MACHINE VENTURES

Vision 2035: The Emergent Singularity

Executive Summary

We are witnessing a remarkable and enduring transformation - from where we program machines to where we teach them to learn and adapt independently. This shift to machine intelligence will inject $13 trillion into the global economy over the next decade[1] and serve as a force-multiplier for humanity, unlocking unprecedented possibilities.

As veterans in the field, we have spent the past decade collaborating with researchers, founders, and investors who recognize the pivotal role of machine intelligence in shaping their strategies. Together, we have consistently delivered substantial economic value, in an ever-evolving landscape.

Being at the forefront of machine intelligence has granted us a unique vantage point. We've witnessed the rapid acceleration of change and disruption, creating a landscape where adaptability is paramount. In this dynamic environment, the window to adjust strategies post-commercial viability is increasingly narrow, underscoring the importance of staying ahead of the curve.

To crystallize our perspective, we present Vision 2035. By sharing this roadmap with you, we aim to provide clarity on our long-term objectives and how they will contribute to creating value across multiple funds and for society as a whole. Some key elements from our vision:

- A 'singularity', or moment when machines will outperform humans collectively, will not only be achieved but within about a decade (our estimation is by 2035).

[1] ("About the Machine Intelligence Research Institute") (Fountaine et al.)

- It will be emergent (suddenly reached) rather than targeted through dedicated development.
- It will be done via specialization of AI and machine intelligence, rather than generalization (AGI) as is widely believed.
- Machine intelligence, consisting of machine: learning, production, perception, and reasoning; will be the key driver of specialization.
- Our hypothesis is that these interwoven capabilities have the potential to create a new order of magnitude in both efficiency (10x) and effectiveness (10x) leading to an increase of 100 times more value and at greater speed.
- Specific domains will benefit more quickly than others. We believe these are Workforce (people/productivity), Industry (manufacturing & logistics) and Infrastructure (next generation data, compute, etc).
- Three elements will be critical to value creation in these domains: i) the development of open stack technologies, ii) the role of data, and iii) the use of collective intelligence.
- Machine intelligence will accelerate various economic and political issues, allowing targeted venture capital to capitalize on them.
- Recognizing and investing in specialization requires specialized knowledge, coupled with generalist experience to understand the breadth of the impact these technologies will have.

Machine Ventures is helmed by Sri Rao and Patrick van Hoof who bring a wealth of experience in the field as founders, executives and advisors. What sets us apart is our unique specialization in technology, design, and business. We invite you to collaborate with us in shaping the emergent singularity and capturing its significant value. Your shared enthusiasm for this endeavor is appreciated, and we encourage you to join us through active engagement and support as we embark on a collective journey toward a future of abundance enabled by machine intelligence.

Sri Rao and Patrick van Hoof

Introduction

The much-anticipated path to an eventual Singularity[2] moment, when one or a network of machines can outperform the collective capability of humans, will not be based *solely* on progress in Artificial General Intelligence.

Our view at Machine Ventures is that it will be more emergent, based on many different highly specialized uses of intelligent machines having outsized impact across domains and industries. Our conviction in this emergent path to machine intelligence guides our strategy and informs how we support founders and ventures shaping that future through their innovative work.

At Machine Ventures we are seasoned investors, founders, and corporate professionals with a unique combination of product, technical, and financial expertise in the domain of machine intelligence. We share a ”maker” mindset, which emphasizes hands-on problem-solving and innovation, with many successful founders.

We furthermore believe that having a well-defined point on the horizon is essential to navigating this rapid transformation as it allows us to identify and support ventures that are forging the future – rather than simply react to the present while driving progress for humanity as a whole.

