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# AMBIGUITY TOLERANCE BEATS ARTIFICIAL INTELLIGENCE

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INVESTMENT DECISION  
ARCHITECTS™

# AMBIGUITY TOLERANCE BEATS ARTIFICIAL INTELLIGENCE



## SUMMARY

This article intends to demystify the use of artificial intelligence in asset management. Readers will learn how to embed AI in their professional investment decision architecture, by managing their own ambiguity tolerance. Presented insights are illustrated with examples.

## INTRODUCTION

As independent applied behavioural finance experts, our consulting and training empowers professional investors to make more rational investment decisions within an aligned choice architecture.

In recent years we have increasingly experienced the need to conduct primary research on asset allocation phenomena ourselves, as the financial literature was still occupied with dogmatic shadowboxing on active/passive, efficient/irrational, alpha/beta or smart/dumb beta. Our research empowers us and our clients to better distinguish between relevant signals and inconsequential noise of new asset allocation-related insights, as shown in our analyses for risk parity ([here](#)), smart beta ([here](#)), ethical/unethical asset allocation methodologies ([here](#)) or our ground-breaking research on measuring the global capital stock ([here](#)).

**This article intends to contribute to a growing debate about using Artificial Intelligence (AI) in investment management by demystifying what AI can and cannot do for a professional investment process.** It is a sequel to our article on how to establish High Performance Investment Teams<sup>®</sup> in early 2016.

## 1. ASSET MANAGEMENT INDUSTRY (R)EVOLUTION

### 1.1 COMPETITIVE EDGE - A PREREQUISITE FOR SURVIVAL

As summarized in our [recent article](#) for the CFA-Institute, in an increasingly competitive environment in the asset management industry, all but a few investment firms can only survive if they specialize by establishing and maintaining an innovation-driven competitive edge through a unique investment process and a learning organization. For an example, consider the statements of the [designated Vanguard-CEO Tim Buckley](#), who recently announced that Vanguard will intensify its predatory competition agenda as the price war on standardized investment strategies has only just begun.

### 1.2 CAPITAL MARKET CHARACTERISTICS

In search for a niche to specialize in, market participants need to accept the characteristics of capital markets: they are complex, adaptive systems with a high level of endogenous dynamic, driven by a large number of heterogeneous market participants with imperfect information and bounded rationality.

Finance is first and foremost a social science. Financial market participants can optimize their interactions by more accurately understanding the behavior of other market participants, while understanding their own behavior. This understanding of how market participants can optimize their own investing behavior comes as a rather recent phenomenon. IT support tools are playing a significant role in this optimization. Artificial Intelligence is a special case

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as it carries, through its deep learning engine, the potential of going beyond an IT support tool, entering the field of “Autonomous Intelligence”. The primacy of the human investment decision maker is being questioned.

## 2. ARTIFICIAL INTELLIGENCE

### 2.1 ARTIFICIAL INTELLIGENCE PROMISES SALVATION

Like in the early 20<sup>th</sup> century, we are living in a time of rapid technological change, in which our research breakthroughs are ahead of our ability to use them inclusively and responsibly. It should therefore come as no surprise that tools like Artificial Intelligence or Distributed Ledger Technology (i.e. Blockchain) offer a projection surface for a diverse set of aspirations. While both are, at their core, disruptive to many areas of our lives, their development, their implementation and their societal acceptance cannot be achieved abruptly.

### 2.2 ARTIFICIAL INTELLIGENCE - ENDGAME SCENARIOS

Mark Zuckerberg and Elon Musk [escalated a dispute](#) last summer in their debate about endgame scenarios for AI. Elon Musk describes it as a potentially existential threat to the human race, whereas Mark Zuckerberg highlights the numerous positive applications in the future, implying that mankind can make use of it inclusively and responsibly.

The broader public debate about AI oscillates between bullish tech evangelists and the fear of AI, further cannibalizing the economic foundation of the middle class in developed economies, which still sources its relative wealth from earned income. The potential threats for mankind with regards to weapons, jobs and privacy are significant. The age of [surveillance is here](#). Elon Musk is not the only one strongly recommending proactive regulation before it is too late to control the outcome.

