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, 04/29/2024

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 interesting problems. In my free time, I enjoy reefing and playing badminton!

I didn't find the MicroRhetoric and Private Sectors modules to be particularly challenging, but I would say that the most challenging aspect was grasping the nuances of the communication forms used to persuade an employer to hire you. I did find the MicroRhetoric and Private Sectors modules to be one of my favorite modules though. I found the MR module to be super interesting, because I have never even considered that, and was a personally relevant course material to me. The Private Sector module was also extremely useful, as I'm sure my peers and I all have to apply to jobs in the near future. Learning to refine my resume and cover letter was not only practical but enjoyable as I learned how it could be applied to my future.

This challenge connected to my prior knowledge of rhetorical devices and persuasive writing techniques acquired in previous English classes. However, the MicroRhetoric and Private Sector modules delved deeper into the application of these concepts in real-world scenarios. While I was able to build upon my existing knowledge, this challenge required me to think more critically about the intentions behind the use of specific language, especially in the resume and cover letters. To meet this challenge, I relied on what I learned in class to revise my resume and cover-letter (for example, adding a proper and standard header, structuring the cover letter specifically to appeal to what a job recruiter might be looking for, etc), which I found to be beneficial in ingraining that knowledge from lecture into real-world applications (this topic is coincidentally my op-ed topic!)

Through this challenge, I learned that I was actually very interested in the psychology behind persuasive communication and how it shapes our perceptions and decisions - for example, on AAVE and how that affected the court trial as we saw in the video shown in class. In terms of writing, I have gained a greater appreciation for the importance of considering the audience's perspective when crafting an argument or message (particularly in the resume and cover letter). Moving forward, I plan to apply this knowledge to my future writing, especially during job searches, ensuring that I am using these techniques to effectively communicate my ideas.

Sincerely,
Maxx Yung

Final Draft of the Op-Ed and Post-Outline

Attached below.

Rhetorical Situation

Proposition: University educators should provide greater opportunities for students to pursue passion projects for self-learning.

Audience: Most likely university staff, including professors, educators, academic advisors, etc. They are most likely interested in helping students learn better, reforming the education system. University students interested in pursuing "better" forms of education for themselves, such as projects or gap year internships may also read.

Genre: An online 600 word editorial in a popular education-based publication targeted towards university staff and students thinking about education reform.

Motive of Author: As someone who wishes to go into engineering and entrepreneurship, both of which are widely regarded as very hands on and cannot be taught in a traditional school-based environment, I wish that Penn and other schools offered their students a greater degree of independent studies and projects that could still fulfill their academic credit limits. As a student myself, I recognize that most students see assignments and the current education system as "broken" and thus aim to game the system and view assignments as grade-focused only instead of learning opportunities. My motive is thus to convince students to pursue independent studies if possible, and for university faculty and administrators to consider a greater degree of supporting independent studies from students. My other motive is to write a compelling editorial that could get me published and all the benefits that come from that.

Motive of Reader: The reader is frustrated with the current educational system, whether they are staff or students, and want to seek ways to either help their students learn better or want to find other opportunities to learn (especially in a hands-on real-world environment). Such readers will be intrigued in my personal experiences with starting a passion project, and from an engineering/entrepreneurship POV, I believe I offer some unique perspectives on this idea.

Author's Goal: To convince the reader that they should pursue passion projects or co-ops or gap year internships (students) or that expanding an independent study program or starting a co-op program is highly beneficial for students (educators), and that the current classroom based learning style is outdated.

Author's Plan: To show the reader several anecdotal examples of learning a lot from passion projects, stats on what industries say about college students (they are ill-prepared) and stats about hiring rates after graduating college, references to other universities co-op or independent study programs.

Rhetorical Strategies: Anecdotes + stats. Emotional + rational appeal!

Logical Outline

(Given) A university/college role is to help students learn.
(Given) Educators want to help their students learn the best they can.
(Given) Traditional education has a focus on grading, assignments, and rigid course structure that does not allow for the student to be flexible and take interesting courses.
(Given) A student within a university wants to graduate in 4 years and thus make the most of their time at university to learn and prepare for their future.
(Given) A major role of university is to prepare students for a future career.

(Thus) University staff, educators, and administrators should allow students to pursue project based, independent studies as a core of their course curriculum.