[2](Vernor Vinge)(“Vernor Vinge on the Singularity”, 1993)

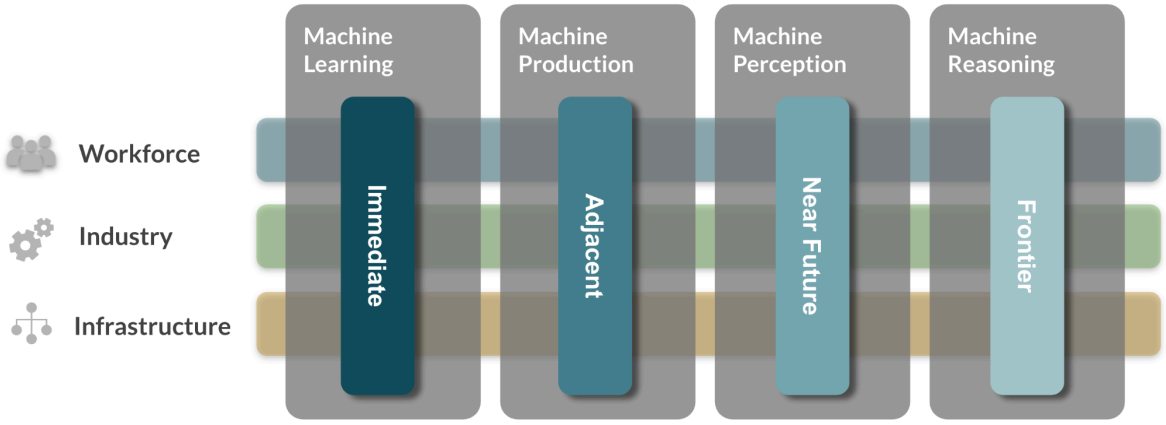
Vision 2035: The emergent Singularity and the significance of machine intelligence in the next decade

We are at the forefront of a transformative shift in the global economy, as we transition from programming machines to instilling them with the ability to autonomously learn and evolve. This pivotal change is poised to inject $13 trillion into the global economy[3], redefining the very fabric of enterprises and fundamentally reshaping how they build, market, and use products.

As we look ahead to the next decade, we see an unprecedented opportunity for capturing transitional yet enduring strategic value through highly specialized machine intelligence. These “agents” will outperform any human doing specialized work, unlocking tremendous potential for productivity gains and competitive advantages across a wide range of domains.

To capitalize on these opportunities, we will focus on identifying and supporting startups that are developing market making solutions for workforce, industry, and digital infrastructure. Building on this, our thesis is further rooted in startups that will leverage advancements in four key areas of machine intelligence - machine learning, machine production, machine perception, and machine reasoning.

[3] (Goldman Sachs et al.) (Fountaine et al.)



Our hypothesis is that these interwoven capabilities have the potential to create a new order of magnitude in both efficiency (10x) and effectiveness (10x).

Therefore, this exponential growth could lead to an increase of 100 times more value and at greater speed[4], giving rise to an emergent singularity - a new form of intelligence that is more than the sum of its parts and acts as a force multiplier for humanity.

Investing in a New Era: A Roadmap for Machine Intelligence and Impact

The journey from humans programming machines to machines that learn, produce, perceive, and reason autonomously is a gradual process that, when fully realized, will lead to a commonly accepted manifestation of machine intelligence.

Today, machine intelligence manifests itself by playing a role in fast-paced developments around language, speech, translation, image processing and prediction at Big Tech companies, a slew of rapidly growing, venture-backed startups and scale-ups, and significant contributions from the open-source community. Most of the focus is on efficiency and productivity gains through

[4] (Kiron et al.)

content generation and meta-programming and less so on product improvements and reduction in cost[5].

The path for machine intelligence to an emergent singularity will be made possible through advances in four pillars, namely machine learning, machine production, machine perception and machine reasoning. These pillars are not necessarily linear stages - partially overlapping, and oftentimes feeding back on one another to accelerate maturity. Here is how they are defined:

Pillar	Definition
Machine Learning	A system's ability to learn and make decisions from data without being explicitly programmed. An area where many advancements have been made but where there is a lot of low-hanging fruit in terms of specialized usage in specific industries.
Machine Production	A system's ability to generate or discover. Examples include synthetic data, statistical insights, novel designs, or media resulting in new IP. Rapid advancements in foundational models, (recently in language), are changing how approach building products and tools – everything from process automation, to materials discovery. As models become multi-modal we expect an inflection in how machine production will be applied in the use of machine-generated tools and interfaces.
Machine Perception	The ability to use multi-sensory inputs to deduce aspects of the world and interact with the environment. Given the rapidly reducing cost and wider availability of sensors, we expect multi-modal models to be adopted in environments where real-time inspection and response is vital – such as manufacturing plants, roads, and supply chain-related facilities.
Machine Reasoning	The ability to reason and interact with the environment autonomously in a meaningful way. This is the long last mile towards independently operating machine intelligence that can apply human-like common sense that is not based on purely statistical approaches. We believe that a major part of this capability will be a form of experience, or long-term memory, rather than an instant guess or prediction that is based on the collective experience of humanity.