In early September, Oren Etzioni (CEO of the Allen Institute for Artificial Intelligence) [proposed three rules for how regulate AI](#), derived from the three laws of robotics (Isaac Asimov, 1942). Carlos Perez (CEO, Intuition Machine) derives a [set of rules for AI](#) from existing legislations in other fields like genetic engineering. In short, the Zuckerberg/Musk dispute induced industry insiders in recent months to reflect on how to manage the significant potential for destructive use of AI.

In finance, the awareness of regulators and policymakers on their proactive role is still limited, but slowly growing. The comprehensive [IOSCO report](#) on Fintechs from early 2017 touched on AI briefly, and if then in the context of assisted intelligence, partly of augmented intelligence (see 2.3). The BIS has seen an uptick on AI-related articles from their central banks in 2017. This spring at the "AI and Financial Services/Financial Markets"- conference in Tokyo, Haruhiko Kuroda (BoJ governor) [indicated this growing awareness](#) among regulators and policymakers: *„Policymakers should carefully monitor the impacts of possible application of new information technologies on market structure and price formation. (...) To facilitate the application of AI to financial services, it would be important for relevant entities to establish reliable structures for effective governance and responsibility in case of events to ensure public trust to innovate financial services.“*

Looking back at the negative implications of unregulated blackboxes via algorithmic trading (i.e flash crashes) over the last 15 years and the regulators response to those, they would only be consequent, if they are also limiting the reach of autonomous intelligence, therefore demonstrating the primacy of the human investment decision maker. Any other regulatory response would naively believe in self-regulation, an approach that has failed over and over again.

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## 2.3 ARTIFICIAL INTELLIGENCE – STATUS QUO

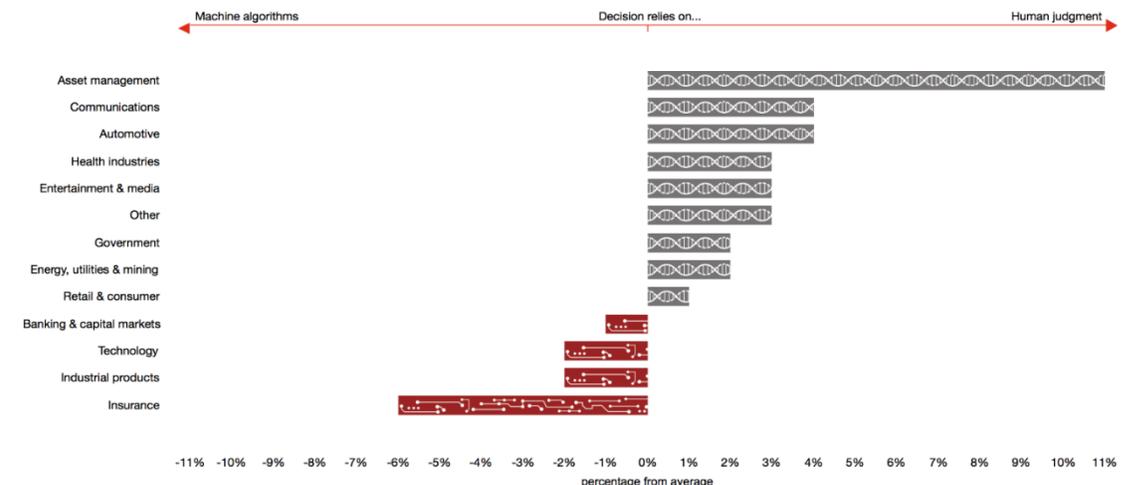
Coming back from endgame reflections and related regulations to where AI technology currently stands, it allows a more nuanced analysis, as Artificial Intelligence is still far from fulfilling the futuristic promises of its preachers.

