Statement of Academic Integrity

My signature below certifies that I have complied with the University of Pennsylvania's Code of Academic Integrity in completing this portfolio.

Name (printed): Maxx Yung

Signature/Date: Maxx Yung, 03/20/2024

Letter of Reflection

Dear Faculty Readers:

I'm studying Materials Science and Engineering (1 of 16 for the class of 2027!) with a minor in Computer Science and Engineering Entrepreneurship. I would say that I'm a very avid reader, attempting to read at least 2 hours a day - primarily through newsletters, books, and journal articles for my research. I enjoy writing both creative works and long analytical works, especially on new technologies or companies working on an interesting problems. In my free time, I enjoy reefing and playing badminton!

A challenge I've encountered this semester was identifying the structure of a particular article or reading. Throughout high school, I was taught to also be able to identify the thesis, reasons, and examples, but only in a pure academic essay setting. I tried to draw upon my previous knowledge of identifying these elements, but for a longer article such as the McKinsey book we read in class, it can be challenging at times to differentiate the premise and propositions, and frame the reasons logically and coherently relative to the proposition. I think I still struggle a little with this challenge, as I believe there is no objective way to frame the proposition of any articles and can differ depending on the chosen premises and reasons. The lesson I drew from this experience is that properly analyzing large bodies of work can be challenging to get exactly right, and that no texts can be analyzed in the objectively same way. Additionally, there are many other situations I might need to apply this lesson - whenever I would need to analyze large bodies of text (books, white papers, longer essays, research journals), I should identify what I believe to be the correct premises/propositions/reasons/examples and also understand that this might not be the correct assumptions. Although I believe this occurred in some of my McKinsey book chapter outlines, I have revised the outlines several times such that there should be no glaring mistakes: the premises make sense given the proposition, the proposition is properly written out (for example, not bifurcated), and that there are many examples for many reasons per the proposition.

Moving forward, I would want to get better at analyzing scholarly works, perhaps using a different framework or method to achieve this goal. A somewhat unrelated goal is to also begin writing more analytical-based scholarly works utilizing this premise-proposition-reason-example framework. I believe that would also help me in accomplishing my goal of better identifying these elements in other works and improve my writings as well. Finally, thank you for taking the time (and providing feedback) on my portfolio - I understand it could be quite long!

Sincerely,
Maxx Yung

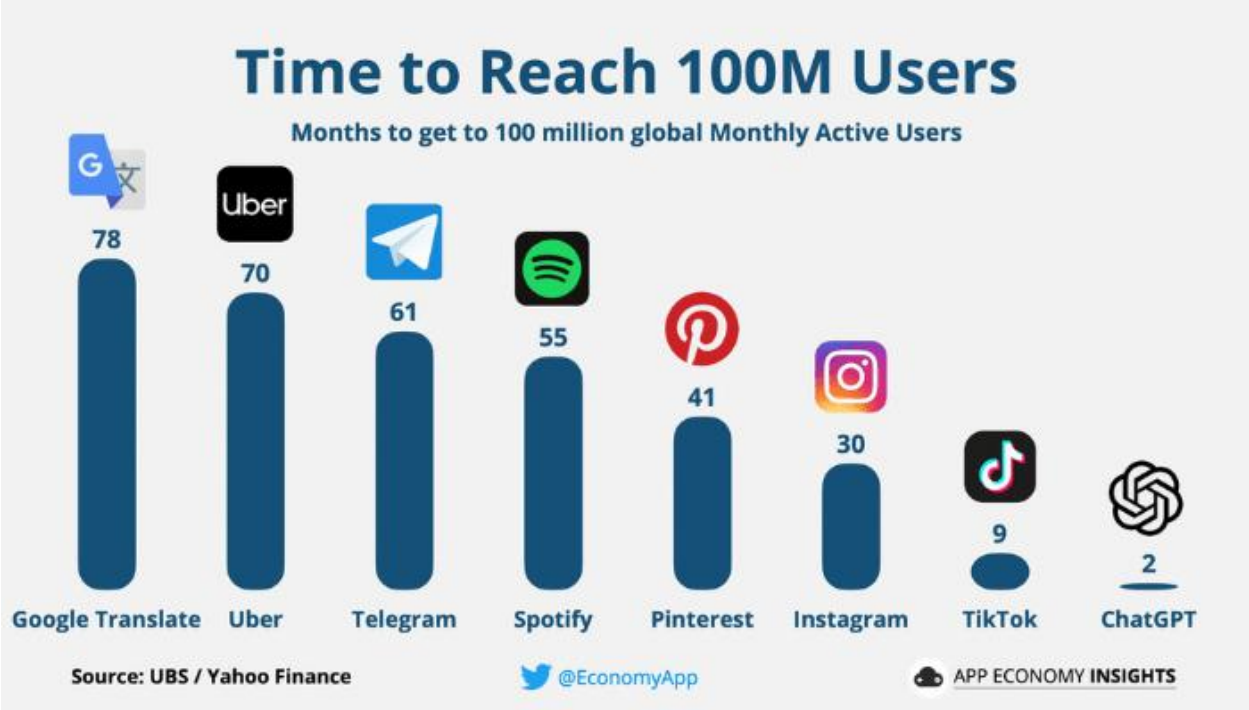
White Paper (1st Draft)

Attached below.

A Primer on Artificial Intelligence

The world has transformed significantly since 5 years ago. We now live in the age of artificial intelligence – an age where the massive sums of information we've collected during the internet era can be used to create, predict, and automate tasks too tedious or too complicated for a person to complete. One major event that signaled this global, accelerating change was the release of OpenAI's ChatGPT3 in 2022.

For the first time ever, non-technical individuals could access and utilize AI models for everyday tasks. And it took the world by storm – becoming the fastest product to reach 100 million users in 2 months, and setting off a global frenzy to develop better AI models, as evidenced by Anthropic's new Claude models, Mistral AI's le Chat, Google's Gemini Models, Meta's Open Source LLaMA models, and many, many more.



But this explosive frenzy for better, larger, and more capable models has a hidden consequence. This whitepaper aims to address how AI will exponentially exacerbate the global climate crisis, current solutions to reducing AI's environmental impact, and highlight a key technological development being developed at this company to drive AI's environmental cost down to zero.

History

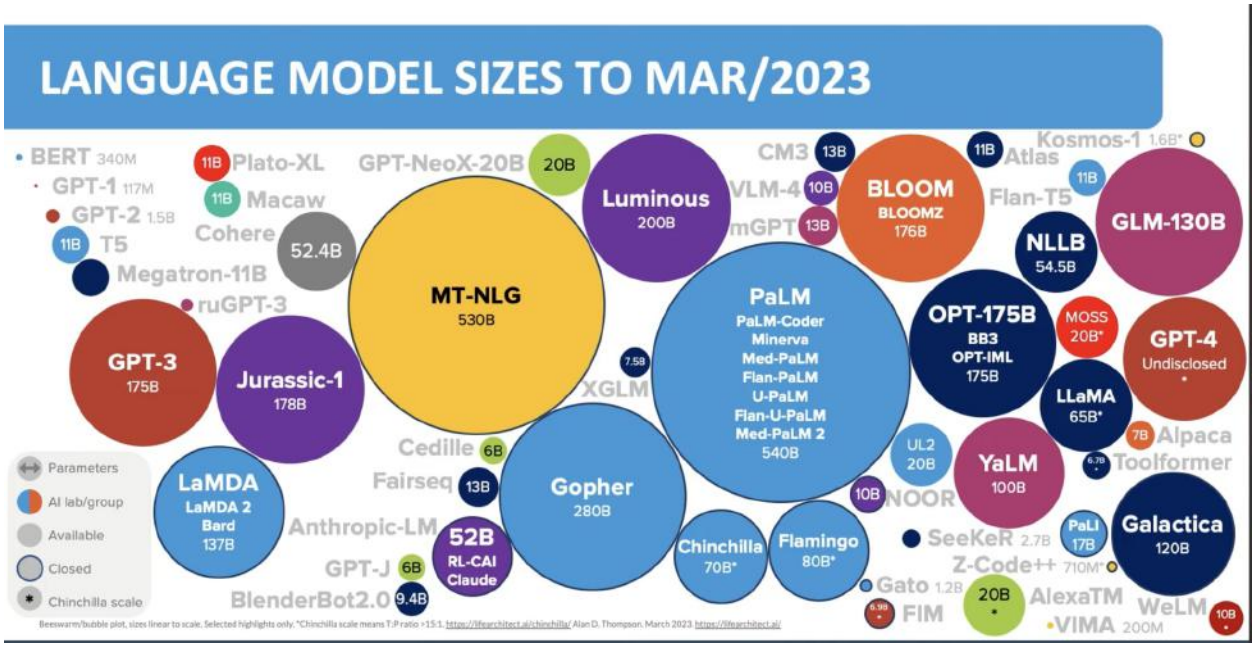
Contrary to mainstream belief, AI research is not a recent development. Breakthroughs in computer science, mathematics, and neuroscience since the 1900s have all served as catalysts

for AI development, leading to slow, but incremental progress, and ultimately culminating to powerful, user-friendly AI models commonly used by the public today.

The beginnings of AI in the 1950s was driven by the rudimentary understanding of how neurons (brain cells) in organisms learn, and implementing that knowledge into computer programs as “artificial neural networks” (ANN). Upon iteration and newer understanding of ANNs, more models were developed, including “deep neural networks” (DNNs) and “reinforcement learning” (RL).

By 1997, IBM’s Deep Blue beat world chess champion Gary Kasparov, and a little more than a decade later, IBM’s Watson beat two former Jeopardy champions. By the 2010s, companies such as Twitter, Facebook, and Netflix started utilizing AI as part of their advertising strategy and user-experience algorithms. By 2021, OpenAI created both GPT-3, a novel DNN trained AI to create virtually indistinguishable human-like content, and DALL-E, which can process, understand, and generate images. Currently, hundreds of advanced AI models have been trained – with popular models including:

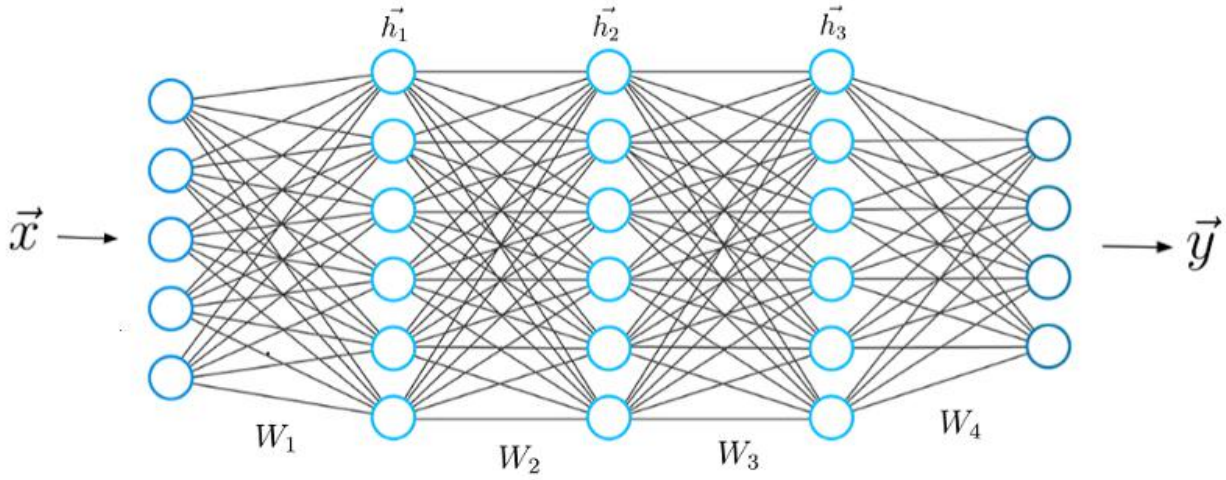
- GPT3, GPT4, GPT4 Vision, GPT4 Turbo, Sora, DALL-E by OpenAI
- Copilot by Microsoft
- Grok by xAI
- PaLM, Bard, Gemini Ultra, Pro, and Nano by Google
- CodeLLaMa, LLaMA and LLaMA 2 by Meta
- Claude 2.0, 2.1, and 3.0 by Anthropic
- Falcon 180B and Falcon 40B by Technology Innovation Institute
- Mistral-7B by Mistral
- Coral by Cohere



How are AI Models Trained?

The hardware driving AI progress currently lies in graphics processing units (GPUs). Created primarily by Nvidia, these GPUs that have fueled the AI boom have become so valuable, major companies reportedly transport them via armored car. In fact, according to a16z, one of the most successful venture capital firms, the “the supply of compute [from GPUs] is so constrained that demand outstrips it by a factor of 10x” and that an average company building in AI spends “ 80% of their total capital on compute resource.” And there is also no sign that the GPU shortage we have today will abate in the near future.

These GPUs are used to fine-tune parameters within an AI model. Parameters are variables that models can adjust during their training process to improve their ability to make accurate predictions, and having additional parameters allow more granular fine-tuning for a more accurate prediction. For example, parameters of DNNs consist of the weights assigned to the connections between artificial neurons (labeled as h1, h2, and h3 below).