[5] ("State of Generative AI in the Enterprise 2024")

We believe that advancements in these four key pillars as applied to the areas of workforce, industrial processes and infrastructure will not only generate substantial high quality opportunities.

Workforce			
Machine Learning	**Machine Production**	**Machine Perception**	**Machine Reasoning**
Automate routine and repetitive tasks, allowing human workers to focus on more complex and creative aspects of their jobs. This can lead to increased productivity and job satisfaction.	Robotic process automation (RPA) and intelligent automation tools can be deployed to streamline workflows and automate rule-based tasks across various industries.	Enhance human-machine interaction[6], enabling more natural and intuitive interfaces for automation systems. Improve medical diagnosis through multimodal perception.	Decision support systems powered by machine reasoning can assist in workforce planning, talent management, and strategic decision-making.

Industry			
Machine Learning	**Machine Production**	**Machine Perception**	**Machine Reasoning**
Optimize industrial processes to identify patterns and trends. Predictive maintenance, quality control, and production leading to increased efficiency and reduced downtime.	Discovering process improvements, novel materials. Adaptive market making and pricing. Tooling for creation of workflows for the automation and streamlining of logistics and supply chain.	Interpret and understand visual information. In industrial processes, this can be used for object recognition, defect detection, and monitoring complex machinery.	Intelligent decision-making to optimize resource allocation, logistics, and supply chain management. Also troubleshooting issues by identifying root causes and suggesting solutions.

[6] (Rao and Steinbock) (Bell and Rao et al.)

Infrastructure			
Machine Learning	**Machine Production**	**Machine Perception**	**Machine Reasoning**
Detecting and preventing security threats in real-time. Optimize network traffic management, improving overall system performance. Improving component yield (e.g. chips and ML for ML)[7].	Improving and discovering new component designs. Discovering efficiencies by rapidly iterating on physical modeling of systems.	Monitor and manage public utilities more efficiently. This includes smart grids for energy management, intelligent transportation systems, and waste management.	Aid in decision support systems for resource allocation, capacity planning, and dynamic optimization of services.

Evaluating Machine Intelligence Opportunities

Fundamental to our thesis are three core elements: open-stack technologies designed specifically for machine intelligence applications, rapid iteration through ecosystems and collective intelligence, and leveraging communities and networks to lower costs and driving value and scaling efficiently.

The Role of Data

The rapid shift toward machine intelligence emphasizes the crucial role of data. The continuous growth in the generation of new data will be accompanied by challenges regarding its utility and accessibility. Consequently, there is a need for a fresh approach to organizing and ensuring the availability of data.

What was classically known as “Big Data” will be exponentially bigger, leading to even greater use cases for technologies such as edge computing, NLP, and

[7] (Phothilimthana and Perozzi)

quantum computing. These will not only be able to handle such amounts of data, but also to achieve real-time predictions, changes and recommendations.

There is, however, a demonstrated tendency towards algorithmic aversion[8] which often leads to policies and practices that limit access to data. Startups can play a key role in overcoming this aversion by demonstrating value through the products they bring to market – driving availability of data both within, and across organizations.

Several causes and reasons contribute to the limited accessibility of data across various industries. These challenges often arise from a combination of technical, organizational, and regulatory factors. Below are some common causes grouped by the types of organizations that play a key role, and where we think venture-backed solutions can have impact.

[8] (Hidalgo et al.)