(Because) The college education's rigid course selections may not be in a student's interest.
(For example) Many students complain about General Requirements that are not related to what they want to pursue.
(For example) The rise of GPT and AI in education proves that assignments are viewed as mundane and unimportant to a student's learning.

(Because) Traditional courses do not reflect the experiences in a real-world career environment.
(For example) Astronomy and education majors are not reflective of what a student's real-world career environment would be like.
(For example) Learning "entrepreneurship" by studying previous case-studies does not teach students to actually launch and run a business and the processes involved in it.

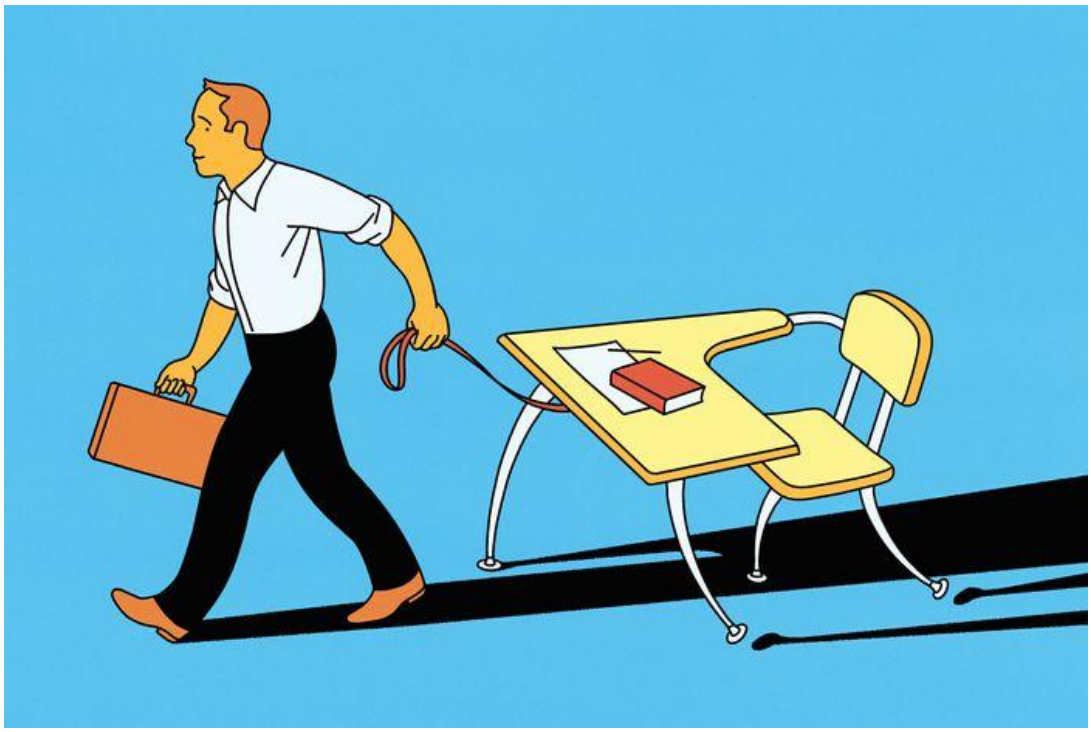
(Because) Students interested in their passion projects will rapidly learn more and provide a better learning experience reflective of a real-world career.
(For example) Personal anecdote of entrepreneurship being my full-time passion rather than just a class for me to take.

(Some may argue that) integrating project-based learning and independent studies into the existing curriculum poses significant logistical complexities, such as the need for specialized faculty expertise. However, universities don't need to be the one teaching and guiding students. Instead, schools could form strategic partnerships with industry and establish co-op programs, which would be beneficial for both the industry (they get more interns and exposure to students who want to work there in the future) and the students (who get to work on real-world projects that actually interest them)..

Rethinking Higher Education: Why Independent Student Projects Matter More Than Ever

Maxx Yung
I am a freshman at the University of Pennsylvania.

Apr 09, 2024, 08:25pm EDT



Is a traditional college education really helping students, or is it simply dragging students down in this day and age?

As my first year at the University of Pennsylvania comes to a close, I find myself drawn towards what Mark Twain once said: "I'll never let my schooling get in the way of my education."