Due to the recent explosion in larger AI models, there has been the emergence of "giant models,” reaching billions or trillions of parameters. While these huge models have achieved massive improvements in performance, they come with a significant computational cost. This is because these “giant models” require a lot more GPUs to train and a lot more time to train. For example, a 175B parameter AI model (like GPT-3) requires over 1000GB of data memory. This exceeds the memory capacity of a single GPU (for reference, Nvidia’s cutting edge A100 chip only has 40GB of memory), and thus requires a model to be split across hundreds of cards for thousands of hours. In effect, this means that:

1. More GPUs are needed to train
2. More powerful (and thus power-hungry) GPUs are required to train
3. More GPU time is needed to train

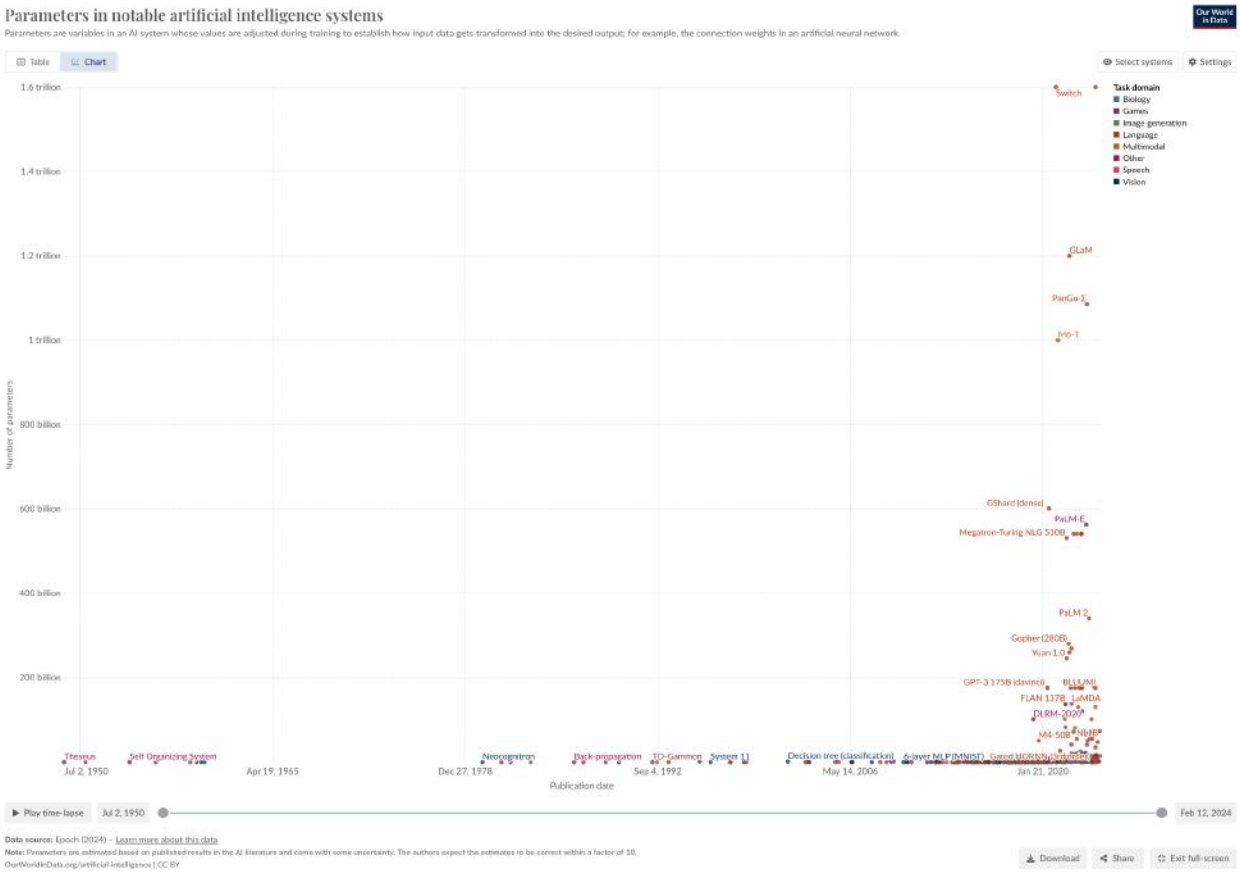
Which means more energy being used.

The AI Race is On

Progress on AI is accelerating. Based solely on OpenAI's GPT models, the number of parameters used by each AI model increases by roughly 10x every 2-3 years.

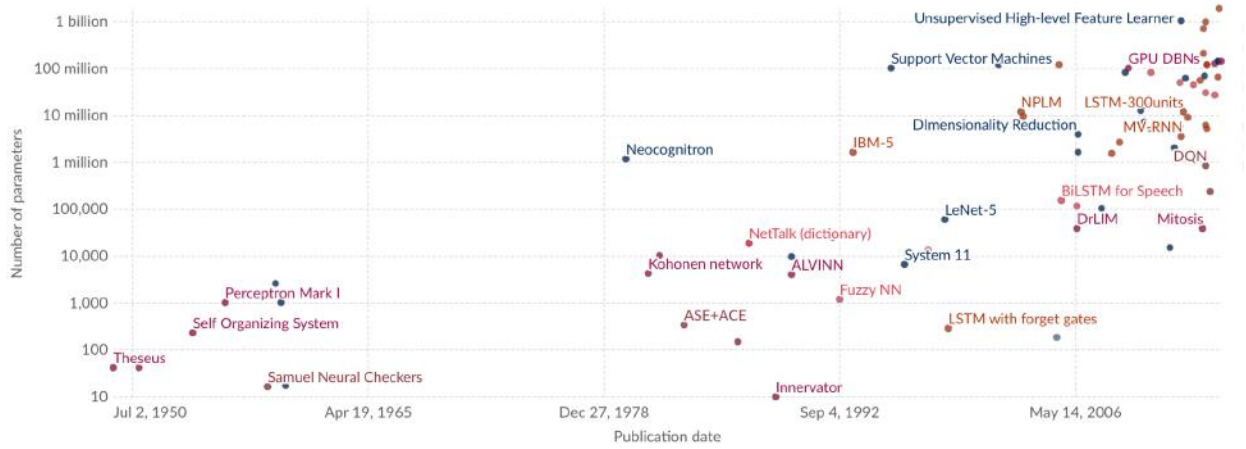
Year	Model	Parameters
2018	GPT1	117M
2019	GPT2	1.5B
2020	GPT3	175B
2023	GPT4	1760B

And across all companies developing AI models, it is clear that the trend of increasing AI model size does not appear to be ceasing.

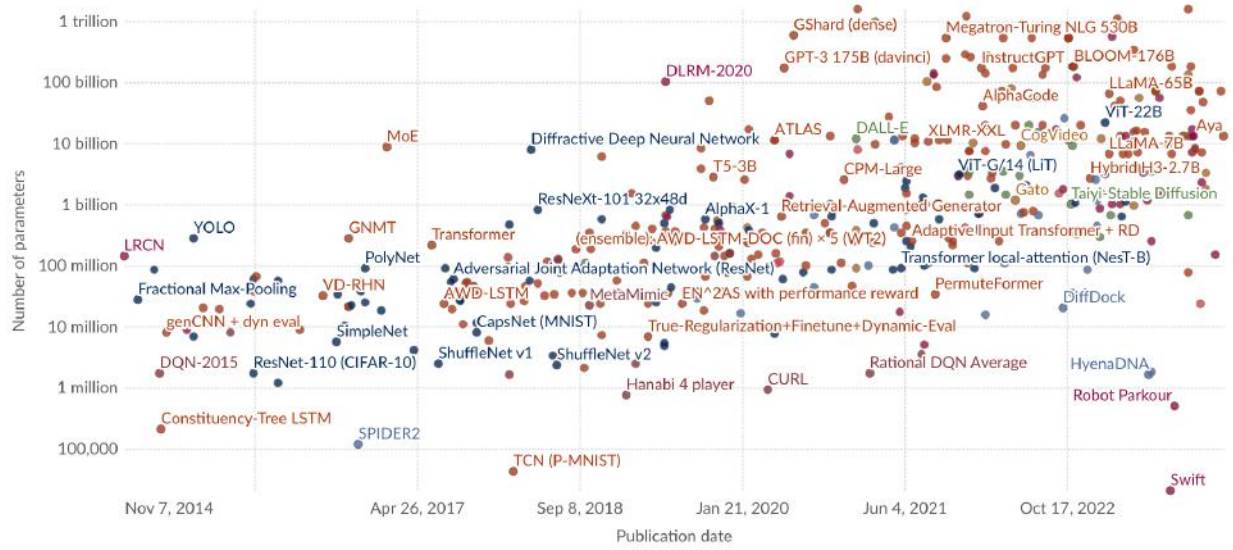


Likewise, in terms of total AI models being trained, it is clear that more and more companies and startups are developing their own.

Below is the number of AI models trained from 1950 to 2014.

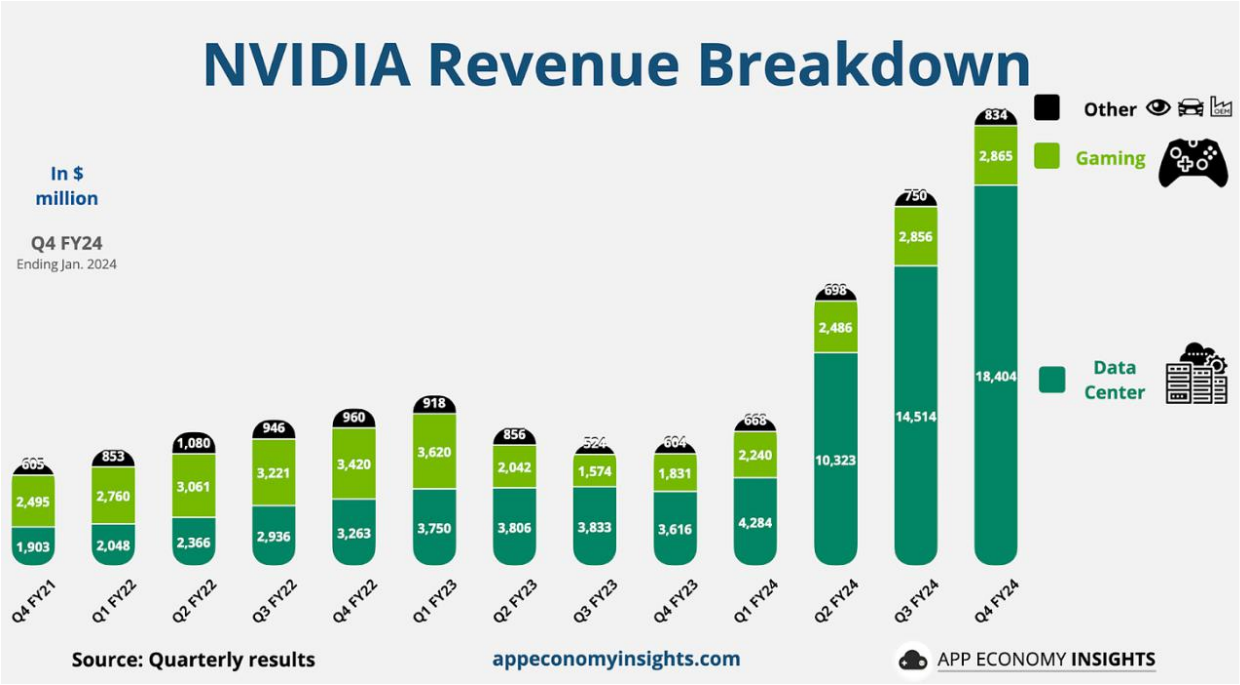


And from 2014 to 2024.



Clearly, a lot more.

Another indicator of the accelerating AI race can be seen in Nvidia's earnings report. According to their Q1F2024 earnings' report, the company stated a 404% growth in data center revenues within the past 10 years. In fact, Nvidia's $47.5 billion in 2023 data center revenues is 18% more than total data center revenues for the past 5 years, combined.



The Age of Artificial Intelligence has arrived, and it's here to stay, along with its negative consequences.

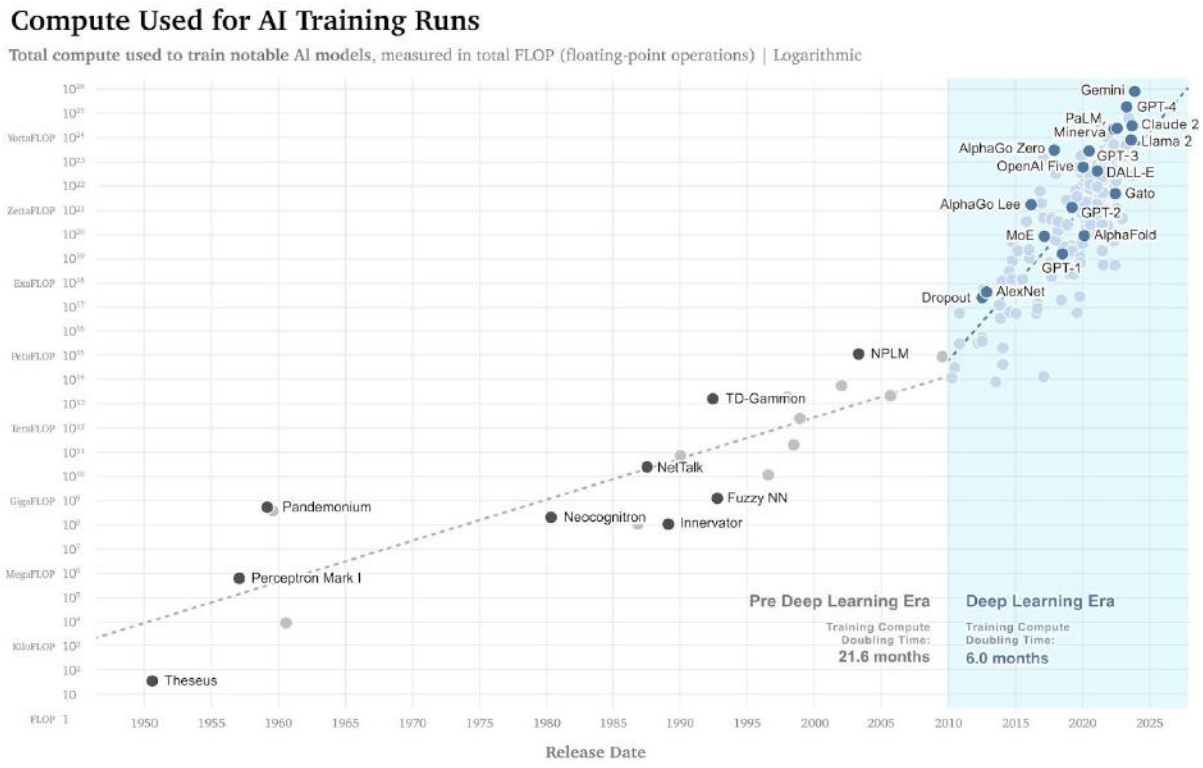
The Impact of AI on Energy and Climate

- Proposition: something along the lines of "We need to be more energy efficient to train AI"

According to the United Nations, climate change is the defining crisis of our lifetime, primarily driven by human activity. If the climate mitigation goal by bringing global emissions to zero by 2050 and limiting the average global warming to 1.5C fails, we will have a global environmental catastrophe of no return.

The acceleration of AI development directly counters this goal.

As the training and deployment of larger AI models grows more elaborate and data-intensive, two things begin to scale up exponentially: the need for more memory storage and the need for more energy. Already, the rise of AI in the past 2 years alone have led to a significant growth in data center utilization and their associated energy usage. Across all AI models from 2012 to 2022, the amount of computing power (provided by data centers) required grew by about 1 million percent, according to Princeton Professor Varma.



In fact, the amount of compute required by current AI systems and models seems to double every 6 months, while OpenAI's research suggests that the compute required has been doubling every 3.4 months since 2012.