The [World Economic Forum](#) summarizes our current understanding of AI implications as follows: „Recent studies, including one from McKinsey and another from the OECD (...) look at specific, repetitive tasks instead of whole jobs and find that, for most of us, some fraction of the work we do each day could be done better with AI, (...) enabling us to spend more time on creative problem-solving and on the parts of our jobs that involve complex human interactions and relationships.“

As Clare Flynn Levy (Founder & CEO, Essentia Analytics) [suggests](#), a useful framework for measuring how far technology’s intelligent capabilities extend practically into different sectors and fields, can be found in the work of PwC’s Anand Rao. He presents AI as a continuum, which ranges from Assisted Intelligence through to Autonomous Intelligence:

- **Assisted intelligence:** Computers take on automation of existing processes, including the replacement of repetitive and standardized tasks previously done by humans.
- **Augmented intelligence:** Where humans and technology learn from each other, empowering humans to do things they couldn’t do before.
- **Autonomous intelligence:** Computers make all the decisions and can program themselves.

The asset management industry is known for being conservative in adopting new technologies. For instance, in the PwC 2016 Data & Analytics Survey of over 2100 senior executives, the asset management industry stood out in its dependence on human judgment in investment decision making. In our [CFA-Institute article](#) on AM survival strategies, we called the following “Schuller’s Law”: The less personal the variable to be optimized in an investment process, the lower the organizational resistance. Due to the shown dependence, optimizing an investment decision process is facing high resistance.



PwC's Global Data and Analytics Survey: Big Decisions TM. Base: 2,106 senior executives

Illustration A Slow Technology Adoption. © PwC

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Concluding on Anand Rao's categorization, we can say that the asset management industry currently uses AI as "Assisted Intelligence" and is slowly shifting towards "Augmented Intelligence", an expression coined by IBM. Taking into account the Zuckerberg/Musk exchange and the manifested antipathy of the regulators for black boxes, "Autonomous Intelligence" might neither be technologically possible, nor regulatory compliant in the foreseeable future.

However, especially hedge fund managers are working intensively on exploiting the use of AI to the maximum. At the forefront Man Group, Renaissance Technologies, Two Sigma and Bridgewater Associates [can be named](#). In their AI-systems, humans are playing a different role. Nick Granger (Man Group): *"For all the talk of machines eliminating the need for humans, the job of building and managing an AI system is labor-intensive, which means Man is more interested in hiring engineers and data scientists than MBAs. Completely autonomous machines aren't taking over anytime soon. (...) The idea that the humans will just disappear and would be banned from the process is just not right. (...) It's just that they move to different tasks, to higher value-added tasks. We need smarter humans than we did."*

First investment products [are being managed](#) by Artificial Intelligence to a varying extent. Their [results are mixed](#). Finance is perhaps AI's most daunting challenge (see 'Capital Market Characteristics' above).

## 3. PRIMACY OF HUMAN INVESTMENT DECISION MAKER

The AI conclusion from above allows to revert to the still dominant human factor in the investment decision process. Over the last 35 years, behavioral economics and finance-related research has led to the insight that neither are market participants rational, nor are markets efficient. However, being as rational as possible in applying a market participants

specialization leads to a competitive edge due to minimizing cost and behavioral gap penalties.

### 3.1 DEFINITION OF RATIONALITY

To measure the extent to which an investment decision is rational requires a workable definition of rationality. Theories of rationality in the history of science are a rather recent phenomenon, emerging at the beginning of the 20<sup>th</sup> century as a result of the reflection on the progress made in different sciences, trying to combine the different approaches to science and their respective understanding of rationality to a meta-description (Bruner, 2006). For instance, philosophers (Husserl, 1965; Derrida, 2005) focused on disentangling the relationship between reason and the reasonable to better understand the history of thought and its progress. During the second half of the century, constructivism established itself as foundation for research conducted on the meta-description.

In recent years, the fast progressing visualization and localization techniques in cognitive neuroscience helped to establish a standard model for defining rationality by adding a biological foundation to the theories of rationality, consolidating several of them while staying compatible to the constructivism framework (Cortes, 2016).

### 3.2 THINKING – A FULL-BODY EXERCISE

According to the standard model in cognitive neuroscience (Roth, 1994), the thinking process is a full-body exercise, for which the rational element can, but not necessarily has to play a role. The sequence of a thinking process begins and ends with our limbic system, the central evaluation system of our brain, orchestrating our emotions by, for instance, managing our hormonal balance.