In agreement, I have found that the traditionally-oriented university curriculum that exists at Penn to be ineffective for my education. Penn, and most other universities, promote a traditional curriculum that can be summed up as:

1. Rigid and inflexible for students to pursue the courses they are interested in.
2. Promotes students to achieve high grades over achieving understanding.
3. Often lecture or in-classroom based instead of real-world or project based.

If the main goal of college is to prepare students for a future in their career, I daresay that the traditional college education is failing us. Instead, it is the students, who themselves scour for internships at nights, who themselves learn applicable skills over the weekends, who themselves fit in independent research time in-between the dense walls of blocked time for classes, to be the prime factor in their success. Rather than hindering this, **university administrators need to provide greater opportunities for students to pursue independent real-world projects for self-learning.**

Many university administrators are opposed to this – citing massive changes to the traditional curriculum – but if you *really care* about students' education and their future career prospects, your resistance should turn into acceptance as evidence suggests that independent real-world learning experiences are significantly better for students and their future.

One evidence is that traditional rigid course structures often fail to align with students' career aspirations, forcing them to slog through irrelevant course requirements. One astronomy student I spoke to was drawn in by the prospect of studying black holes, but was stuck to slog through "core" courses such as chemistry or cell biology. Another student in the education major was disappointed to learn that becoming a teacher meant sitting through law and policy courses.

Furthermore, the traditionally common "class lecture followed by dozens of psets" learning approach has been criticized for its inability to prepare students for real-world career experiences. Higher-level economics students often complain that their "psets" are too abstract or mathematically intensive, while lacking clear applications to real-world economic issues or the practical aspects of economic policy. Additionally, with the rise of AI, up to 56% of students use AI on their assignments, particularly in classes deemed irrelevant to their career goals. For example, computer science majors may use AI to complete their chemistry assignments without actually learning the material.

It is likely that more students will rely on AI tools to breeze through their disliked general education requirements, focusing solely on maintaining that perfect 4.0 rather than acquiring true knowledge. You, university administrators and professors, must now more than ever encourage and allow students to pursue career-related independent projects they are interested in, thereby intrinsically motivating the students to learn for the sake of learning, rather than for a grade. Adopting this learning paradigm would allow students to actually mirror a real-world experience of their future career. As a student pursuing entrepreneurship by running my own startup, I find that I am learning far beyond what Penn's Entrepreneurship courses could possibly offer.

Furthermore, allowing students the opportunity to explore topics they are passionate about, they are more likely to take personal initiative and can oftentimes lead to a deeper learning experience. In my case, entrepreneurship became not pages of case studies to memorize, or

memorizing formulas to calculate churn rates. Rather, it became something I now work on full-time – learning far more than I would've if I stuck with the traditional way of teaching entrepreneurship in university education.

Now, besides being hesitant to imposing significant changes to your universities' curriculum, you may also question the logistical complexities involved in weaving project-based learning and independent studies into the traditional educational fabric — pointing out the challenges like the need for faculty with niche expertise, the need for additional funding among universities, and the already busy schedules of professors who cannot facilitate individual assistance with projects.

And I agree these challenges exist at the university level.

But it doesn't have to be universities to implement this. Instead, universities could offer co-op programs to students, where they receive class credit by doing semester internships in companies they *actually* want to work in for the future. These companies often have the funding and experts necessary to accommodate student interns. Moreover, these companies are incentivized to attract students to their co-op programs to foster brand awareness, loyalty, and talent – and will actively attempt to recruit students from established co-op programs.

Universities such as Drexel and Northeastern have already been doing this. This approach not only enriches a student's education, but also significantly enhances employability upon graduation as co-op students regularly accept return offers. Northeastern reports that over 50% of their graduating students receive full-time job offers from their co-op employers, while Drexel reports a 47% full-time offer rate from their co-op employers. Moreover, these co-op programs are highly acclaimed by students themselves, who often view these co-ops as a highlight of their college experience. The same cannot be said for traditional courses at virtually any other institution. According to one student, "the co-ops have been wonderful… Drexel has a very well structured program and will walk you through it."

It's a compelling model that enables students to broaden their educational experience while enjoying the merits of independent, real-world learning. And it's about time for you to adopt a progressively-oriented university curriculum.