The exponential demand for computing power can also be generalized from the explosive growth of data centers revenues from Nvidia, as previously evidenced. Meanwhile, traditionally software-focused companies like Amazon, Google, and Meta have also been building more data centers all over the country – resulting in increased carbon dioxide emissions that drastically exacerbate the climate crisis. For example, this led to Amazon's carbon emissions increasing by 15% last year.

In fact, data center power and carbon emissions associated with data centers roughly doubled or tripled between 2018 and 2020. In 2018, global data centers consumed roughly 1-2% of the global electricity supply. By 2020, this figure was estimated to be around 4-6%, according to the International Energy Agency. If this trajectory is maintained, by 2030, global energy usage from data centers is projected to rise to 8-21%, creating a global energy shortage crisis. A recent peer-reviewed study from Joule by Dr. Vries estimated that AI would consume at least 85,000,000,000,000W of electricity every year by 2027. For reference, the entire country of Netherlands consumes marginally more electricity (117,000,000,000,000W).

In agreement, research from the University of Massachusetts Amherst also identified AI as a significant emitter of carbon. It is estimated that the process of training each moderate-sized

language model results in 300,000kg of carbon dioxide emissions. (It is generally accepted that a moderately-sized LLM has about 40B parameters.) In comparison, GPT4 was released with over 1760B parameters and Gemini Ultra at 1560B. The newly released Claude-Opus in 2024 has 2000B parameters alone.

Put simply, AI is compute bound. And the problem is, for a linear gain in AI performance, exponentially training parameters and thus compute is required. And that means exponentially more carbon emissions and energy consumption. As of now, the field of AI remains unsustainable. **Thus, AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.**

Current Flawed Solutions

Software

- Talk about why making AI training more energy efficient from a software perspective is unlikely/unfeasible as a solution

OpenAI Model	Release Date	Parameters, B	MMLU
GPT2	2/14/19	1.5	0.324
GPT3	6/11/20	175	0.539
GPT3.5	3/15/22	175	0.7
GPT4	3/14/23	1760	0.864

Even as parameters increased by 1000x, the MMLU score only tripled. Clearly, exponential compute is needed to accelerate AI progress. And with compute, comes increased energy usage.

Thus, the cost of training AI is exponentially increasing. For example, the Falcon-40B model was trained on 384 A100 40GB GPUs, and it took two months. If you rent $2.0/hr, then $2.0 x 384 GPUs x 24 hours x 30 days x 2 months = $1,105,920. Falcon-7B, the smaller model with only 7 billion parameters, took two weeks. Still, that means $2.0 x 384 GPUs x 24 hours x 14 days = $258,048. What about GPT4's 1760 billion parameters? It would cost a lot more.

Energy Scaling

- Part 2: Talk about why scaling clean energy supply in the grid (whether that be through solar or nuclear) is unfeasible in a 10-15 year timeframe to make a meaningful impact on climate change

While Amazon and Microsoft are buying nuclear power plants to power their data centers, the incentive to use clean energy to power data centers is minimal, and thus not widely used. In Virginia, USA, the data center hub of the world, only 1% of electricity comes from renewable sources.

Hardware

- Part 3: Talk about why advancing silicon chip technology is not a viable option due to breaking the laws of physics and the shortage of silicon

Previously, traditional silicon hardware made exponential progress. Driven by both Moore's Law (the number of transistors on a chip doubles every two years) and Dennard's Scaling Law (doubling the number of transistors effectively means shrinking them but also maintaining their power density, so smaller chips meant more energy-efficient chips), silicon chips has been the go to computers.

But Moore's Law and Dennard's Scaling Law have slowed. Each individual transistor is so small – smaller than a virus – that chip manufacturers are breaking the fundamental properties of physics. And thus, improving traditional silicon hardware to make better, denser, and more efficient chips have also slowed dramatically in progress.

Taking into account that the number of transistors on a chip doubles every three to four years now, and coupled with the fact that current AI systems and models require the doubling of compute every 6 months, silicon computing is no longer the answer.

Gopalakrishnan said that innovation within existing computing architectures, as well as improvements in silicon technology, began slowing at exactly the time when AI began creating massive new demands for computation power and efficiency. Not even the best graphics processing unit (GPUs), used to run today's AI systems, can mitigate the bottlenecks in memory and computing energy facing the industry. "A new type of chip will be needed to unlock the potential of AI."

Another problem with silicon chip manufacturing is, well, silicon itself. An estimate from the Semiconductor Research Corporation, a consortium of all the major semiconductor companies, posits that if we continue to scale data at this rate, which is stored on memory made from silicon, we will outpace the global amount of silicon produced every year.

Another problem with silicon hardware is the general release of heat as a byproduct of computing. Currently, Nvidia GH200 AI chips use kilowatts of energy. In a typical server rack, that means 21-24 kilowatts of thermal load needs to be dissipated – resulting in huge energy costs just to cool the silicon hardware required to power AI. Newer GPUs require additional cooling systems: AMD's new accelerators jumped from 560W to 760W, and Nvidia's new rumored chips are projected to use over 1000W. Chips will get hotter and this trend is likely to continue. It is estimated that global data centers, on average, will add 50% to their energy usage just to keep silicon chips cool.

In cases outside of pure AI models, such as autonomous vehicles, researchers from OpenAI have stated that the amount of compute to train AI systems have increased 350 million times in the past 15 years. Another source states that the amount of compute required by current AI systems and models doubles every 6 months, while OpenAI research reveals that the compute used in large AI models has been doubling every 3.4 months since 2012.

The Convergence of Silicon and Biology

The Interconnected History of AI and the Brain

- History of how AI is inspired by the brain

Digital Biology: Engineering, no Longer Science

- Where do I think the next amazing revolution is going to come? There's no question that digital biology is going to be it. For the very first time in our history, in human history, biology has the opportunity to be engineering, not science.

With advances in cell culturing techniques, bioengineering technologies, and AI, biological computing is poised to emerge as a viable and feasible solution to the requirements of AI training and deployment.

1. Part 4: Propose the solution to create biologics-based AI computing chips.
    1. Go into more depth on how they work and why they are more energy efficient

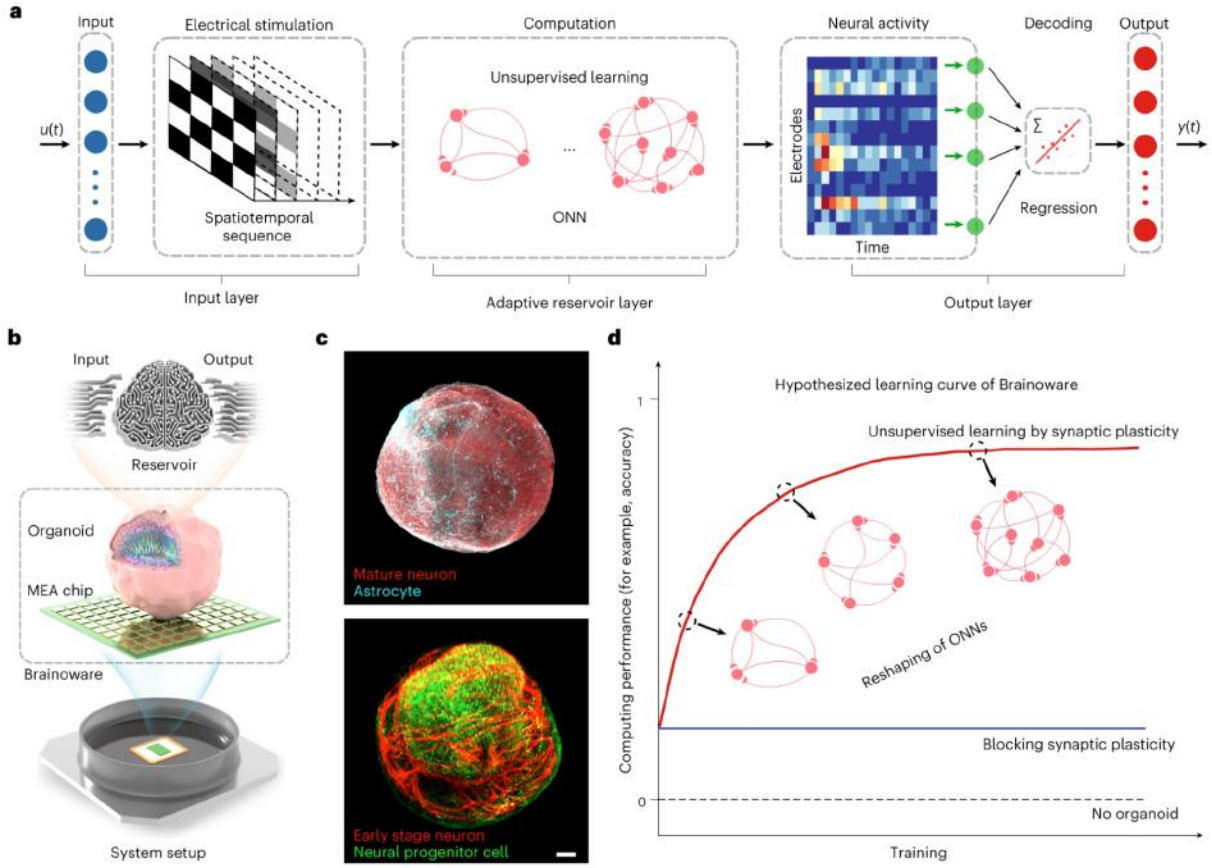
The core architecture of virtually every digital computer has followed a deceptively simple pattern first developed in the 1940s, known as the von Neumann model: store data in one place, do computation in another. Then, shuttle information between memory cells and the processor. Because these currently exist in two separate locations that are millimeters to centimeters apart so electricity needs to travel great distances to facilitate computation which makes it energy and time inefficient. This is called the von Neumann bottleneck or the memory-wall problem. However, each individual neuron within the human brain operates as *both* a memory cell and a processor. As the fusion of data storage and processes within biological neural networks bypasses this von Neumann bottleneck, one major promise of biologics-based computing is that in-memory computing will reduce the time and energy it costs to move and process large amounts of data. This "vertically heterogeneous-integrated architecture" is key to reducing energy consumption, according to Professor Deep Jariwala at the University of Pennsylvania.

The speed and energy efficiency of silicon-based computing hardware is approaching its theoretical limit - hindered by the slowing of Moore's law scaling and the von Neumann bottleneck, which increases the cost for big data movements.

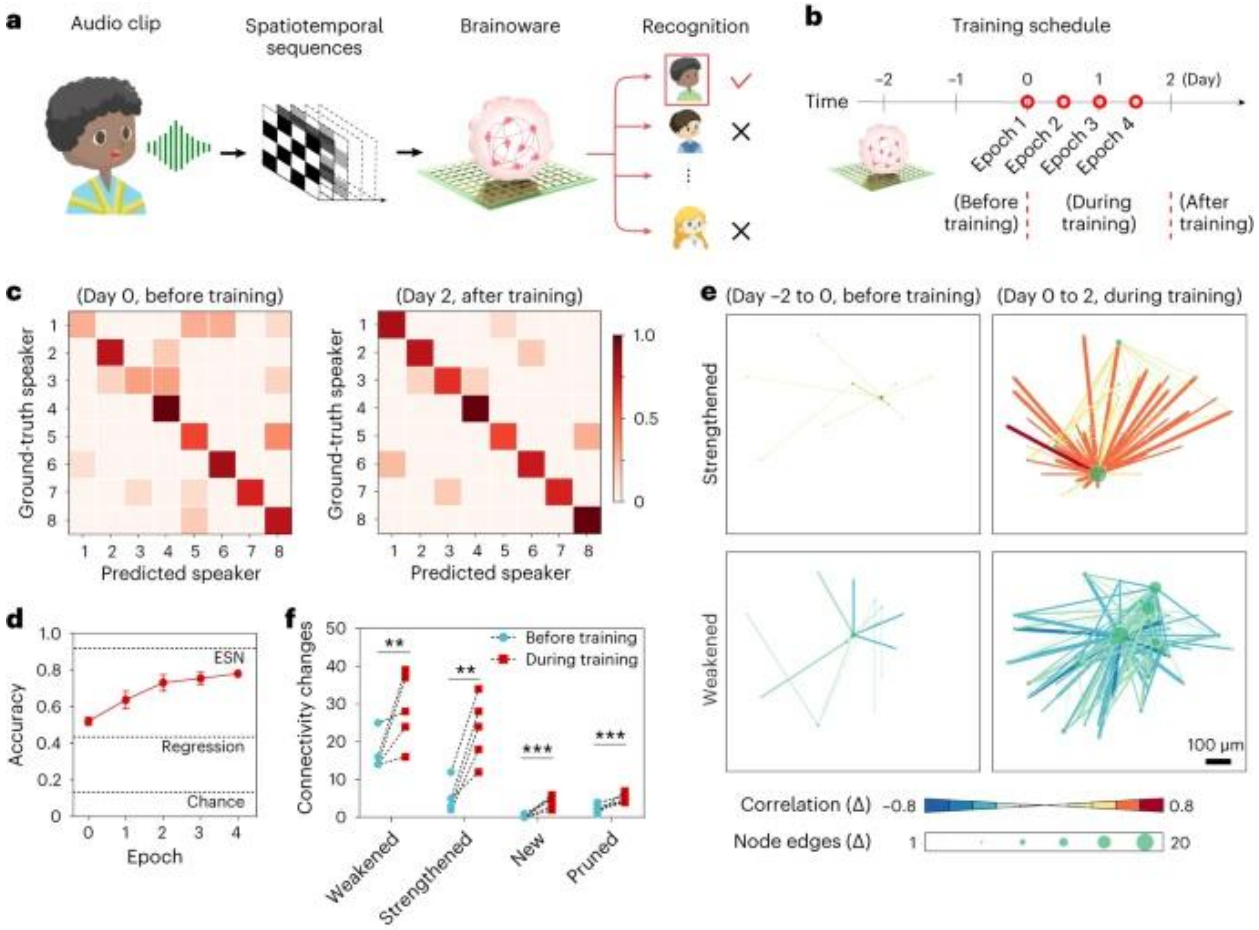
The human brain is a complex, three-dimensional massively parallel network of over 200 billion cells, linked by hundreds of trillions of synapses, and expends only 20 watts while current silicon hardware consumes about 8 million watts to power a comparative ANN model.

It is commonly said that “neurons that fire together, wire together.” On a deeper level, the human brain can learn because it is a living, adaptive mesh of cells that automatically conducts unsupervised learning due to the processes of neuroplasticity and neurogenesis.

Another major advantage of the brain is that it doesn’t produce heat. Therefore, thousands of watts of electricity used to cool silicon chips are no longer needed.