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Illustration B Sequence of a Thinking Process. © Panthera Solutions

## 3.3 AMBIGUITY TOLERANCE AS KEY TRIGGER FOR RATIONALITY

The dominance of our limbic system when taking decisions is plausible from an evolutionary perspective. Throughout the evolution of our species it increased our survival probabilities when gaining immediate clarity on whether a fight or flight response is more suitable. Ambiguous and/or complex situations do not allow immediate clarification on a preferred choice. The overwhelming character of ambiguous/complex situations leads our limbic system to switch to anxiety mode, limiting the exposure of Prefrontal Cortex (PFC) and Orbitofrontal Cortex (OFC) to a decision making process and (Hartley/Phelps, 2012).

With our limbic system being at the centre of decision making, we are at constant risk of being exposed to cognitive dissonances that lead to cognitive biases that might lead to cognitive dissonances, and so on. If this spiral is triggered, it results in an increased gap between epistemological market reality and market perception of the decision maker, where the gap-induced blind spots create self-fuelling momentum (herding, groupthink, pro-cyclical investment behavior, etc.).

## 3.4 IMPERATIVES FOR MAXIMIZING RATIONALITY IN DECISION MAKING

In a non-trivial system like capital markets, market participants are constantly exposed to the risk of being overwhelmed. To maximize the rational element in decision making, **the limbic system needs to be**

**stimulated so as to maximize the contribution of PFC and OFC.** In other words, we need to minimize the likelihood of our limbic system getting overwhelmed by ambiguity and complexity aversion. When becoming more ambiguity and complexity tolerant, intellect, reason (S2/ consciousness) and intuition (S1/ preconscious heuristics) increase their relevance in the decision making process.

In conclusion, the following imperatives can be defined to maximize rationality:

- 1 As thinking is a full-body exercise, stimulate the limbic system as such to maximize the contribution of intellect, reason and intuition for more rational decision making
- 2 Proactively manage heuristics - primary focus on preconscious heuristics, secondary focus on unconscious heuristics
- 3 Utilize latest technology, explicitly including AI, to proactively manage heuristics

Summarizing it with the words of Dan Ariely, Professor of Psychology and Business Economics, Duke University: *"Algorithms create some kind of discipline in how we are going to approach the world, rather than allowing us to take each situation separately, fully on gut intuition. We basically are forced to be more systematic about our decisions."*

## 4. INVESTMENT DECISION ARCHITECTURE

Summarizing the findings so far: the art of managing assets most rationally in an evidence-driven, rule-based investment process depends on proactively managing the heuristics of investment decision makers ("ambiguity tolerance"), which are to be supported by quantitative tools (i.e. "artificial intelligence"). The concluding investment decision architecture provides a framework within which the decision makers can specialize to develop or maintain their competitive edge. It provides measurability and accountability. See illustration C.

