[43], connecting skirt lengths [44] and other spurious correlations. Because the whole idea is newsworthy, the industry continues to see mushrooming of sentiment analytics based funds [45] and thematic ETFs [46] which rely on fads and investor appetite. We don’t question the assumption of social systems because we enjoy spending

disproportionately large resources understanding social over understanding Systems. The wisdom of crowds vs. madness of crowds. [47] The hypothesis that social moods lead the System is a correct assumption if we want to study causality and is the an incorrect assumption if we want to study Systems because agents are of many kinds but the System is universal. The assumption that social behavior drives the System assumes that behavioral divergences are flaws. It's an inefficiency that needs to be curtailed for efficiency. A similar argument has kept Eugene Fama busy by extolling the Efficient Market Hypothesis [48] despite evidence that markets are inefficient. The efficiency-inefficiency debate [49] is correct till we want to debate the behavior of agents but if we place the System before the Social (Agent) than inefficiency becomes a necessity, an ingredient for the System functioning. It's not a new approach, it's an approach which gives nature credit for self replication and regeneration. The approach accepts that in the bigger picture, human thinking is predictable and is of little importance for the proper functioning of the System.

### **System Driving Behavior**

*-Information:* Informational research has outlived its utility. Starting from the Reuters pigeons to information arbitrage to the Dynegy accountant [50] to Victor Niederhoffer's breaking news research [51] to the imprisonment of Raj Rajaratnam [52] to Goldman Sach's disassembling of its trading desks [53]. Information is accessible, it is inexpensive, it's inconsistent, it's data. Economics and psychology (behavioral finance) also suffers from unexplainable information inconsistencies. The economics tool box is limited to answer such inconsistencies like the equity premium puzzle. It's one thing to say that investor behavior is flawed but it's another thing to explain social behavior inconsistencies. Social Systems rely on information and information is transforming and evolving and losing its premium. Services and businesses based on such information are fighting for a lost cause. The decay of the dismal science might seem like a dramatic thought but the increasing irrelevance of our economic systems in the fast changing information landscape is a reality hard to ignore.

*-System Thinking* is not just a relevant case for AI finance for strong AI. This is not the first time that System thinking has been broached. Schumpeter's Business Cycles did it in 1850 [54]. Herbert Simon, father of AI emphasized System thinking in 1952 [55]. But the lure of causality is addictive even if nature thrives and propagates, Social Systems are lost without the popular vocation of discourse. Information dynamism is finally challenging the idea as general AI starts solving world problems by model thinking. The assumption that agents in a System could be less important than the System itself is the new age thinking because agents can be of different types while System functioning could remain universal. And if the System is more stable than a Social System, is able to map and explain behavior, is able to anticipate imbalances, explain inconsistencies of the modern finance, is self-sufficient, self-regenerating, dynamic and also a System that relies on inefficiency, embraces it, explains complexity, order, and disorder, then the System is intelligent.

### **The Opportunity**

*- No Early Birds:* The AI 100 of 2016 had five names in finance [56]. Cape Analytics is for the insurance industry. Kasisto is conversation AI for personal banking. Alpha Sense is a financial information service provider. Numerai, is based on the wisdom of crowds, encryption, disintermediation, infrastructure, dynamic data modeling, collaborative tool for stock market enthusiasts. Kensho is about information service, data analytics, cost efficiency, stock prediction, data mining and propagating legacy finance, the very areas the author believes are the vestiges of the old finance. What will become of USD 67 million Kensho has raised is not hard to predict.

*- Infancy Reasons:* The reason why AI money management segment is in its infancy is because of legacy bias. The 85-year-old secular trend, disinterest from millennials, multiple stock market crisis, Active money opacity, electronic trading (Virtu) [57], exodus from the industry, reducing fees, regulation, entry barriers. A large part of the industry still relies on information and crude systems the reason for market frauds, Ponzi schemes, and large hedge fund

losses (LTCM, Amaranth, Tiger, Marin etc.) continue to color the landscape. The recent increases in computing power, fintech infrastructure players are changing the trend, but we still have to see real contenders in the space. According to the PWC report [58] the market growth is going to come from new innovations, but none of such innovations are visible today.

*-The Whales* – Renaissance USD 65 billion and 72% annualized returns [59] stand in stark contrast to an industry that is firing fund managers because passive low fee seems the best way forward. Such a divergence between USD 100 trillion dollar investment management industry which can't beat the S&P 500 on a consistent basis while computational linguists applying mathematics continue to outperform. Their success suggests that outperformance might have nothing to do with our understanding of Social Systems but may have a lot to do with pattern recognition and computing. Whether the linguists keep winning is not the question. The question is, what is the wrong that the USD 100 trillion is doing? This is the opportunity for AI finance, which can retake up the Warren challenge from where Protégé left [60]. How strange is it that Science has no qualms about talking about the ineffectiveness of the 50 year old Turing test, the essential history of computer science, but Finance professionals lack the courage to challenge a 250-year-old economic thought, Social System thinking and the modern finance that we have built on it.