Already, current biologics-based chips have been used in computer vision and speech recognition tasks.



In this study, researchers converted audio clips into spatiotemporal sequences of bipolar pulse stimulations to the brain organoid. The evoked neural activity was recorded and fed into a logistic regression function for classification, then trained and optimized.

Nanoneuro Systems

Our Technology

We aim to grow brain organoids: 3D mini-brains in a dish through the self-organization of human iPSC neuronal cells. Then, by implanting them onto a custom-designed chip at the Singh Nanotechnology Center and sending inputs via external electrical stimulation through embedded shell electrodes and receiving outputs via evoked neural activity, we envision training future LLM models directly on the biology that have undergone 4 billion years of evolution to reach peak efficiency and processing power.

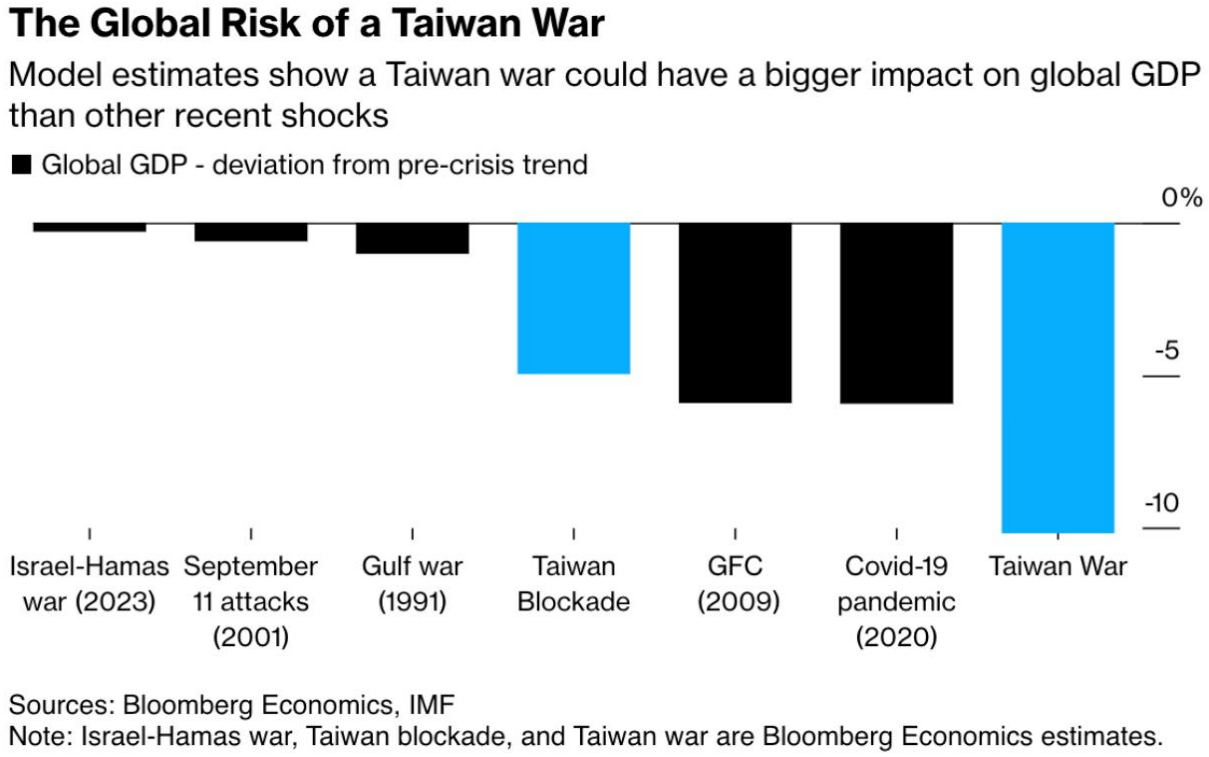
We are implementing new paradigms in ANNs – a Spiking Neural Network (SNNs). SNNs use neuron spiking events to communicate floating point numbers, and information is encoded in the timing and frequency of spikes through event-based processing. The goal is to approach one-shot learning similar to human learning experiences. For example, traditional deep learning models are successful when there is a large, labeled, and unnoisy dataset. But humans are adept at learning from just one or few instances of data. This is due not only to the

computational power of human brains, but also to the ability to synthesize and learn new object classes from limited information about different, previously learned classes. One-shot and few-shot learning aim to achieve a similar goal.

Our Vision

The backlogs to buy or lease Nvidia GPUs stretch over a year. Meta and Amazon have openly supported the notion to buy chips from other companies.

A big risk factor for the AI race is a possible war over Taiwan. The Taiwan Semiconductor Manufacturing Company manufactures 90% of all chips globally, and if disrupted, will impact an estimated 10% of the global GDP.



That's why there is a huge investment in domestic chip manufacturing companies; the US CHIPS Act alone provided $52B to accelerate domestic chip developments.

Conclusion

- Summarize everything

That's not to say AI and advancing it needs to stop because it's incredibly useful for important applications like accelerating the discovery of therapeutics. We just need to remain cognizant of

the effects and keep pushing for more sustainable approaches to design, manufacturing, and consumption.

Bibliography

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Logical Outline

Premise

- Given that AI has undergone recent explosive growth in the past 5 years
- Given that AI development shows no sign of slowing down and is actually accelerating
- Given that AI research requires computers (GPUs) to train, which requires energy
- Climate change is a major problem which is mainly caused by carbon emissions from human activities

Proposition

- Thus, AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.

Reasons & Evidence

1. (How) Current silicon chip design should be abandoned in favor of newer technologies
    a. Silicon chips are not inherently energy efficient due to the memory gap problem
    b. Silicon is unsustainable as the world enters into a silicon shortage
    c. Silicon chips requires massively amounts of energy in order to cool
    d. Silicon technology is reaching the limits of physics and can no longer be advanced at a rate suggested by Moore's Law
2. (How) Focusing on massive clean-energy supplying technologies is a long-term goal that will make AI training more climate friendly
    a. Developments in solar and nuclear technologies are decades away from feasible scalability
    b. Clean energy from solar and nuclear technologies will be a long-term solution for supplying clean energy for data centers
    c. Clean energy from solar and nuclear technologies is not favored or implemented by companies currently due to high upfront costs and low efficiencies and a lack of pressure to reduce their climate impact
3. (How) Biologics based chips should be developed for AI specific training and deployment
    a. Biologics-based chips are inherently 10000x more efficient than silicon chip
    b. Biologics-based chips uses less silicon and is thus sustainable in the long term future
    c. Biologics-based chips do not generate heat and thus use less energy
    d. Biologics-based chips have undergone 4 billion years of evolution, resulting in both energy efficiencies and fast processing power

Rhetorical Outline

- Proposition: AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.
- Audience: Chip companies, deeptech venture capitalists
- Genre: White paper
- Motive of the Author: To promote biologics-based computing for investment and R&D
- Motive of the Reader: To recognize the climate problems caused by AI & to fund biologics-based computing and support climate tech solutions in the long-term
- Plan: Publish as a company white paper research (similar to Bitcoin's whitepaper: https://bitcoin.org/bitcoin.pdf), publish in TechCrunch or related site
- Rhetorical Strategies: No idea what this means!
- Keywords: AI, climate, energy, biologics-based computing, biocomputing, neuromorphic computing

White Paper (2nd Older Draft)

Attached below.

Biocomputing as a Solution for Future Sustainable AI Developments

A White Paper Advocating the Development of Biocomputing for Venture Capitalists, AI Researchers, and Chip Manufacturers

Introduction: Artificial Intelligence and Climate Change

The world has shifted into the age of artificial intelligence – an age that began with the release of OpenAI's ChatGPT3 in 2022. Since then, there has been an explosive frenzy for better, larger, and more capable models. Currently, hundreds of advanced AI models have been trained – with popular models including:

- GPT3, GPT4, GPT4 Vision, GPT4 Turbo, Sora, DALL-E by OpenAI
- PaLM, Bard, Gemini Ultra, Pro, and Nano by Google
- CodeLLaMa, LLaMA and LLaMA 2 by Meta
- Claude 2.0, 2.1, and 3.0 by Anthropic
- Falcon 180B and Falcon 40B by Technology Innovation Institute

Over time, it is clear that more and more models will be developed. There is a clear dramatic increase in the number of AI models trained from 2014 to 2024, as shown in Figure 2, compared to Figure 1, which shows the number of AI models trained from 1950 to 2014[1].

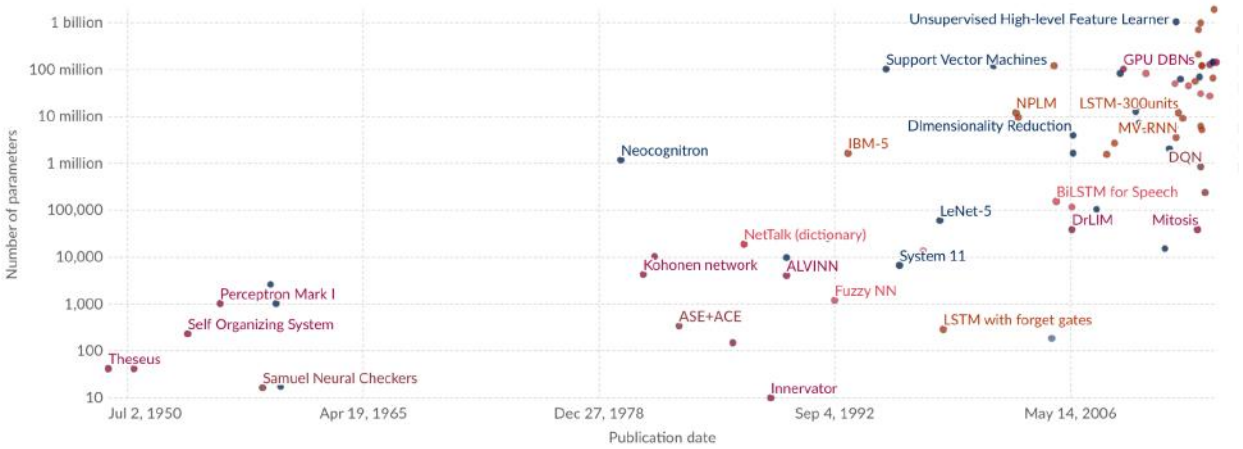

Figure 1. Number of AI Models Trained from 1950 to 2014.

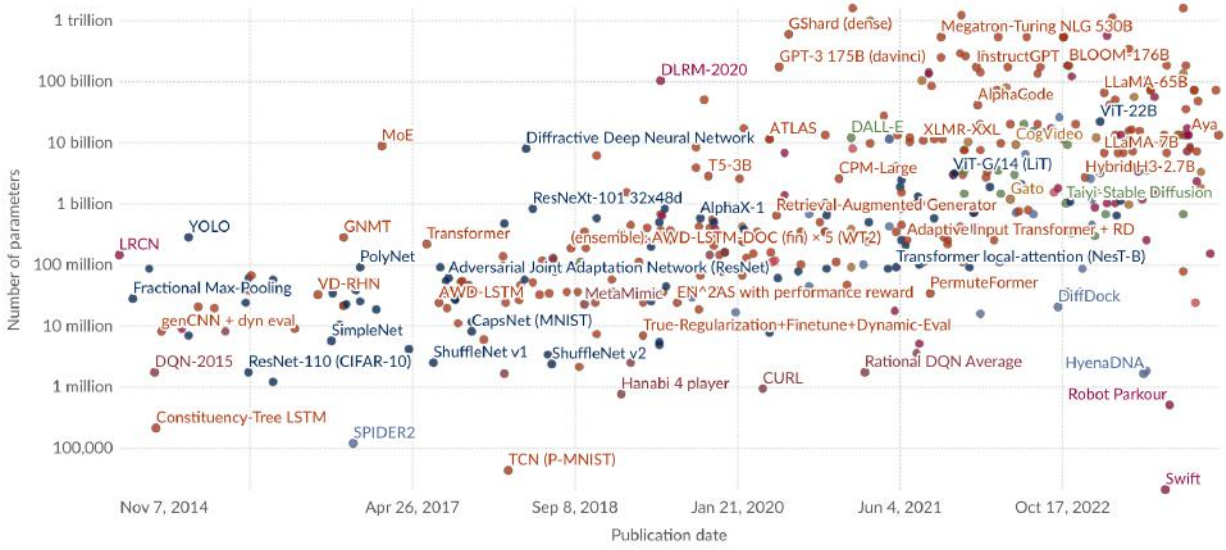

Figure 2. Number of AI Models Trained from 2014 to 2024.

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1. Parameters in Notable Artificial Intelligence

The Age of Artificial Intelligence has arrived, and it's here to stay. However, the acceleration of AI developments has a hidden consequence: the acceleration of global climate change.

Already, the rise of AI in the past 2 years alone have led to a significant growth in data center utilization. Across all AI models from 2012 to 2022, the amount of computing power (provided by data centers) required grew by about 1 million percent, according to Princeton Professor Varma[2]. In fact, the amount of compute required by current AI systems and models seems to double every 6 months[3], while OpenAI's own research suggests that the compute required has been doubling every 3.4 months since 2012[4]. And to access more compute, more energy is required, resulting in increased carbon dioxide emissions that drastically exacerbate the climate crisis. For example, increased AI-related data center usage increased Amazon's carbon emissions by 15% in 2023[5].