Impact ventures might have: High | Med | Low

Consortia and Joint Ventures		
Data Silos	Many organizations store data in isolated systems or departments, making it difficult to share information across the entire enterprise. Lack of interoperability between different databases and systems can result in data silos.	High
Lack of Standardization	Absence of standardized data formats and protocols can hinder seamless data sharing between organizations and systems. Non-uniform data structures and naming conventions make it challenging to integrate and analyze information.	Low
Lack of Awareness	Some industries may lack awareness of the potential benefits of data sharing and analytics. Education and awareness campaigns are crucial to promote the advantages of adopting data-driven practices.	Med
Corporate or other Internal Organization		
Resource Constraints	Limited financial resources and budget constraints can impede the implementation of advanced data infrastructure. Small businesses may lack the resources to invest in sophisticated data management systems.	High
Data Privacy and Security Concerns	Industries dealing with sensitive information, such as healthcare and finance, often face strict regulations regarding data privacy and security. Concerns about breaches and unauthorized access can limit the willingness to share data.	High
Technological Barriers	Outdated technology and legacy systems may lack the capabilities needed for efficient data sharing. Incompatibility between different software and hardware systems can hinder integration efforts.	High

Cultural and Organizational Barriers	Resistance to change and a lack of data-driven culture within organizations can lead to reluctance in adopting new technologies or sharing information. Organizational structures that promote compartmentalization may hinder cross-departmental data access.
Legal and Policy	
Regulatory Compliance	Industries, particularly in finance, healthcare, and government, must comply with stringent regulations that control the collection, storage, and sharing of data. Strict compliance requirements may impede data sharing across organizations and sectors.
Data Ownership Concerns	Disputes over data ownership and control can arise, especially when multiple entities are involved in data creation or collection. Clear policies and agreements are needed to address ownership issues.
Digital Divide	Disparities in technology adoption and access to digital tools can create a digital divide, particularly in sectors like education and small-scale agriculture. Limited connectivity in rural areas can hinder the flow of data.

In this context, ”data” refers to structured or unstructured information that companies, and organizations generate, collect, or possess in the course of their operations. This information can include various types of data such as imagery, log readings, meta-data, customer demographics, transaction records, market trends, and any other relevant insights that are digitally recorded and stored. The term encompasses both quantitative and qualitative information that organizations accumulate through their activities.

Addressing these challenges often requires a multi-faceted approach involving technological upgrades, regulatory reforms, and cultural shifts within organizations. Overcoming these obstacles is essential for fostering a more interconnected and data-driven landscape across industries.

“Open-stack” > Moat in evaluating startups

Aside from honing our understanding of the machine intelligence pillars and how they will develop, we also have a unique view on the mechanisms that will be key to startup success in the upcoming years. It starts with the fact that “open-stack” technologies, tailored for machine intelligence, is an emerging force.

Open-stack technologies, based on open software, data, storage, and compute specifically designed for machine intelligence applications – will let startups build products more quickly and efficiently than before. Companies that build on open-stack technologies, avoid the limitations of closed systems and platforms that hinder adaptability and innovation.

The conventional approach to evaluating companies, based on the ”moat” concept, overlooks the rapid pace of change and the opportunity for a new paradigm of value creation. Open-stack will allow for the democratization and rapid iteration via collaborative ecosystems, which - in turn - will lead to further cost reduction.

Open-stack startups, much like open-source, will be built on top of existing communities and networks; they may have lower customer acquisition costs compared to traditional venture-backed companies. Much like open-source startups we believe these companies will have more engaged and dedicated user bases, which can lead to higher retention rates and longer-lasting relationships with customers.

Collective intelligence and ecosystems create frontier opportunities and access

Due to the sustained pace of innovation and change, combined with increasing reliance on data, open-stack centric startups in machine intelligence are well positioned to leverage collective intelligence and federated learning to accelerate

product development and reach a larger customer base more quickly, ultimately positioning themselves for more rapid growth and success.

By pooling resources and expertise through collective intelligence, and in particular federated learning, startups can reduce the time and cost associated with data collection, curation, and labeling, and improve the accuracy and applicability of machine intelligence. The use of collective intelligence also hedges against data risk by creating data through the interaction of intelligent machines and the world, much the same way a lot of data is produced by humans today.