## **AI Games**

*-The Brilliance of AI Games.* The increasing diversity of games, the ability to train on trillions of hands of Poker, the procedural improvements, combination of reinforcement learning with neural networks, the move towards general AI, closed system thinking, variable enhancing, task generality focus, computing reduction, risk reduction and the garbage to gold approach is the brilliance of AI Games.

*-The AI Games Myopia:* Pattern recognition has a limitation when it comes to solving real world problems. If it was that easy then we would not suffer from the USD 65 billion -USD 100 trillion paradox. If pattern recognition was all that mattered than the whole Science of Chaos and the idea of risk management would have collapsed. Law of large numbers [61] has its excitement in perfect information games, but the law of large numbers will collapse when there is information asymmetry [62]. AI may feel emboldened because it can fool its way to seem human [63] but these are early victories. AI has a bigger problem which comes from its statistical assumptions. The reason finance has failed is not just because it relies heavily on linearity but also because it has a limited understanding of complex systems. AI has limited understanding of complex systems too. Inability to understand and decipher complex systems is why fields like evolutionary robotics are stagnating [64]. It will be a while before we move to Smart AI.

*- AI's Stock Market Problem:* To move towards Smart AI, algorithms have to be made to think about a composite of decisions which need to be assigned weights, where the focus is more on stability than accuracy. The algorithms need to learn the tradeoff between scalability vs. predictability, between cross-domain applicability vs. single domain expertise etc.

## **Strong AI**

*- The Fooled Frog:* I don't think building models of the world and acting on it is the crux of intelligence [65] because nature has already done it. The fooled frog is a part of nature. Its nature is about being fooled. It's not designed to be intelligent. Agreed that systems can also be fooled by patterns as they have limited ability to imagine or reason, but the comparison of today's AI to old brain, which should learn from worldly interactions assumes that human naivety is unnecessary and also that the ability to process information signals is intelligence. To solve the computers semantic and common sense problem we need an alternative outside the Brain. We can not discount that a network is smart and brain is not the only network. Kurzweil's vision [66] seems intuitively flawed to me. He assumes Statistical robustness. The more I think about the Brain project, the more it reminds me of the idea of Boltzmann's brain [67], the braid which proclaimed "I exist" but then nature decided to give the brain a body too

because the law of entropy decided to behave differently, creating life despite bleak probabilities. What if self-replication natural systems are all that we need and not emulated brains.

### **Big Data – Small Problems**

Pre internet era was about physical books and libraries, information was premium and access to data was for the elite. This is why data had a mysticism about it. Though ‘Big Data’ is nearing 70 years [68] as an idea, the world still faces problems linked to poverty, diseases, conflicts, population, energy, economics and climate change. One could conclude that the big data can offer us a window to a more objective world, but it is oblivious to what makes the data tick and what is knowledge. We ostensibly have made science fiction of the 1987 a reality (take Star Trek IV: The Voyage Home as an example, when Scott assumed talking computers), but it took Siri nearly 20 years to appear on our phones.

### **Listening computers**

The semantic web also referred to as Web 3.0 was expected to be a web of a data that can be processed by machines, hence allowing a faster and more optimal search. The expectation was a meaningful manipulation, a language through which machines could make databases talk. The databases still don’t talk, but some machine reading has already started happening between inter and intra-domain databases. It may still take a while before computers can talk.

Tagging data is assumed to be a pre-step to listening computers. First comes the tagging, then the reading, relating and the listening. After that comes “I don’t understand”, but that’s all fine if the user is patient and willing to give feedback to the computer about where it is wrong. Something like a parent teaching a child. This is not how we perceive technology today and this is not how Tim Berners-Lee imagined the semantic web process, which is more about knowledge navigation than knowledge machines, more about searching for knowledge than about assimilation of knowledge.

Even if we assume the stages of Lee’s vision about semantic web were sequentially correct, and the industry starts adopting technologies for tagging data, we might still lose some of the older, untagged information. A lot of information might just stay untagged and hence unsearched. The problem can only be addressed if the intelligent web tags itself as it adapts to old and new information. This might seem like science fiction, but if we aspire an intelligent web, tagging is the least of its impediments.

### **The Semantic Puzzle**

One of the surprises I had in 2014 was the number of data sharing companies presenting at the Web Summit. The speed with which we are moving to the cloud and overcoming resistance to data sharing suggests that we are moving in the right direction. Adding logical inference to the interconnected databases brings us closer to what Lee, Hendler, and Lassila envisaged [69] and wrote about in Scientific American in 2001, but this is not all that the semantic web can accomplish. Semantic web is the step before the intelligent web. This is why any set of assumptions play a cardinal role in the future of the web. If by chance the assumptions are wrong, the intelligent web may miss us by a generation and we may still be in the dark tunnel of data, without the knowledge of lighting the proverbial firewood.