Maxx Yung

I am a freshman studying Materials Engineering and Entrepreneurship at the University of Pennsylvania. After six years of research at Stanford Med and Penn Med, I am now leading Nanoneuro Systems, where I am building the future of sustainable AI and paving the way for AGI and biocomputing, currently raising over $1.5M in non-equity grants.

Final Draft of the White Paper and Post-Outline

Attached below.

Hardware Solutions to Ensure Future Sustainable AI Developments

A White Paper Advocating the a Sustainable Development of AI for Researchers, Deeptech VCs, and Chip Manufacturers

Introduction: Artificial Intelligence and Climate Change

The world has transitioned into the era of artificial intelligence (AI) amid an explosive demand for better and larger models, driven largely by their numerous use cases in autonomous vehicles, automating tedious tasks, personal education, and more. There is a noticeable dramatic increase in the number of AI models trained from 2014 to 2024, as shown in Figure 2, contrasting with Figure 1, which illustrates the number of AI models trained from 1950 to 2014[1].

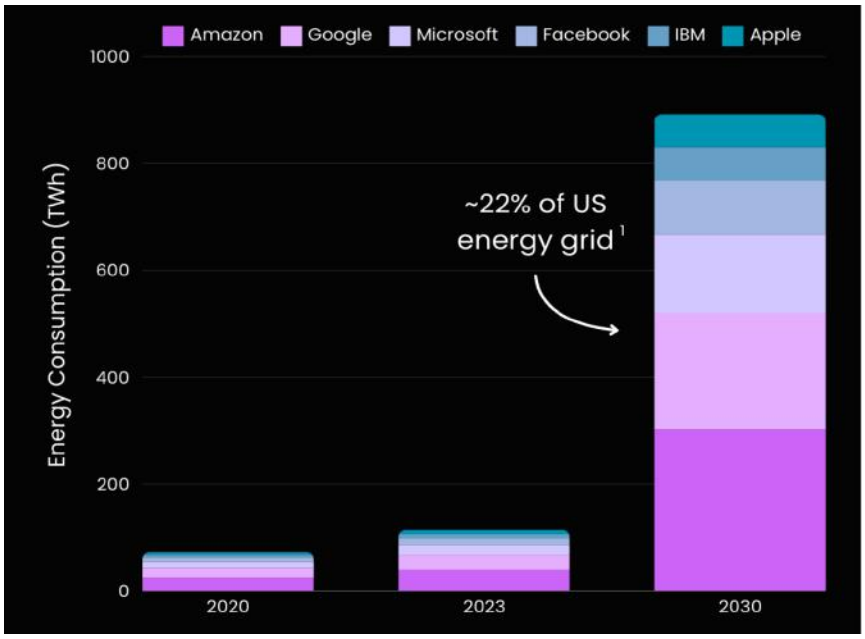


Figure 1. Number of AI Models Trained from 1950 to 2014.