Through federated learning, startups can develop foundational technology as well as speed up product development by allowing multiple parties to collaboratively train machine learning models on their collective data without sharing the data itself. This approach enables organizations to leverage their existing data assets, while maintaining control and privacy over their sensitive information, and also quickly adapt to changing market conditions and customer preferences.

Being a frontrunner in machine intelligence also requires close collaboration with ecosystems where advanced research is being done. Examples where we have relationships include, but are not limited to our alma mater MIT, but including Stanford, UC Berkeley, ETH Zurich and the Eindhoven University of Technology, as well as various independent labs, corporate R&D environments, and open source communities. There is a natural affinity in these communities for the collaborative development of fundamental technologies which will be central to future products based on machine intelligence.

Lastly, we believe that public organizations and public-private partnerships play a major role in paving the way for disruptive innovation. This has been true throughout the last century in the United States and is increasingly important in Europe.

Anticipating and understanding potential risks

The World Economic Forum refreshes its outlook on global risks every year in its Global Risk Report. The latest edition (January 2024) highlights a somewhat "negative outlook for the world over the next two years that is expected to worsen over the next decade." [9]

In our view, based on the above and various other credible reports, the main tensions will come from a combination of the effects of climate change, increasing ideological differences across the globe, accelerating technological progress, and declining populations in developed economies.

Economic/financial risk

The first thing to look at is macro-economic conditions, as they influence markets and startup activity to a great extent. In the short term, the World Bank states that global growth is projected to slow for the third year in a row—from 2.6% last year to 2.4% in 2024, almost three-quarters of a percentage point below the average of the 2010s. Developing economies are projected to grow just 3.9%, more than one percentage point below the average of the previous decade.[10]

According to The Economist, Western economies did better than expected in 2023 but are not out of the woods yet, and interest rates staying "higher, for longer" will be painful for companies and consumers alike, even if recessions are avoided.[11] Europe might still see the economy starting the year in mild recession and/or broad stagnation, but growing again in the second half of the year.[12]

The US has avoided a recession in 2023, but it could still happen as there are signs that have historically pointed in that direction. The yields of the 2-year and 10-year US Treasury notes, for example, have been inverted since July 2022. When

[9](World Economic Forum)(Global Risk Report 2024, 2024)
[10] (The World Bank)("Global Economy Set for Weakest Half-Decade Performance in 30 Years", 2024)
[11](The Economist)("Ten Trends To Watch in 2024", 2024)
[12](CNBC/Deutsche Bank)("Investors are cautiously optimistic on Europe in 2024. Here's what to look out for", 2024)

long-term bond yields fall below short-term bond yields it means that investors are more nervous about the immediate future than the longer term. These types of inversions have preceded each of the last 10 recessions in the US.[13]

Longer term, real US GDP growth is expected to be stable at/above 2% between 2024-2033, even though labor market participation continues to decline over that period. More evidence of productivity gains following advances in (emerging) technologies, such as machine intelligence[14] – presenting an opportunity to "buy low" in companies that will leverage it.

Aside from macro risk there are also challenges associated with the capital markets, specifically relevant to our activities as an early stage firm/fund. These include the limited availability of late stage - and non-government early stage - VC in Europe, as well as a likely lukewarm IPO market in 2024 and potentially in 2025.

Political Risk

While recognizing the potential of responsible AI systems to make the world more prosperous, productive, innovative, and secure, both the EU and US also acknowledged that irresponsible use could make societal issues such as fraud, discrimination, bias, and disinformation worse.

This could result in potentially displaced and disempowered workers, stifled competition, and risks to security. This is why the governments on both sides of the Atlantic have put forth legislation to attempt to address it. We believe, however, that the pace of development and change in machine intelligence will outpace and outmaneuver any attempts at regulation.

In 2023, the European Union introduced and formalized new legislation for the development and use of Artificial Intelligence and related technologies. This

[13] (CNN Business)("Recession avoided? History says otherwise", 2024)
[14](Congressional Budget Office)("The Economic Outlook for 2023 to 2033 in 16 charts", 2023)

“Artificial Intelligence Act” aims to “ensure that fundamental rights, democracy, the rule of law and environmental sustainability are protected from high risk AI, while boosting innovation and making Europe a leader in the field.” The rules establish obligations for AI based on its potential risks and level of impact.