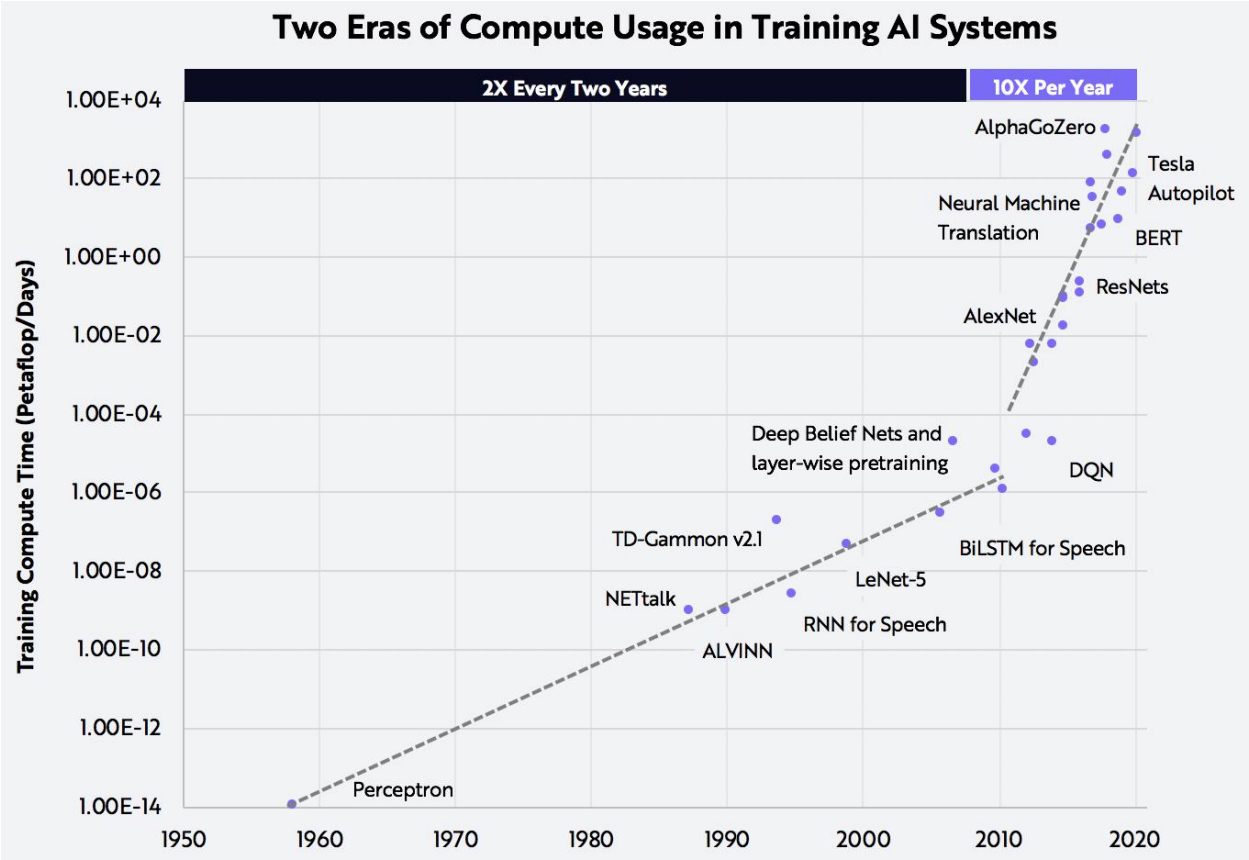

Figure 3. Exponential Growth in Compute Usage for AI Training.

According to the International Energy Agency, the proportion of global electricity consumption attributable to data centers, along with their associated carbon emissions, tripled from 2% to 6% between 2018 and 2020[6].

—

2. New Chip Built for AI Workloads
3. Computational Power and AI
4. AI and Compute
5. Carbon Impact of Artificial Intelligence
6. Electricity 2024 – Analysis

Should this growth pattern persist, projections indicate that by 2030, data centers could account for between 8% and 21% of worldwide energy consumption, precipitating a crisis in global energy supply. In a comprehensive analysis published in Joule, Dr. Vries projected that, by 2027, the annual electricity consumption of AI related technologies could reach at least 85 terawatt-hours[7]. For context, the total annual electricity consumption of the Netherlands is roughly 122 terawatt-hours[8].

Findings from the University of Massachusetts Amherst also highlight AI as a considerable contributor to carbon emissions. To train a moderately-sized language model – typically 40 billion parameters – approximately 300,000 kilograms of carbon dioxide is released[9]. Yet, OpenAI's GPT-4 and Google's Gemini Ultra models were launched with over 1,760 billion and 1,560 billion parameters, respectively. More recently, the release of Claude's Opus model in 2024 introduced a model with over 2,000 billion parameters, underscoring the escalating environmental impact of advanced AI technologies.

Put simply, AI is compute bound. And the problem is, for a linear gain in AI performance, an exponential amount of parameters and thus compute is required[10]. And that means exponentially more carbon emissions and energy consumption[11]. As of now, the field of AI remains unsustainable. **Thus, AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.**

This whitepaper aims to address how AI will exponentially exacerbate the global climate crisis, point to current primary solutions funded by venture capital or researched by AI and chip companies to reduce AI's environmental impact, and highlight biocomputing as an alternative solution that should attract greater research and funding focus.

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7. Growing Energy Footprint
8. Electricity Generation in the Netherlands
9. Energy and Policy Considerations
10. High Cost of AI Compute
11. Carbon Impact of Artificial Intelligence

Problem: Current Silicon Hardware Solutions to Create Sustainable AI is Unfeasible

As AI grows more elaborate and data-intensive, two things begin to scale up exponentially: the need for more memory storage and the need for more energy. Based on OpenAI's GPT models, the number of parameters used by each successive model increases by roughly 10x every 2-3 years, indicated in Table 1.

Year	**Model**	**Parameters**
2018	GPT1	117M
2019	GPT2	1.5B
2020	GPT3	175B
2023	GPT4	1760B

Table 1. Release Date of GPT Models and their Associated Parameter Count.

And across all companies developing AI models, it is clear that the trend of increasing AI model size is likely to continue, as shown in Figure 4[12].

Figure 4. Exponential Increase in Parameter Count for Recently Developed AI Models.

—

12. Parameters in Notable Artificial Intelligence

The current strategy pursued to address this issue involves the creation of more energy-efficient silicon hardware chips. The evolution of traditional silicon hardware has been historically driven by two foundational principles:

1. Moore's Law, which posits that the number of transistors on a microchip doubles approximately every two years, thereby increasing its processing power.
2. Dennard's Scaling Law, which suggests that as chips get smaller, they become more energy efficient.

These developments have resulted in the production of silicon chips that possess the capability to efficiently train and operate AI technologies.

But Moore's Law and Dennard's Scaling Law have slowed[13-15]. Each individual transistor is so small – smaller than a virus – that chip manufacturers are breaking the fundamental properties of physics[13]. And thus, improving traditional silicon hardware to make better, denser, and more efficient chips have also slowed dramatically in progress[13].

Taking into account that the number of transistors on a chip doubles every 3-4 years now coupled with the fact that current AI models require the doubling of compute every 3-6 months, silicon computing can no longer keep up with the rapid requirements of AI. To fix this, companies use massive amounts of chips to train AI models, which in return requires massive amounts of energy to operate.

Another problem with silicon chips is silicon itself. An estimate from the Semiconductor Research Corporation posits that if the current exponential growth in AI's data usage persists, relying on memory components made of silicon, global demand for silicon would soon exceed the annual worldwide production of the material, leading to shortages and bottlenecks in future silicon chip manufacturing[16].

Current silicon chips also cannot bypass the von Neumann bottleneck[13-15]. The core architecture of virtually every digital computer has followed a simple pattern first developed in the 1940s, known as the von Neumann model: store data in one place, compute the data in another, then shuttle information between the two places. Because these currently exist in two separate locations, electricity needs to travel a non-trivial distance to facilitate computation, which makes silicon chips energy and time inefficient, driving increased energy consumption and thus carbon emissions that accelerate global climate change.

A final challenge with silicon hardware is the general release of heat as a byproduct of computing. Current Nvidia GH200 AI chips use kilowatts of energy to operate. In a typical server rack, that means 21-24 kilowatts of thermal load needs to be dissipated – resulting in massive energy costs just to cool the silicon hardware – typically 40-50% of a data center's electricity consumption, according to Figure 5[15]. Moreover, AMD's latest AI accelerator chip has seen a power consumption increase from 560W to 760W, while Nvidia's upcoming chips are anticipated

—

13. Hidden Costs of AI
14. Brain Organoid Reservoir Computing
15. Thermal Management
16. Plan for Semiconductors

to require more than 1000W. This trend towards higher power consumption. suggests that chips will generate more heat, a pattern expected to persist. Consequently, it is estimated that global data centers will experience a 50% increase in energy consumption solely for the purpose of cooling the silicon[17].

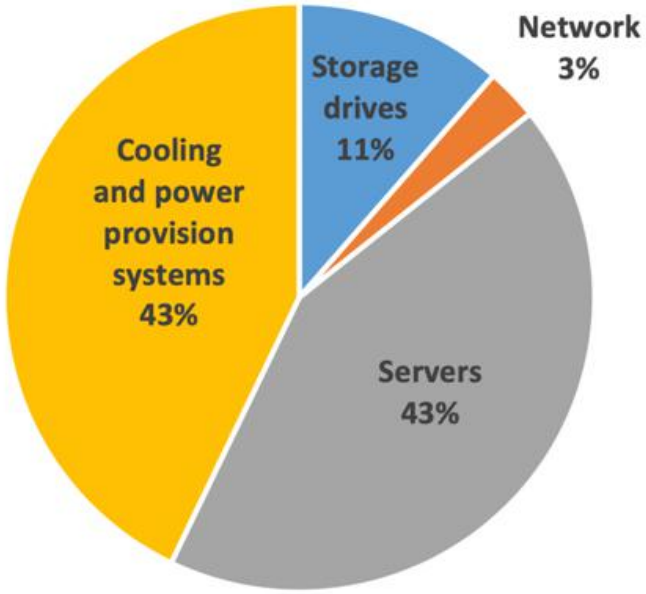

Figure 5. Division of Electricity Consumption in Data Centers.

Given the mounting challenges faced by the current silicon-based computing paradigm, it is imperative for deeptech investors and chip manufacturing companies to recognize that continuing along this trajectory is unsustainable for future AI developments. The exponential growth in AI's complexity and resource requirements demands a radical shift in the global approach to computing. To sustain the rapid advancement of AI technologies and their applications, investors and companies must explore and invest in alternative computing architectures that promise greater efficiency, scalability, and environmental sustainability. A new paradigm of computing that can meet the ambitious demands of tomorrow's AI is required.

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17. Shocking Amount of Electricity

Solution: The Convergence of Silicon and Biology

The next amazing revolution is going to be digital biology. For the first time in human history, biology has the opportunity to be engineering, not science. With advances in cell culturing techniques, bioengineering technologies, and AI, a biologics-based computing paradigm is poised to emerge as a viable, efficient, scalable, and sustainable solution to the requirements of AI technologies[18].

The human brain is a complex, three-dimensional massively parallel network of over 200 billion cells, linked by hundreds of trillions of synapses, and expends only 20 watts while current silicon hardware consumes about 8 million watts to power a device of similar computational strength[19].

A biologics-based computing model offers profound advantages over traditional silicon-based systems. One benefit of biologics-based computing is its lack of heat byproduct generation. Unlike silicon chips that generate significant heat and require extensive cooling mechanisms, biological neurons operate without producing substantial thermal energy. This characteristic eliminates the need for the thousands of watts typically consumed in cooling processes, dramatically reducing the overall energy and carbon footprint of computing operations[18-20].

Moreover, through four billion years of evolution, neurons have evolved to become highly efficient in both performance and energy use. The unique architecture and operational mechanisms of neurons allow for more effective processing and storage of information with minimal energy requirements. Neurons also bypass the limitations posed by the von Neumann architecture prevalent in current silicon systems. Neurons serve dual functions as both processors and memory units, enabling faster data processing without the need to shuttle information back and forth between separate components. This integration facilitates a more efficient computation process, which is necessary for the complex and data-intensive tasks involved in AI training[20].

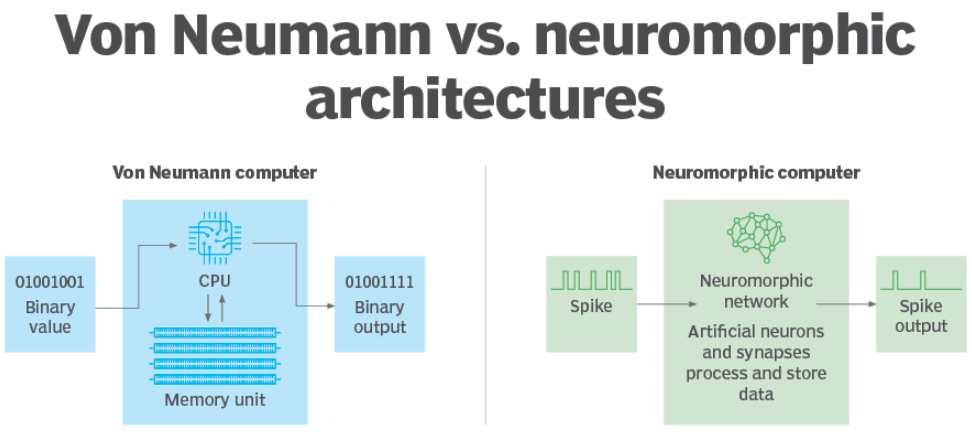

Figure 6. Comparison of von Neuman and Neuromorphic Computing Architecture.

—

18. Reservoir Computing
19. Brain Organoid Reservoir Computing
20. Bridging Biological and Artificial

Finally, sustainability is another compelling advantage of a biologics-based computing paradigm. Neurons, unlike silicon, do not need to be mined from the ground and processed at complex manufacturing processes that contribute to environmental degradation. Neurons can be grown from biological sources, such as cells derived from rats, or replicated through advanced biological processes researchers have developed in the past century. This method of production is infinitely sustainable, providing a renewable resource for computing that lessens the environmental impact associated with the extraction and processing of silicon and other materials used in traditional computing hardware[21].

Already, current biologics-based chips have been used in rudimentary computer vision[21] and speech recognition tasks[22-23]. In one study, researchers converted audio clips into spatiotemporal sequences of bipolar pulse stimulations to the brain organoid. The evoked neural activity was recorded and fed into a logistic regression function for classification, then trained and optimized.

A future goal is to approach one-shot learning in neurons similar to human learning experiences. For example, traditional deep learning models are successful when there is a large, labeled, and unnoisy dataset. But humans are adept at learning from just one or few instances of data[24]. This is due not only to the computational power of human brains, but also to the ability to synthesize and learn new object classes from limited information about different, previously learned classes. One-shot and few-shot learning aim to achieve a similar goal. spatiotemporal sequences of bipolar pulse stimulations to the brain organoid. The evoked neural activity was recorded and fed into a logistic regression function for classification, then trained and optimized.

—

21. Face Classification
22. Analogue Signal
23. Temporal Data
24. Bridging Biological and Artificial

Conclusion

That’s not to say AI and advancing it needs to stop because it’s incredibly useful for important applications like accelerating the discovery of therapeutics. The world just needs to remain cognizant of the effects and keep pushing for more sustainable approaches to design, manufacturing, and consumption.

NEED TO WORK ON MORE

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Logical Outline

Premise

- Given that AI has undergone recent explosive growth in the past 5 years
- Given that AI development shows no sign of slowing down and is actually accelerating
- Given that AI research requires computers (GPUs) to train, which requires energy
- Climate change is a major problem which is mainly caused by carbon emissions from human activities

Proposition

- Thus, AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.