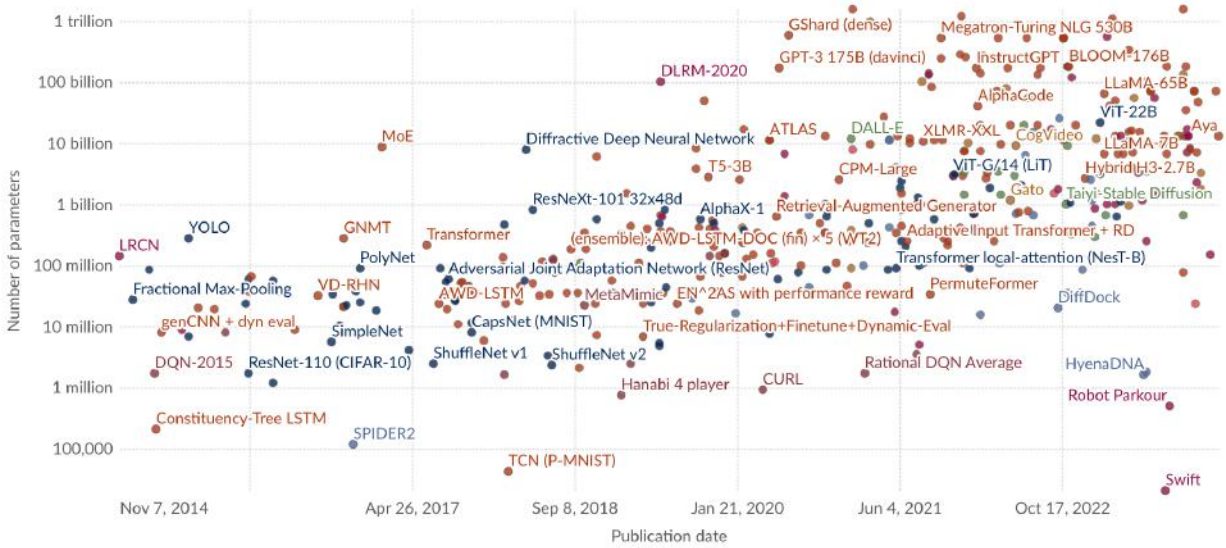


Figure 2. Number of AI Models Trained from 2014 to 2024.

However, this rapid advancement in AI technologies comes with a hidden consequence: an acceleration of global climate change.

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[1] OurWorldInData, “Parameters in Notable Artificial Intelligence”, np.

Already, AI related usage has led to a significant growth in data center utilization – cloud computers that allow AI models to operate. Dr. Naveen Varma, a data center expert and Princeton professor, notes that data center usage has increased by approximately 1 million percent[2] and is projected to double every 6 months[3]. The global electricity consumption attributable to data centers has tripled from 2% to 6% between 2018 and 2020[4] and is forecasted to account for 8% and 21% of worldwide energy consumption by 2030[5].

OpenAI and the University of Massachusetts Amherst also highlight the resulting increase in CO2 emissions[6]. Training a moderately-sized language model—typically 40 billion parameters—results in approximately 300,000 kilograms of carbon dioxide emissions[7]. The GPT-4 and Google's Gemini Ultra models, which are 44 and 39 times larger, respectively, are driving further increases. Emerging data from Amazon already indicates a 15% increase in CO2 emissions due to AI[8].

AI's dependence on computational power means that a linear gain in performance requires an exponential increase in parameters[9] – the information that feeds and trains a specific model – and consequently, in carbon emissions and energy consumption[10]. Currently, the field of AI remains unsustainable. Researchers predict that if AI is operated as they are today, the resulting carbon emissions and energy use would lead to a greater than 2°C increase in global temperature – the limit set by the world during the Paris Agreement to prevent dooming the Earth to irreversible climate damage. **Thus, achieving AI growth that remains in line with the Paris Agreement requires it to be made more energy efficient.**

This whitepaper aims to address how AI will exponentially exacerbate the global climate crisis and highlight what current solutions chip manufacturers, researchers, and venture capitalists are working on or funding. Among them, this whitepaper will highlight biocomputing – the ability to perform AI tasks on biological cells – as an extremely promising solution. This paper emphasizes the emerging and exciting developments in the biocomputing field to academics that may be interested in pursuing or knowing about, the growing feasibility of designing biocomputing chips to chip manufacturing and design companies beginning to look for alternative climate-friendly solutions, and finally to venture capitalists who believe that the global tailwinds around AI and biocomputing would lead to the emergence of a $100 billion dollar valued startup.

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[2] Princeton University, "New Chip Built for AI Workloads", np.
[3] AI Now Institute, "Computational Power and AI", np.
[4] IEA, "Electricity 2024 – Analysis", np.
[5] De Vries, "Growing Energy Footprint", 2191.
[6] OpenAI, "AI and Compute", np.
[7] Strubell, "Energy and Policy Considerations", 4.
[8] Dhar, "Carbon Impact of Artificial Intelligence", 425.
[9] Appenzeller, "High Cost of AI Compute", np.
[10] Dhar, "Carbon Impact of Artificial Intelligence", 425.

Background: The State of Silicon Hardware

AI model development across companies clearly indicates that these models will grow larger and will increasingly require more processing power and energy[11].

The prevailing strategy involves creating more energy-efficient silicon hardware chips. Historically driven by the trend that chips will progressively increase in memory capability (Moore's Law) and energy efficiency (Dennard's Law), these developments have produced silicon chips capable of efficiently training and operating AI technologies.