The United States is working on a similar initiative, and a related Executive Order titled ”Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence” has already been signed by President Biden at the end of 2023. The 53-page document significantly advances the United States’ policy framework regarding artificial intelligence. This directive outlines a comprehensive strategy aimed at “positioning the United States as a leader in the guidance of responsible AI development and application”.

Lastly, there are significant - and potentially increasing - international tensions. These are largely based on differences in ideologies between the West and other large economies, especially China. It has been challenging to focus on the “G2” rivalry in the past few years, mostly because of the (hot) wars in Ukraine and Gaza. In the coming years, all eyes will be on Taiwan to see if conflict there will keep its ‘cold’ status. Considering the next 10-15 years, it is not unthinkable that the situation there will change.

Chip supply and industrial risk to Machine Intelligence

As of 2024, the global chip shortage has exposed a weakness in the supply chain that could have far-reaching consequences for future startups and economic growth. As demand for chips and components continues to outstrip supply, innovative companies are struggling to obtain the materials they need to bring their products to market.

This shortage not only delays the launch of new technologies but also stifles R&D efforts, as researchers are forced to focus on workarounds rather than pushing the boundaries of what’s possible. Moreover, as the chip shortage persists, it could discourage investment in the semiconductor industry, leading to a decline

in the number of startups and a slowdown in economic growth. In the long term, this could have serious consequences for the global technology landscape, as the lack of investment in R&D could lead to a decline in innovation and a loss of competitiveness for countries that rely heavily on the semiconductor industry.

The current inadequacy in the supply of chips and components, particularly in the context of Artificial Intelligence (AI), poses a critical technological risk with direct implications for the future landscape of machine intelligence startups and economic growth.

The shortage of components essential for training and inference hardware, such as GPUs and specialized processors, impedes the development and deployment of AI solutions could have downstream effects on the acceleration and evolution of the four pillars of machine intelligence that we have outlined.

This limitation not only hampers the progress of emerging AI startups but also constrains the capabilities of established industries looking to integrate machine intelligence. Given the pivotal role of AI in driving technological innovation today, this supply-demand gap represents a formidable obstacle to sustained economic growth.

The availability, quality, and access to data

The insufficient volume and quality of data, failing to meet the escalating demands of future algorithms and training processes, present a formidable risk to the scalability of AI companies in the future. As artificial intelligence systems become more sophisticated, they necessitate vast amounts of high-quality data for effective training and continuous improvement. Inadequate data volume or compromised data quality can compromise the accuracy and efficiency of AI algorithms, undermining the core foundation of AI applications.

As AI algorithms continue to advance, they will require increasingly larger and more diverse datasets to achieve state-of-the-art performance. Future machine

intelligence applications will likely have less reliance on data volume (especially in the realm of machine reasoning), but the roadmap to that point will likely continue to require rich and abundant data.

In scaling this to the machine intelligence roadmap, companies rely heavily on access to diverse, robust datasets to refine their models and stay competitive. Addressing this data shortfall is crucial for the sustained momentum in machine intelligence to drive innovation and meet the evolving demands of the technology landscape.

Mitigation

While the aforementioned forces at play are many orders of magnitude greater than we at Machine Ventures wield, we believe that the roadmap for machine intelligence - together with technologies relating to computing advancements - will play a pivotal role in mitigating each of these risk areas, while offering plenty of opportunities for economic growth/value capture.

- Our core conviction in the 'open-stack' philosophy and the power of collective intelligence hedges us against the current AGI trends, which often hinge on a single large model — a strategy we find likely unsustainable.
- Having exposure to both the US and Europe - and various domains and industries - will allow us to make changes to our allocation as risks materialize, related to the economy, markets, legislation and international relations.
- Our deep background in the machine intelligence field we can adapt our strategy to startups and related value chains to mitigate the effect of chip supply, negative industrial developments and/or availability of high quality data.
- Our experience with public-private partnerships along with deep roots in various startup ecosystems allows us to be in-the-know and giving us advance signal in adapting our focus.