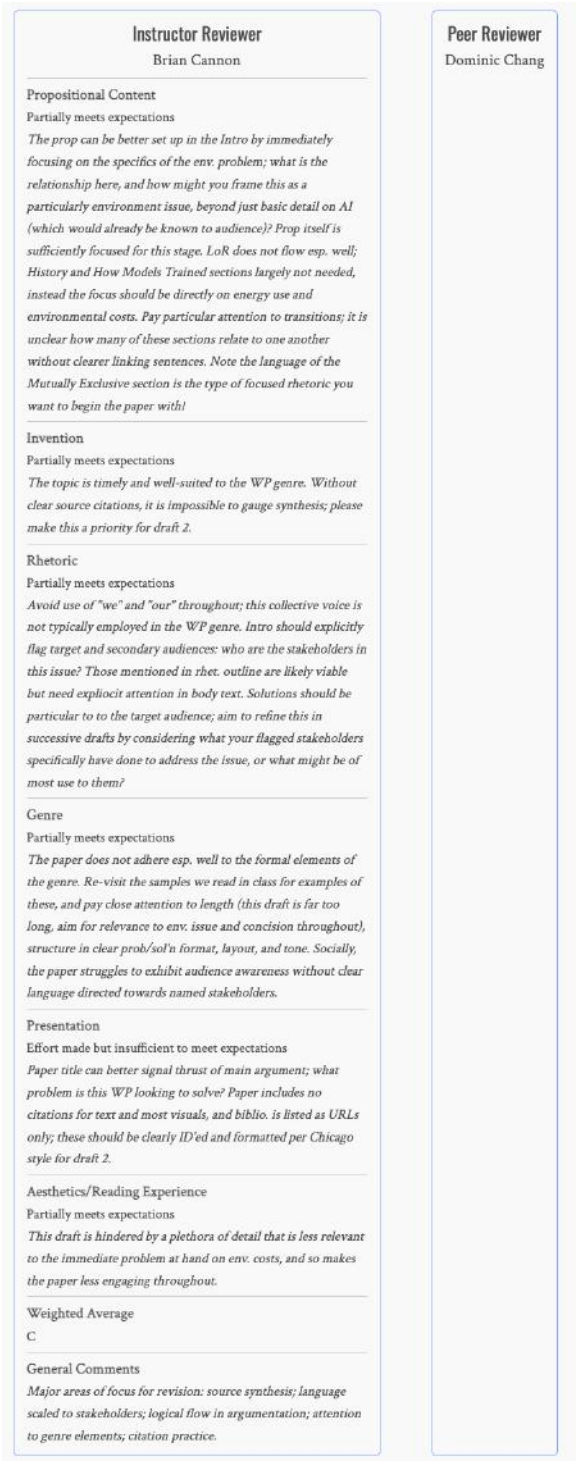
Reasons & Evidence

1. (How) Current silicon chip design should be abandoned in favor of newer technologies
    a. Silicon chips are not inherently energy efficient due to the memory gap problem
    b. Silicon is unsustainable as the world enters into a silicon shortage
    c. Silicon chips requires massively amounts of energy in order to cool
    d. Silicon technology is reaching the limits of physics and can no longer be advanced at a rate suggested by Moore's Law
2. (How) Focusing on massive clean-energy supplying technologies is a long-term goal that will make AI training more climate friendly
    a. Developments in solar and nuclear technologies are decades away from feasible scalability
    b. Clean energy from solar and nuclear technologies will be a long-term solution for supplying clean energy for data centers
    c. Clean energy from solar and nuclear technologies is not favored or implemented by companies currently due to high upfront costs and low efficiencies and a lack of pressure to reduce their climate impact
3. (How) Biologics based chips should be developed for AI specific training and deployment
    a. Biologics-based chips are inherently 10000x more efficient than silicon chip
    b. Biologics-based chips uses less silicon and is thus sustainable in the long term future
    c. Biologics-based chips do not generate heat and thus use less energy
    d. Biologics-based chips have undergone 4 billion years of evolution, resulting in both energy efficiencies and fast processing power

Rhetorical Outline

- Proposition: AI training, deployment, and research needs to be made significantly more energy efficient to align with climate change goals.
- Audience: Chip companies, deeptech venture capitalists
- Genre: White paper
- Motive of the Author: To promote biologics-based computing for investment and R&D
- Motive of the Reader: To recognize the climate problems caused by AI & to fund biologics-based computing and support climate tech solutions in the long-term
- Plan: Publish as a company white paper research (similar to Bitcoin's whitepaper: https://bitcoin.org/bitcoin.pdf), publish in TechCrunch or related site
- Rhetorical Strategies: No idea what this means!
- Keywords: AI, climate, energy, biologics-based computing, biocomputing, neuromorphic computing

Received Peer Reviews



Instructor Reviewer
Brian Cannon

Propositional Content
Partially meets expectations
The prop can be better set up in the Intro by immediately focusing on the specifics of the env. problem; what is the relationship here, and how might you frame this as a particularly environment issue, beyond just basic detail on AI (which would already be known to audience)? Prop itself is sufficiently focused for this stage. LoR does not flow esp. well; History and How Models Trained sections largely not needed, instead the focus should be directly on energy use and environmental costs. Pay particular attention to transitions; it is unclear how many of these sections relate to one another without clearer linking sentences. Note the language of the Mutually Exclusive section is the type of focused rhetoric you want to begin the paper with!

Invention
Partially meets expectations
The topic is timely and well-suited to the WP genre. Without clear source citations, it is impossible to gauge synthesis; please make this a priority for draft 2.

Rhetoric
Partially meets expectations
Avoid use of "we" and "our" throughout; this collective voice is not typically employed in the WP genre. Intro should explicitly flag target and secondary audiences: who are the stakeholders in this issue? Those mentioned in rhet. outline are likely viable but need explicit attention in body text. Solutions should be particular to to the target audience; aim to refine this in successive drafts by considering what your flagged stakeholders specifically have done to address the issue, or what might be of most use to them?

Genre
Partially meets expectations
The paper does not adhere esp. well to the formal elements of the genre. Re-visit the samples we read in class for examples of these, and pay close attention to length (this draft is far too long, aim for relevance to env. issue and concision throughout), structure in clear prob/sol'n format, layout, and tone. Socially, the paper struggles to exhibit audience awareness without clear language directed towards named stakeholders.

Presentation
Effort made but insufficient to meet expectations
Paper title can better signal thrust of main argument; what problem is this WP looking to solve? Paper includes no citations for text and most visuals, and biblio. is listed as URLs only; these should be clearly ID'ed and formatted per Chicago style for draft 2.

Aesthetics/Reading Experience
Partially meets expectations
This draft is hindered by a plethora of detail that is less relevant to the immediate problem at hand on env. costs, and so makes the paper less engaging throughout.

Weighted Average
C

General Comments
Major areas of focus for revision: source synthesis; language scaled to stakeholders; logical flow in argumentation; attention to genre elements; citation practice.

Peer Reviewer
Dominic Chang

Instructor Reviewer

Brian Cannon

Peer Reviewer

Simon Lee

Propositional Content

Mostly meets expectations

I think you did a good job of setting up your premise which is that AI is unsustainable right now. Maybe you could make it more concise.

Invention

Mostly meets expectations

I think that this is a creative and nontrivial solution to the problem you describe. You've coherently brought together a variety of different sources.

Rhetoric

Mostly meets expectations

I think that your language is appropriately technical to the level of the audience. Just something I'm wondering: You have three distinct readers. The level of understanding a pure AI researcher has about chips might be significantly different from a chip manufacturer. Maybe narrow the "AI researcher" reader to "AI computing researcher?"

Genre

Meets and sometimes exceeds expectations

The paper meets all of the white paper content requirements.

Presentation

Meets and sometimes exceeds expectations

The paper is organized and the visuals are put at appropriate locations. I think you could introduce subheadings to to ensure that a reader that skims can easily find information.

Aesthetics/Reading Experience

Mostly meets expectations

I like how you create personal connections by mentioning pertinent global issues such as the global climate crisis.

Weighted Average

B+

General Comments

I think you're on the right track. Conciseness could be helpful generally.

Draft 1 Revision Plan

Valuable Suggestions:
- The prop can be better set up in the introduction by making the introduction shorter and focus on the relevant specifics of the environmental problem. How is it an environmental issue beyond AI?
- LoR does not flow well
- Pay attention to transitions as it is unclear how sections relate to each other.
- Intro should flag the stakeholders in this issue - both target and secondary audiences.
- Draft is too long and not a formal white paper structure.

Invalid/Non-Applicable Suggestions:
- No clear citations and unclear title.
- Avoid the use of “we” and “our”

What is Working Well:
- Prop is good.
- Topic is timely and well-suited to the WP genre.

Action Items:
- Removed the extensive background section on History of AI and Training AI Models to focus more on the environmental impacts of climate change (energy usage associated with data centers and the consequent carbon emissions impact) – which should also simplify the Line of Reasoning
- The first draft had paragraphs out of order for drafting purposes – will rearrange the paragraphs to have the correct order and transitions, which should help with the LoR and make clear how the sections relate to each other. In the end, it should have a proper problem, solution format and layout.
- My citations were in Google Doc comments, which did not get translated onto the PDF. For the next draft, I will simply move the citations into the actual paper in the Chicago format.
- Unsure of not using "we" and "our"... need more clarification. Didn't the McKinsey paper we read use "we"? Also the linked whitepaper published by Bitcoin foundation used "we" and "our" in their white papers.
- Directly mentioned target and secondary audiences in the prop, which were “deeptech VCs, chip manufacturers, and AI researchers” and specifically mentioned how problems/solutions can affect the audiences.
- Added a paper title: Biocomputing as a Solution for Future Sustainable AI Developments
A White Paper Advocating the Development of Biocomputing for Venture Capitalists, AI Researchers, and Chip Manufacturers
- Adjusted tone to be more “white paper” formal.

Draft 2 Revision Plan

Valuable Suggestions:
- Make background more concise (I agree that it is long)
- My language is not scaled technically to all my distinct readers, which I said was AI researchers, chip manufacturers, and VCs.
- Add subheadings to make my paper easier to skim.

Invalid/Non-Applicable Suggestions:
N/A

What is Working Well:
- Setting up the premise that AI is unsustainable.
- Creative, nontrivial solution to the problem after analysis of shortfalls of current solutions
- Genre is like a white paper.
- Organized and has lots of visuals.

Action Items:
- Based on the valuable suggestion to make my background more concise, I aim to shorten the background section. My first step would be to remove repetitive details, as I cited many examples of the same topic or idea to reinforce an idea. I might also cut down more on the introduction section, particularly within the paragraphs that highlight the explosive growth of AI (beginning 2-3 paragraphs). But the heavy use of graphs and figures I think serves to reinforce my premise, so I will not remove graphs and figures from my introduction. My question is also: since I want to continue this writing past this semester and write a longer and more substantial white paper, should I write a short white paper for the class specifically and expand on it after the class ends?
- I need to figure out how to scale my language to all my distinct readers. For example, AI researchers would know a lot about AI but not a lot about chip solutions, and vice versa for chip manufacturers, while VCs in general would have a lower knowledge of this entire field. How can I accomplish this? Need more assistance here. I might start off by narrowing my audience to purely deeptech investors and chip manufacturers. For investors, I will lean more heavily towards selling the introduction section to reinforce the idea that this is a big problem with lots of monetary potential, and for chip manufacturers, I will lean more heavily on problem section to show that current “solutions” to mitigating the AI energy crisis is flawed, and then lead them onto the solutions section. Both VCs and chip manufacturers should have a basic understanding of the problems associated with traditional semiconductors.
- As per the received suggestions, I will add a lot more subheadings to differentiate between certain paragraphs, for example in the solutions paragraph I would have subheadings on "Heat", "Bottlenecks", "Sustainability", etc. Overall, it would make it easier to skim.

Peer Review of Colleague's Draft 1

Reviewer: Maxx Yung
Submitter: Dominic Chang

Propositional Content: Meets and sometimes exceeds expectations, 4

- The prop is short (which is good) but further define "proper" within your prop. Proper should be defined within a premise, perhaps something along the lines of "lacks proper regulation to ensure it isn't abused" or something similar.
- The background/intro sets up the prop nicely, and it was easy to follow along.

Invention: Partially meets expectations, 2

- I believe your solutions to your defined problem is mostly a summary of various statements put out by the organizations you mentioned in your paper, and not really your own thoughts. Your analysis is what the 3 organizations have said instead of your own proposed solution. I know you didn't finish, but when you write "it becomes clear that crypto needs specialized regulation", are you going to input your own unique view on the regulations?
- However, I do believe this paper is timely, as crypto is starting to gain more steam in the financial sector.

Rhetoric: Partially meets expectations, 2

- You are targeting crypto interest groups and regulating entities, so you would need to frame your paper at a higher level since these major institutions would know a lot more than the introductory statements you provide. You would probably need to go more into specific details regarding this problem, such as specific legislations passed and previous attempts to solve this problem. I think this will be hard to do as someone who isn't an expert in crypto legislation, though.
- Find and cite real life examples of crypto regulations, what worked, and what didn't, like case studies, I feel like that would be more engaging to the targeted audience of what regulations they should implement based on prior ones.
- Ultimately, I think your paper and the language used throughout the paper is scaled for more of a general audience and not for crypto organizations who should be very knowledgeable of this field beyond the introductory comments.

Genre: Meets and sometimes exceeds expectations, 4

- Proper use of citations, titles, and subheading to allow for skimmability.
- Clear social purpose: calls for more crypto regulation.
- You would probably need to work more on "Genre knowledge entails understanding what readers expect from the genre, what reader/writer relationships the genre creates and generates, how, when, where and why to use one genre rather than another, and what the

motives are of the genre's author and readers" If targeting regulatory bodies, you would probably need a more defined solution path as stated above, and go into what works and what doesn't work right now in terms of crypto regulation.

Presentation: Meets and sometimes exceeds expectations, 4

- Nice presentation of your work. Some minor grammar mistakes that can be fixed easily.
- I would add bullet points/numbers everywhere possible for readability. For example, maybe a table for the "International Consensus" section, since I think that can all be summarized nicely in a giant table.

Aesthetics/Reading Experience: Mostly meets expectations, 3

- Ignoring lack of images, I would say add more tables in certain sections, and try to bullet point as much as possible (my personal preference) but it makes info easier to read and skim (which apparently is very big since we have to assume "people won't read your entire paper")
- Paper is well-written, and as someone who is interested in crypto, I found the paper engaging from a not-well-educated-in-crypto-legislation viewpoint.