Lee et. al said that “The human language thrives when using the same term to mean somewhat different things, but automation does not.” The assumption that automation cannot flourish where human language prospers is the semantic puzzle that could circumscribe our vision.

Agreed that automation has limitation today in terms of learning how humans use the language, but it's the ambition of learning this subtlety which is the real hurdle for the creation of the intelligent web. The final objective of the web is to have a conversation with the user. If computers can listen they should also be able to have a conversation, a thinking web. Semantics can not be simply visualized as a half suspended bridge to knowledge navigation. Any semantics bridge we build should allow the humans to tap into the knowledge of their own network, a real journey, with an intelligent guide.

Semantics is the answer for the machines to understand the human language and even become better. Only then can we discuss mathematical conjectures, puzzles and ideas of complexity with a machine, which is smarter than us.

We may have unintentionally slowed down this process (previous assumptions) or may wish to slow down the process intentionally, fearing the uncertainty accompanying a thinking web, but eventually, the 'Web Singularity' is a reality, which will obviate the need for supercomputers at every home. The intelligent agent will be for everyone with an internet connection.

### **Mathematical History of Language**

The answer to the semantic puzzle can be found in the mathematical history of language. In 1916 the French stenographer J.B. Estoup [70] noted that frequency ( $f$ ) and rank ( $r$ ) were related by a "hyperbolic" law which stated that the multiplication of rank and frequency ( $rf$ ) was approximately constant. This meant that human use of language was distributed mathematically. American linguist George Kingsley Zipf (1902– 1950) confirmed [71] that the hyperbolic rank-frequency relationship appeared to be a general empirical law, valid for any comprehensive text and with a surprisingly high accuracy. This is Zipf's law.

In their paper "Zipf's law, hyperbolic distributions and entropy loss" [72], Harremoës and Topsøe suggest how Zipf argued that language development was about a vocabulary balance which was driven by two opposing forces, the forces of reversion (unification) and diversion (diversification). The force of reversion tended to reduce the vocabulary and corresponds to a principle of least effort made by the speaker while the force of diversion had the opposite effect and was linked with the listener (auditor). Zipf did not transform these ideas into a mathematical model, his basic consideration was that conversation (knowledge) was as a two-person game, a speaker, and a listener.

### **The Intelligent Agent**

Assuming that the missing mathematics of Zipf is available today, machines could be taught language just like a child learning to speak from a parent. The child adopts the path of least effort, while the users make an effort to impart meaning to the speech. This is unlike what is happening today, as the conversational learning is for the knowledge navigators and not for machines which assimilate knowledge. Conversation is knowledge. This is a dramatic change from machines reading information to machines assimilating knowledge as an intelligent agent.

Once the machines start understanding, leveraging on their ability to read a cross section of tagged databases and their ability to comprehend the subtlety of human language, the machines will be able to assimilate knowledge and become intelligent. These machines will crawl the web and look for solutions to complex problems, as they become more and more intelligent. This will not be artificial but pure intelligence. This is already happening as supercomputers assimilate information, but this is centralized learning. Knowledge assimilation will eventually move to the web, as the mass of cross-sectional domain data is on the web.

Singularity is about knowledge assimilation and web singularity is about the assimilation of knowledge on the web. The latter being exponentially larger in scope than the former. As scary as it may sound, the decisions are still

human and web agent remains a decision support system. The internet is used for the good and the bad. The intelligent web will be no different, but the pace of science will accelerate as knowledge assimilation systems start assisting in developing solutions for bigger world problems and maybe even beyond this world.

## **Conclusion**

Computation is not the answer to societal problems and human AI. Human naivety is essential for the functioning of a Social System. We should have understood this from the Stanford marshmallow [73] experiment, the Solomon Asch [74] three line experiment, the Milgram experiment [75] and the other experiments that have consistently confirmed that human's herd. Any system including Social Systems work because agents herd, show randomness and order. This is the very nature of complexity. The real evolution for us as a society is to think System, think complexity and make efforts understanding it. Disruption can not be forced, it's natural. The author believes that building a cognitive brain is a wasteful way to build intelligence because Systems should be stable first before they are intelligent. Nature already has the answers for stable Systems. Infrastructural and method innovations like Blockchain and Fintech should not be confused with financial innovations. The industry needs financial innovations to bridge the underperformance opportunity and change Finance. FinTech will cease to be a standalone segment but become one with a broader trend towards data universality, driven by connected data, common behavior, and Intelligent Systems that can use not only process data but assimilate it, reconstruct the past and anticipate the future of a System. AI Finance is an essential milestone for technology to advance to Human AI, Web.4.0 and the Web Singularity. It's an unending journey in terms of the human epoch which may or may not turn into machines or cyborgs but persist the trend towards better Systems.

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