About Us

Machine Ventures was founded by Sri Rao and Patrick van Hoof, both of whom are veteran professionals in the broader Artificial intelligence space. Over the last decade, they have made a significant impact in the industry as operators, advisors, and thought leaders. As operators, they ran teams that developed new machine intelligence enabled value propositions at or for Big Tech and other Fortune 500 companies. Following that, they have led both acquisitions and corporate venture capital efforts.

Machine Ventures is a firm that prides itself on having not just seasoned generalist partners who are also highly experienced in machine intelligence, but also an extended team of advisors with top-tier credentials, having worked as leaders in AI at Meta, Google, Whatsapp and various VC/law firms.

Acknowledgements

We'd like to thank the following for their review and contributions:

Rishi Pravahan (Product Lead Google AI), John Kilpatrick (Paypal, frmr. Meta, Amazon, Samsung), Sumeet Maniar (Startup advisor, U of Chicago Booth), Abhijt Mehta (Frmr Akamai, Google, Twitter), Tamara Berg (frmr. Meta AI Research)

References

"About the Machine Intelligence Research Institute." *Machine Intelligence Research Institute*, https://intelligence.org/about/. Accessed 12 December 2023.

Becher, Brooke, and Vernor Vinge. "What Is Technological Singularity?" *Built In*, 17 October 2023, https://builtin.com/artificial-intelligence/technological-singularity. Accessed 18 December 2023.

Fountaine, Tim, et al. "Building the AI-Powered Organization." *Harvard Business Review*, 2019, https://hbr.org/2019/07/building-the-ai-powered-organization. Accessed 10 October 2023.

"Global Risks Report 2024 | World Economic Forum." *The World Economic Forum*, 10 January 2024, https://www.weforum.org/publications/global-risks-report-2024/digest/. Accessed 22 January 2024.

Goldman Sachs, et al. "Upgrading Our Longer-Run Global Growth Forecasts toReflect the Impact of Generative AI." *Goldman Sachs Research*, Goldman Sachs, 2023, https://tinyurl.com/mchngs01. Accessed 01 Oct 2023.

Hidalgo, Cesar A., et al. *How Humans Judge Machines*. MIT Press, 2021. Accessed 12 December 2023.

"How to Invest in AI." *SSGA*, https://www.ssga.com/us/en/intermediary/etfs/library-content/assets/pdf/north-america/fund-docs/2023/how-to-invest-in-ai-case-for-july-2023.pdf. Accessed 22 January 2024.

Kurzweil, Ray. "The singularity is near : when humans transcend biology : Kurzweil, Ray : Free Download, Borrow, and Streaming." *Internet Archive*, 26 October 2009, https://archive.org/details/singularityisnea00kurz. Accessed 22 January 2024.

"Modeling the global economic impact of AI." *McKinsey*, 4 September 2018, https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy. Accessed 22 January 2024.

Phothilimthana, Phitchaya Mangpo, and Bryan Perozzi. "Advancements in machine learning for machine learning – Google Research Blog." *Google Research Blog*, 15 December 2023, https://blog.research.google/2023/12/advancements-in-machine-learning-for.html. Accessed 13 January 2024.

Polovets, Leo. “Betting on Deep Tech - by Leo Polovets.” *Coding VC*, 21 November 2023, https://www.codingvc.com/p/betting-on-deep-tech. Accessed 22 January 2024.

Rosenbloom, Paul S. “Combining Neuroscience, Psychology, and AI Yields a Foundational Model of Human Thought.” *Singularity Hub*, 28 July 2022, https://singularityhub.com/2022/07/28/combining-neuroscience-psychology-and-ai-shows-us-how-humans-think/. Accessed 12 December 2023.

Singh, Vic, et al. “Cracking the AI Open Source Code: Will History Repeat Itself in the Next Platform Shift? Part I.” *Eniac Ventures*, 26 November 2023, https://eniacvc.medium.com/eniac-open-source-ai-study-d250d0d0d321. Accessed 22 January 2024.

UNGER, GABRIEL. “The Macroeconomics of Artificial Intelligence.” *International Monetary Fund*, https://www.imf.org/en/Publications/fandd/issues/2023/12/Macroeconomics-of-artificial-intelligence-Brynjolfsson-Unger. Accessed 22 January 2024.