Weighted Average: B+

General Comments

- Fix minor grammars
- More images, more tables, more bullet points.
- If you are going to continue targeting regulatory bodies in crypto, I think adding specific case studies would be valuable.
- Consider another audience group, such as voters to pressure certain crypto regulations.

Peer Review of Colleague's Draft 2

Reviewer: Maxx Yung
Submitter: Simon Lee

Propositional Content: Mostly meets expectations, 3
Easily understandable prop and tailored for the target audience. Background provides solid information to demonstrate AI bias and why that's important.

Invention: Partially meets expectations, 2
Good solutions to problems. I feel for HR specialists, some of these solutions are out of their control and more tailored for people making the model for recruitment. Based on initial reading, solutions seem to be the common solutions already pursued by companies.

Rhetoric: Mostly meets expectations, 3
Scaled for HR specialist audience well, the information is understood for a non-specialist in AI, the table makes it an easy summary. Only question/concern is HR specialists grasping the more specialized terms in AI, and the relevance to them since they do not manage or alter the models they use.

Genre: Meets and sometimes exceeds expectations, 4
Sounds like a white paper. Throughout it, aims to convince that this topic is a problem, and provided context for HR specialists on why it is a problem, and offered a better understanding of the solutions.

Presentation: Consistently exceeds expectations, 5
formatting and grammar, etc, looks fine.

Aesthetics/Reading Experience: Partially meets expectations, 2
too text heavy, even if it is broken up with lots of headings. need more images, figures, tables.

Weighted Average: B+

Copy of Draft 1 White Paper that I Peer Reviewed

Attached below.

The Future of Cryptocurrencies

Introduction:

Cryptocurrency was born in 2009 with the initial launch of Bitcoin. Ever since then, the digital innovation has grown to become a major piece of the economy, but not without its share of issues. Essentially, cryptocurrency is a digital asset that functions as a store of value and a medium of exchange. It employs a blockchain, allowing all participants to transact without a central organization. This blockchain not only houses records of all validated financial transactions, but also has power over creation of new currency. In comparison, sovereign fiat currencies, like the USD, are managed by central banks and distributed via financial banks[1].

Commonly, supporters of crypto technology highlight the benefits of its decentralized nature. Without centralized organizations presiding over such currencies, there are lower associated transaction costs and no risk of government confiscations or control. Additionally, the technology aids the underbanked and unbanked, who now can access financial services. Finally, the digital nature allows quick transactions and a decrease in counterparty risk[1].

However, crypto is not without its failures. In 2022, the enormous crypto exchange FTX went bankrupt after it was revealed for fraud. Despite cases like these, investors are as optimistic in crypto as ever, evidenced by Bitcoin doubling in 2023[2]. Naturally, this calls for strong regulations on crypto, though applying current regulations of assets like stocks to the technology prove to be difficult. Cryptocurrency is a novel asset that continues to evolve by the second, requiring regulations, and regulators that establish them, to continually be adapting. Finally, the digital aspect means big efforts must be put into acquiring data[3].

Thus, crypto lacks proper regulation. This white paper addresses the three main issues of crypto: fraud and volatility, the issue of resounding international consensus, the question of which asset class it falls in and who should regulate it in the US. It is directed to crypto interest groups like the Blockchain Association, in addition to entities that should be regulating crypto like the Securities and Exchanges Commission, Commodities Futures Trading Commision, and International Monetary Fund.

Problems:

Asset Class:

Additionally, a big cause for the mix of crypto regulation is from the ongoing question of which asset class it lies in. On one hand, crypto could be labeled a commodity because of its similarities to gold and silver, which would lead to it being regulated by the Commodity Futures Trading Commission (CFTC). On the other hand, it could be classified as a security because of its expectation of profit, which would put it at the hands of the Securities and Exchange Commision (SEC). All these US regulators are fundamentally different, with some prioritizing consumer protection, while others security or integrity. And there are many entities involved in crypto, such as miners, validators, and protocol developers, that are not protected by conventional financial regulation[3].

There also have been problems regarding crypto being put in one category or another. With the SEC, the argument is that they might too closely regulate it, letting the technology die out. For the CFTC, it is almost the opposite. The recent FTX disaster, as it happens, discredited the idea of instating the CFTC as the main regulator for crypto because FTX CEO Sam

Bank-Fried and the company donated a lot of money and effort into getting the commission to take the charge[4].

International Consensus:

Finally, it is difficult for crypto to be properly regulated without international agreement. Because crypto is entirely contained online, it can easily cross borders and travel far distances which causes complications. Some countries jumped the gun and placed heavy regulations, some even banning, while others warmly welcomed crypto as a way of boosting economic growth. For example, the Bahamas' lax regulatory climate brought in FTX, the company that went bankrupt from fraud. This fragmented reaction does nothing to prevent companies from moving to the most welcoming countries with the least stringent regulations, where fraud could occur under the radar[3].

Fraud and Volatility:

To start, one of the fundamental issues with crypto lies with its susceptibility to fraud and the resulting volatility. The digital nature of the currency puts it at risk to many technology-related threats that regulators have yet to control. These risks have culminated in cyber attacks and loss of credentials[3]. Moreover, the difficult to regulate facet of the technology has led it to be exploited by evil entities. For one, crypto has been used to buy illegal drugs, such as on online black market Silk Road, and in 2017, it was revealed crypto allowed criminal organizations to easily move their illegal funds across borders. The group of Russians that was charged with unlawfully interfering in the 2016 US elections was alleged to have used almost

$100,000 in Bitcoins in their illicit activities[1]. Finally, there have been emergences of bad cryptos stemming from initial coin offerings (ICOs) that offer deceiving or insufficient information[1].

As a result of fraud and speculation, asset values will always swing. However, crypto is known for its extreme volatility, with variations that can result in wide scale gains or losses in a short period. Irrational selloffs are caused by the market's speculative character and lack of fundamental value, which all accentuate fluctuations and threaten stability. Although this volatility draws speculative investors looking for large profits, it discourages the large herd of risk averse institutional investors and traditional businesses[5].

Solutions:

Asset Class:

Crypto's special nature requires a hybrid approach to how it should be regulated by government entities.

International Consensus:

Countries must come together for international consensus on crypto. So far, the International Monetary Fund (IMF) has called for a coordinated and complete response that will address the pressing issues of crypto's ability to move long distances easily[3].

Additionally, the Financial Stability Board (FSB), an international group of major countries, issued a report showing that, while the volume of crypto assets is still small compared to government currencies, the FSB "will identify metrics for enhanced monitoring of the financial stability risks posed by crypto assets and update the G20 as appropriate" [1]. The group also released a guide on the treatment of stablecoins and is advising on other crypto assets like

the unbacked. Other influential entities are also issuing guidance, ranging from the application of current financial principles to stablecoin regulations and "prudential treatment of banks' exposures to crypto assets" [3].

The International Organization of Securities Commissions (IOSCO) has also highlighted the increased use of ICOs as an area of concern and issued a statement discussing the associated risks and the various approaches taken by the regulatory bodies of member states" [1].

Although much has been done by the international community, there are ways to go in terms of international consensus. So far, only guidance has been issued by organizations that do not have influence over all governing bodies, so an important step that must be reached is consistent regulation that spans the globe.

Fraud and Volatility:

It becomes clear that crypto needs specialized regulations protecting investors from fraud, as well as stable currencies to combat volatility.

Conclusion

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Book Summary

In *When McKinsey Comes to Town (2022)*, Walt Bogdanich and Michael Forsythe unveils the hidden influence of McKinsey across industries and governments. Through accessible case studies for the general public, the authors investigated McKinsey's omnipresence in sectors like oil, pharmaceuticals, and government. Yet, throughout all sectors, McKinsey's expert management consulting advice leads to three main strategies to satisfy corporate interests: product strategy, cost-cutting, or layoffs. Disturbingly, McKinsey's advice often prioritizes these three strategies regardless of the consequences, such as compromising worker safety in U.S. Steel and Disneyland incidents, endangering lives through extreme cost measures in immigrant facilitates, or ignoring their firm's values of ethics and global positive change in their work with oil majors and the governments of China and Saudi Arabia. This pattern, as revealed by the authors, underscores a stark contrast between McKinsey's public image and their work, which have tangible adverse effects on the public.

Rhetorical Situation

By: Maxx, Gaurav, Cathy, Dominic

Proposition:

- Walt Bogdanich and Michael Forsythe unveils the hidden influence of McKinsey across industries and governments through accessible case studies for the general public.

Audience:

- The intended audience is the general public—anyone who may be affected by McKinsey's consulting practices or is interested in the consulting world.
- Perhaps a more American focus rather than international audiences.
- Yes, we feel that we are part of the text's intended readership because we are American students not only exposed to McKinsey's practices but go to a university that places a heavy emphasis on consulting.

Genre:

- Investigative Journalism / Expose Writing.
- It is not an academic text nor a monograph.
- It is published by 2 ex-NYT investigative journalists.

Exigence:

- The exigence of the text is the increasing influence of consulting companies such as McKinsey and the various instances occurring as described in the book. The authors are worried about their expanding influence that allows them to influence many parts of our lives behind the scenes.
- The writers want to expose the consulting industry, specifically McKinsey, and their expansive influence that oftentimes lead to negative outcomes for the people and environment.

Motive of Reader:

- General public readers would want to read this out of curiosity, perhaps to gain a better understanding about how McKinsey influences their lives, and we (American students in a university that heavily emphasizes consulting) to know what consulting firms do in general.
- As McKinsey gets more well-known and richer, people would perhaps want to understand the causes for this and why they are so successful.
- They would most likely read the book with an open mind, as most people probably don't know that much about McKinsey's operations to begin with and are more curious or interested in what they do.

Author's Goal:

- Target a larger, more general audience who know of McKinsey but may not be too familiar with its practices and clients
- Discussion about how McKinsey's practices shape critical economic and policy outcomes worldwide
- Raising important questions about the firm's transparency and accountability
- Prompt a deeper discussion of the power McKinsey has in global affairs and the need for greater scrutiny in the consulting industry
- The authors definitely do achieve their goals as they effectively drive home their statements about McKinsey

Plan:

- The text is organized as case studies of McKinsey in multiple industries.
- Each chapter (a case study) highlights an influence that McKinsey had on that specific industry, and the negative outcomes associated with their consulting work. These chapters as a whole demonstrate the hidden influence of McKinsey across industries and governments, which oftentimes leads to slightly negative to disastrous results.

Other Rhetorical Strategies:

- Using quotes and other people's words to make points.
- Using specific evidence from McKinsey employees or from company employees that highlights McKinsey's involvement in these situations and tying that directly to the negative outcome that occurred.
- The writer uses many depictions of suffering, especially in chapters like the one on ICE, China, and opioids. The writer also contrasts these depictions of suffering with depictions of the wealth of affluence of McKinsey's executives, such as the Ferraris described in the South African chapter.

Book Outline of Research Text

Introduction
Given that McKinsey is an influential consulting firm who aims to advise companies to increase profitability.

Thus McKinsey's advice instead did have detrimental effects on their client's company.

What McKinsey often recommends drastic cost-cutting measures which can compromise employee safety and lead to accidents.

What McKinsey's advice can cause companies to value short-term financial gains at the expense of overall long-term gains.

Chapter 1
Given that McKinsey is an influential consulting firm who emphasize their moral and ethical values to attract business.
Given that examples of McKinsey's values include observing high ethical standards, safety, and environmental protection.

Thus McKinsey prioritizes client interests and profits over everything else (such as their moral and social values).

What McKinsey is willing to work with controversial industries or governments despite ethical dilemmas or questionable social impact.

What McKinsey's culture nudges their consultants to accept almost all consulting cases despite moral choices or face pressure to leave the firm.

Chapter 2
Given that outsourcing and restructuring jobs depresses wages and lower job security.

Thus McKinsey's consulting practices have played a key role in exacerbating wealth inequality.

What McKinsey nudges corporate executives to inflate their salaries.

What McKinsey nudges companies to cut costs by outsourcing and restructuring instead of improving revenue.

Chapter 3
Given that McKinsey can work with both private companies and public governments.

Thus McKinsey's involvement in the healthcare industry poses a clear conflict of interest.

What its advantageous connections with the government helps it secure contracts that other firms can't.
For example, when Illinois was trying to evaluate and overhaul Medicaid, McKinsey was able to obtain non-bidding contracts at a higher cost due to policies being bent in their favor.

What its connections with the government helps its clients bypass regulations.
For example, McKinsey was able to get the FDA's approval of Biogen's Aduhelm drug, despite clear evidence that it wasn't effective.

Chapter 4
Given that McKinsey's consulting with ICE presents clear violations of its Values.

Thus McKinsey faces backlash and criticisms from the public for their work on ICE

What the firm's business practices conflict with ethical standards.
For example, McKinsey consultants spoke out against its work with ICE, only to be replied with "We don't do policy, we do execution."

What McKinsey violates human rights to save on costs.
For example, McKinsey advised ICE to cut spending on food for detainees, a recommendation the ICE workers were even against.

Chapter 6
Given that McKinsey has a long history of be extremely secretive about the recommendations it provides its clients.
Given that tobacco companies attempt to hide the fact that cigarettes and tobacco is dangerous for public health and safety in order to earn more revenue.

Thus McKinsey's secrecy has allowed it to help tobacco companies create toxic products without penalty while making a fortune doing so.

How McKinsey maintained a dual consultancy role, advising both cigarette companies and the FDA to influence the tobacco industry regulations subtly to help the interests of their tobacco clients.
For example, McKinsey's consultancy with Big Tobacco was deeply buried in industry documents, demonstrating its desire to remain secretive in their involvement with tobacco company as they consulted for the FDA.

What McKinsey and its clients agreed to keep marketing strategies confidential, preventing damage to McKinsey's reputation as an enabler of harmful products.
For example, among the list of McKinsey recommendations for Big Tobacco, many of the reports were marked “highly confidential” that included recommendations for how the research department should structure its experimental pilot plant.

Chapter 7
Given McKinsey's extensive expertise in the pharmaceutical sector.

Thus McKinsey's engagement in the pharma industry has exacerbated the opioid epidemic.

What McKinsey advised pharmaceutical firms to focus their marketing efforts on individuals more susceptible to opioid addiction.
For example, McKinsey recommended that Johnson & Johnson concentrate their marketing efforts on patients at greater risk of abuse.

What McKinsey employed false marketing strategies to boost sales of opioids.
For example, McKinsey instructed Purdue Pharma to market their opioid specifically as Oxycontin because it was viewed as positive.

Chapter 8
Given McKinsey claims to have a public commitment to sustainability and climate action.