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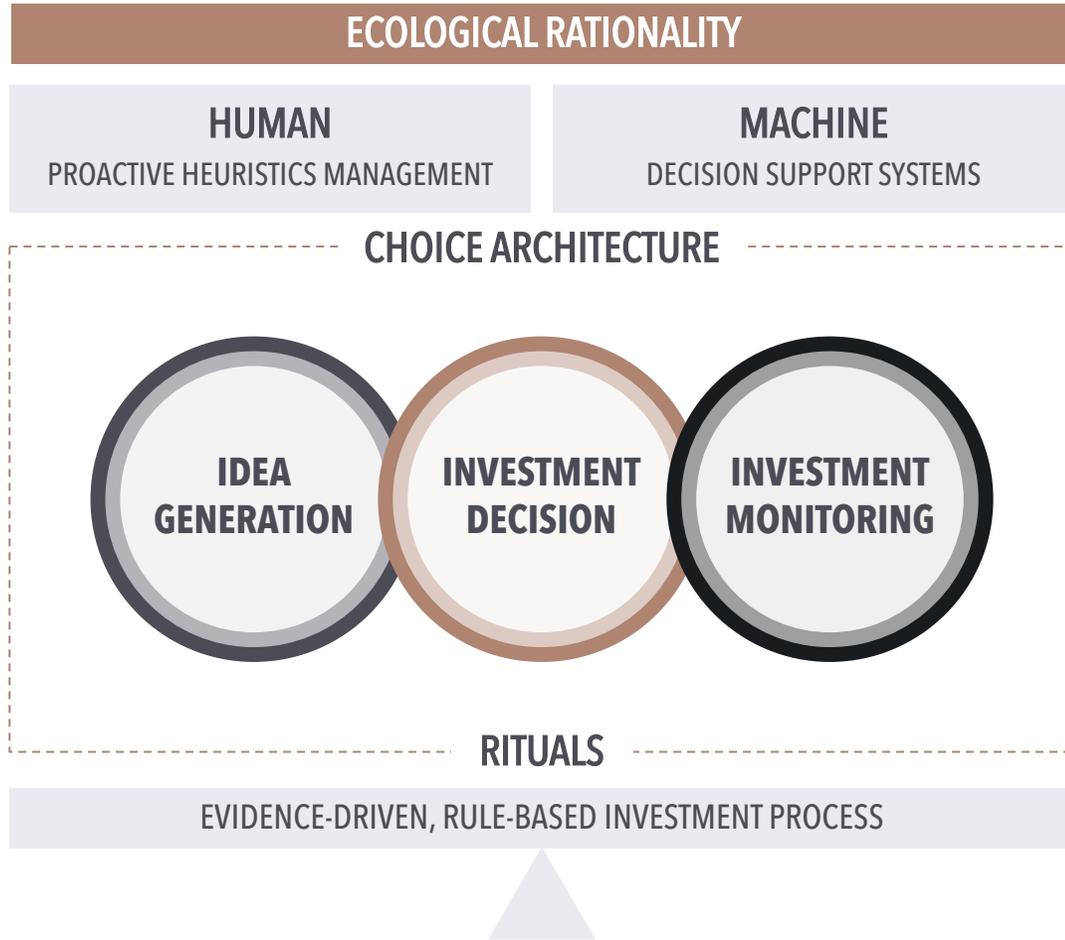


Illustration C The Most Rational Investment Process. © Panthera Solutions

If professional investment decision makers are accepting the need for a competitive edge (see 1.1) that positions them as specialized leaders in an investment management niche, the following optimization goals within the above described investment decision architecture have to be targeted to establish a High Performance Investment Team®:

HIGH PERFORMANCE INVESTMENT TEAMS		
META	INTERVENTION LEVELS	GOAL
CHOICE ARCHITECTURE	CULTURE	INNOVATION ABILITY
	PROCESS	
RITUALS	TEAM	SELF-ORGANIZATION
	INDIVIDUAL	SELF-RESPONSIBILITY

Illustration D High Performance Team® Optimization Goals. © Panthera Solutions

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## 5. ASSET MANAGEMENT KNOWLEDGE FRONTIER

Research has been focusing separately on individual decision making and organizational decision making in the past, mostly based on a concept of man as rational agent. This concept has been disproven, but the individual-organization divide survived despite the behavioral finance/economics critiques over the last 35 years. The persistent divide is explained as follows: the behavioral influence on decision making was considered a deficiency and not an opportunity. Solution-based thinking that tries to explore conditions under which our cognitive in/abilities can be managed to produce better (more rational) decisions, is a recent phenomenon.

This approach is especially new for investment decision making in several dimensions.

- First, many still consider the rational agent model and its related theories and methodologies as state-of-the-art.
- Second, even those considering behavioral finance insights, use it as a monstrosity of knowledge, showing how considerate they are when being aware of cognitive biases while not making use of them – an expression of the common pretense in finance.
- Third, those who started working on solutions based on behavioral insights, are rather outward-oriented, trying to sense the sentiment of others (economies, groups of market participants, etc.) for instance through sentiment indices or cognitive finance.

## 6. CONCLUSION

In short, using introspection to improve the investment decision making quality by bridging the individual-organizational divide through an interplay between choice architecture (organization, including IT and AI architecture) and nudging (individual), enabling investors to become more ambiguity tolerant, can be considered the knowledge frontier in this domain.

Quod erat demonstrandum.

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