Thus McKinsey’s consulting practices for major polluting companies is in contrast to their values of environmental protection.

What McKinsey's continued profitable engagements with the fossil fuel industry and major polluters.
For example, McKinsey has counted at least seventeen mining and fossil fuel companies among its biggest clients, generating hundreds of millions of dollars in fees.
For example, McKinsey has advised at least 43 of the hundred companies responsible for the most carbon emissions since 1965, indicating a significant portion of its business is with industries contributing to global warming.

What McKinsey's influence on clients' decisions that do not prioritize sustainability efforts.
For example, McKinsey is involved in projects like "Coal Processing Optimization" and advises on the expansion of coal production.
For example, McKinsey still advises major steel and oil companies and defend their work with them.

For example, the firm has not committed to disclosing the total carbon emissions of its clients or refusing projects that would increase carbon emissions.

Chapter 9
Given the proliferation of securitization in financial markets exacerbated the financial crisis of 2008,

Thus McKinsey played a pivotal role in forming financial practices that precipitated the global financial crisis.

What McKinsey is known to encourage risk-taking and discourage regulatory oversight in the financial sector.
For example, McKinsey's advice on restructuring to institutions like Continental Illinois promoted decentralization, leading to more hazardous lending behaviors and significant failures within the banking industry.

What McKinsey's contribution to advising banks led to widespread economic instability and ultimately the 2008 financial crisis.
For example, the Securitization Project by Lowell Bryan at McKinsey, which sought to revolutionize banking through securitization, was heavily marketed as a positive financial innovation.
For example, through its publications and advisory services worldwide, McKinsey actively endorsed securitization, persuading banks and financial entities to embrace these methods broadly, neglecting the potential dangers involved.

What McKinsey advised banks to adopt their positive strategies but avoided discussing its potential downsides.
For example, McKinsey persisted in its support for securitization despite mounting evidence of its role in inflating the housing bubble and the ensuing crisis.
For example, in the aftermath of the financial debacle, McKinsey and its advisors primarily shifted blame, pointing to regulatory oversights as the root cause of the catastrophe.

Chapter 10
Given insurance companies make less money if they pay increased compensation.

Thus McKinsey advised Allstate to reduce payout compensation to policyholders.

What McKinsey encourages Allstate to quickly adopt strategies to minimize payouts.
For example, McKinsey's suggested Allstate expedite and economically resolve 90% of claims.

What McKinsey advised Allstate to vigorously contest the remaining 10% of claims to decrease disbursements.
For example, McKinsey proposed that Allstate apply a "boxing gloves" approach to policyholders or claimants resisting initial low offers, leading to extended and expensive legal confrontations for the claimants.

What McKinsey strategies primarily benefited top executives at Allstate and neglected policyholders.

What McKinsey advises Allstate to use the judicial system to avoid responsibility.

Chapter 5
Given McKinsey provided consulting to Chinese state-owned enterprises.
Given McKinsey's goal of increasing international influence led it to work with China
Given The consultancy's work facilitated projects with strategic purposes, notably in the South China Sea.
Given China is an authoritarian, communist government, which opposes the democratic ideals of the United States.
Given McKinsey is an American company.

Thus McKinsey's consulting for China has allowed the Communist Party to amass more control and influence.

What McKinsey's advice directly supported China's geopolitical strategies.
For Example Advising on the transformation of the Fiery Cross Reef into a militarized island.
For Example Strategic planning for China Communications Construction Company, enabling the execution of projects with military implications.
For Example Championing China's Made In China 2025 plan, which aimed to increase Chinese production to compete globally.
For Example McKinsey simultaneously consults for the Pentagon and Chinese companies involved in strategy.

How McKinsey's consultations enhanced the expansion and efficiency of Chinese state-owned enterprises.
For Example Restructuring advice that improved the global competitiveness of state-owned enterprises.
For Example They consulted for 26 companies within China's *zhongyang qiye*, a group of powerful state-owned enterprises.

What McKinsey's work consolidated the power of the CCP, letting China get away with human rights violations to maintain control.
For Example McKinsey advocated smart cities projects in China that expanded CCP's surveillance capabilities.
For Example McKinsey did not make any statements during protests for freedom in Hong Kong, despite their large business dealings there.
For Example McKinsey consulted for the CCP even when Xi Jing Ping came into power and proceeded to crack down on Uyghur Muslims to reassert party dominance.

Chapter 12
Given McKinsey has experience in working with securing government contracts.
Given State capture occurs when private companies influence a state's decision-making processes for their own benefit.
Given McKinsey's practices in South Africa were questioned for ethical standards, corruption, and legal compliance.
Given Corrupt practices result from unethical decisions being made that can avoid or bypass legal compliance such as money-related scandals.

Thus McKinsey's work with South Africa led to profits from corrupt government contracts.

What McKinsey's consultancy facilitated projects entwined with corrupt activities or firms.
For Example Advisory roles that led to controversial contracts with Eskom, contributing to financial mismanagement.
For Example McKinsey worked with Trillian, even when their leaders were implicated in corrupt government scandals.
For Example South African Airways hired McKinsey after their bribed the airline's treasurer to get the work.
For Example Thuli Madonsela revealed that there were unethical government contracts.

How McKinsey's contract works with South Africa lacked proper due diligence.
For Example Inadequate vetting of partners like Trillian.
For Example Failure to foresee the ethical implications of engaging in high-stakes contracts without competitive bidding.
For Example McKinsey engaged in high-stakes contracts without competitive bidding, leading to possible ethical dilemmas.

Chapter 13
Given McKinsey advises on significant national projects that go against Western democratic interests.
Given Saudi Arabia has a poor track record of geopolitical actions from a Western point of view.

Given There are international concerns over Saudi Arabia's human rights practices from a Western point of view.
Given McKinsey consultations with Saudi Arabia because of the nation's lucrative oil wealth boom and their desire to modernize their economy entangled them with their political dynamics and controversies

Thus McKinsey consultations with Saudi Arabia revealed the ethical dilemmas of consulting work in authoritarian regimes.

What McKinsey's strategic advisory services supported initiatives central to Saudi Arabia's authoritarian regime, which goes against their values.
For Example McKinsey’s production of a report identifying key influencers in the Saudi public sphere who were skeptical of the government’s Vision 2030 reforms became a tool for the government to monitor and suppress dissent.
For Example McKinsey's involvement in projects that directly supported the Vision 2030 initiative indirectly granted legitimacy to a regime frequently criticized for human rights abuses.
For Example Advising on NEOM, a project with implications for consolidating the regime's vision.
For Example Sentiment analysis projects that could be used for suppressing dissent.

What McKinsey’s work on public sentiment analysis helped support the suppression of free speech, which goes against their values.
For Example McKinsey’s report led to arrests, mysterious disappearances, and executions.

How McKinsey's consultancy aided in the regime's international and domestic image management.
For Example Involvement in projects like the Vision 2030 aimed at modernizing Saudi Arabia's image while repression continued.
For Example Assisting in the Saudi government's international outreach, potentially influencing U.S. perceptions.

On-Demand Writing 1

This is a great starting point, Joshua, Elyssia, and Lu! Just spoke with the CEO and here are some of our suggestions for improving the graphic for next week's board meeting.

Group the data points by context – split the graphic so one section focuses on the use of AI to analyze consumer response to ads and the other section to focus on generating AI ad content. Provide recommendations to the board with a clear title per section. Based on our initial review, it seems your R&D demonstrates that producing AI ad content is unfavorable to consumers, while analyzing consumer response to ads is becoming adopted by roughly half of our competitors, demonstrating strong potential for cost-savings through this approach.
Try simplifying the graphic – I would begin by removing the last information node and the 5th information node. While there are a lot of valid data points, we believe the visual is too cluttered. Provide sources to the data provided, and identify whether each data supports either AI ad content or AI powered analytics.

To reiterate, this graphic will be sent to the board of directors in strategizing the company's future direction in utilizing AI in our products and services. We understand that AI comes with many pros and cons, and therefore your R&D, and simplifying that down for the board of directors to make recommendations, would be crucial to the future success of Advertise.ly. If you have any questions, email me at EMAIL@EMAIL.com.

Writing Reflection

I wrote this piece in 11th grade AP Lang. The class had to write an opinion/creative essay on their own perspective of what love is. So here is my perspective of love. I always like to begin with an outline of what I want to write, but inevitably, my writing becomes significantly different as I think about new ideas. So, I'm probably a combination of both strategies. I have written papers citing academic sources and newspaper articles. As a researcher, I find and organize my sources using Zotero and Obsidian. I think it's hard to connect different ideas from different papers together, but I try to remedy that with Obsidian. I think a strength of my Love essay is the demonstration of my capability for a unique writing style. A weakness of my submitted work is that I could have fleshed out the writing more, with opposing ideas and more examples, but I would argue that I was under a deadline! I'm sure there are more weaknesses I could fix, like it being too rambly. I like academic writing if I don't have many limitations and I am interested in the topic. This submitted piece was exactly that - the assignment was more on the creative side and I thought it was an interesting topic to write about. I think I have a lot of experience with academic writing. I've primarily written in research journals, and a couple in AP Lang and Lit classes. Yes, I love reading! I spend 1-2 hours reading everyday. Yes, a lot of my research work in Penn and previous research labs have required me to read academic journals. But on my own, I primarily read non-fiction books (biography, history) and articles from WSJ or NYT or the like. I hate poems, sorry! And I find it hard to believe people would read textbooks for fun. I sometimes read fiction books. I think I'm a fast reader. I'm not sure about any challenges that I struggle with. Hopefully I'll discover some during the course of the class to improve upon.

Writing Sample

Attached below.

Maxx Yung

Ms. Cirringione

AP Language P5

18 February 2022

Love: Less a Dream, Than a War

Love is less a dream, than a war. It is not the idealistic, perfect dream that many make it out to be – rather, a war defined by the bloodied casualties of many, many conflicts, a war defined by woeful defeats before obtaining joyous victories. Society was, is, and always will be attracted to the quixotical aspect that love offers, yet disregard the inevitable misfortunes and tragedies that one must encounter to reach the end of the journey of love. Love can never prosper under this ignorant belief; in no other situation would a person weigh the benefits without also weighing the downfalls, and as such, love should be approached through cautionary lenses, and with a strong sense of will. Therefore, when one ascends towards their fated journey of love, it is wise to ignore the deafening voices of those who claim that love has no equal and overlook the blinding light of illusionary perfection that love offers. Only those who have realized the quixotical nature of love, only those who have cautiously prepared for the hardships that will arise during their journey of finding true love, could travail through the winding path of love and keep marching through the path riddled with defeats and sorrow to eventually experience the nature of the coveted true love.

My goal, however, is not to suggest that one should not undergo this journey. In fact, I believe in the opposite – love is a journey that should be conquered, as it not only biologically allows for the survival of the human species but is the "purpose of human life, no matter who is controlling it" (Popova 2013). To love, and have that love reciprocated upon yourself is a wonderful feeling; it is a blip of bliss in our insignificant lives that provides the fulfillment of our psychological needs,

according to *Maslow's Hierarchy of Needs* ("Maslow" 2022). Intimate love, a feeling of "closeness and bonding in relationships… and the feeling of being at ease," provides pure happiness to the lives of those who have cultivated it ("Triangular" 2022). Love allows us to enjoy life at its fullest and "experience the micro-moments of positivity" that life has to offer (Smith 2013). It is only when individuals believe that intimate love can be found thoughtlessly is there uttermost fault. Like a peach tree, intimate love does not spring up suddenly to provide us with the sweet juices of the fruit – it must be cultivated through cautious and attentive care. The sweet juice of the fruit is not a product of the fruit tree, it is the product of your efforts. Thus, the intimate love that society is so fixated upon, yet almost always out of grasp, can only be gained through the careful advancement of love. Don't recklessly rush out to seek love!

The consequences of reckless love can be disastrous. Sometimes, it leads to what we know of as a "toxic" relationship. Other times, it leads to overwhelming heartbreak, leading some to take their own lives. Martin Luther King once said that "love has the ability to cut the chains of hate that entrail all of humanity" (Luther 2017). Yes, love is powerful. But have we ever considered that love is also powerful in promoting hatred and destruction? Over the course of history, love has made monsters of men. Men have killed in the name of love. Men fought wars in the name of love. As C.S. Lewis once said, "To love is to be vulnerable… is no safe investment… your heart will certainly be wrung and possibly be broken" (Popova 2013). There is no worse feeling than knowing the one you love has betrayed you. To love, therefore, does not necessarily guarantee harmony in the world. In fact, I would go as far as to say that love is a harbinger of conflict, not peace. Every conflict, in essence, is the result of love's powerful influence, which we have established is not always pure. Is not the American Revolution fought because of the colonists' love of freedom? Is not the Trojan War due to the love for Helen of Troy? Love should be approached cautiously, or risk succumbing to the consequences of reckless love-making.

I have established that the journey to love would be riddled with obstacles, but how can you and I avoid the mistakes made by those who came before us? I believe love is a war, a war of attrition. It is about approaching love cautiously; whether you can withstand all the consequences of love and keep on marching through the path. Therefore, I believe that love is a journey meant to be taken slowly. Contrary to modern dating trends, "mass-sampling" of "matching" individuals through an app like Tinder is ineffective and a waste of time. It is better to get to know someone for a long time, in which you can put your full trust in them and theirs in you. Gradually, an intimate relationship would be reached, and eventually, sexual desires and attraction will arise. While this intimacy does not always endure the test of time; it is the love that society most focuses on, as I believe that it is stronger than any other type of love there is. To be intimate is to be vulnerable and true, to accept the other despite their differences. After all, "what is love, but the acceptance of the other, whatever they are?" (Povova 2013). To be intimate is to invest your trust in an unsafe position and hope for your trust to never be abandoned. Upon reaching this level of intimacy, you should also realize that in order to maintain this intimate love, a battle must be fought every day to maintain trust in each other. You will lose some battles along the way and there will be times where the war seems to be a lost cause, but if you fight continuously to maintain the relationship, it will provide far greater benefits than anything else could ever provide. Sadly, society today seems to be fixated on the idea that the war is not worth the effort. They praise those who give up upon a whim of effort and emphasize the misguided belief that one day, you will find intimate love by swiping right a couple dozen times on Tinder; but no great things come from those who put no effort.

Love can be a beautiful thing, but only if it is cultivated slowly over time. My advice? Do not get swept up seeking love – all that would lead to is heartbreak. Do not become irrationally infatuated with your partner in a relatively short period. Take your time and tread carefully; know

which battles are worth fighting for and which battles are better left alone. Love is a war, and to emerge victoriously is to stand up after each defeat and look onwards without fail.

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