However, four primary reasons demonstrate why current silicon hardware cannot sustain energy-efficient AI demands:

1. Silicon Advancements Cannot Keep Up With AI Demands

The innovation in silicon chips as described by Moore's Law and Dennard's Law have decelerated[12-14]. Each individual transistor is so small – smaller than a virus[12] – that further miniaturization breaks the fundamental properties of physics[13]. Attempts for further miniaturization introduces novel quantum problems that only occur at the increasingly smaller scales. Consequently, progress in improving traditional silicon hardware to make better, denser, and more efficient chips has also dramatically slowed[14].

Taking into account that the number of transistors on a chip doubles every 3-4 years 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.

2. Silicon Shortage Threatens Future Silicon Advancements

Another problem with silicon chips is the supply of silicon itself. According to estimates from the Semiconductor Research Corporation, the relentless pace of AI's data usage expansion could soon push the demand for silicon-based memory components beyond the annual global production capacity of the material[15]. This is because the process of mining and processing silicon is not keeping up with the demand for processed silicon. This scenario is projected to lead to significant shortages and create bottlenecks in the manufacturing of silicon chips, severely impacting the availability of essential components for a wide range of industries, from consumer electronics to critical infrastructure systems. Such constraints could not only inflate costs due to scarcity but also delay the production of new technology, stifling innovation and technological advancement in sectors dependent on these components[16].

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[11] OurWorldInData, "Parameters in Notable Artificial Intelligence", np.
[12] Penn Today, "Hidden Costs of AI", np.
[13] Cai, "Brain Organoid Reservoir Computing", 1032.
[14] Mann, "Thermal Management", np.
[15] SRC, "Plan for Semiconductors", 5.
[16] Leffer, "Shocking Amount of Electricity", np.

3. Silicon’s Memory Bottleneck Limits Energy Efficiencies

Current silicon chips are also hampered by an inherent memory bottleneck[12-14], a limitation rooted in their core architecture, which dates back to the 1940s. This traditional design paradigm requires data to be stored in one location and computed in another, necessitating the constant shuttling of information between these two sites. As a result, data transfer between the storage and computing units within a single chip are slowing down the entire system. This leads to inefficiencies in both energy consumption and processing time. This separation exacerbates the energy inefficiency of silicon chips, leading to higher operational costs and increased carbon emissions, which contribute to the acceleration of global climate change. This architectural inefficiency not only affects the environmental footprint of these technologies but also limits their potential for scaling up to meet the growing computational demands of advanced AI systems.

4. Silicon’s Heat Output Demands Energy-Hungry Cooling

A final challenge with silicon hardware is the general release of heat as a byproduct of computing. Current Nvidia chips, for instance, generate kilowatts of heat as a byproduct. In a typical server rack, this results in a 21-24 kilowatts thermal load that must be dissipated in order to maintain optimal chip performance. Ultimately, this leads to massive energy costs just to cool the silicon hardware — typically 40-50% of a data center’s electricity consumption[15]. Moreover, the latest chips from AMD and Nvidia are seeing rapid increases in power consumption, which further exacerbates the cooling demand. Consequently, it is estimated that global data centers will experience a 50% increase in energy consumption solely for the purpose of cooling the silicon[16].

Silicon Is Not Capable for Achieving AI Sustainability

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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[12] Penn Today, "Hidden Costs of AI", np.
[13] Cai, "Brain Organoid Reservoir Computing", 1033.
[14] Mann, "Thermal Management", np.
[15] SRC, "Plan for Semiconductors", 5.
[16] Leffer, "Shocking Amount of Electricity", np.

Solutions: Silicon, Architecture, and Biocomputing

Silicon Advancements from Large Companies

Currently, major companies who design and manufacture chips, such as Intel, Nvidia, and AMD, continue to address the energy and carbon footprint problem of silicon chips with further advancements in silicon technology. For example, they claim that new materials combined with silicon, such as Germanium, would enhance the computing properties of using silicon. However, this approach stems from a short-sighted vision of sustainable AI developments and is fundamentally flawed for numerous reasons:

1. A silicon shortage will continue to exist as long as chip manufacturers rely on silicon as the base of their technology. In the near future, silicon supply will not keep up with the demand needed in AI development.
2. Although combining Germanium and other materials into silicon chips would theoretically improve the compute power of a chip, it does not address the memory bottleneck issue of traditional silicon chips. AI researchers project that the bottleneck in AI developments stems from this memory issue and not solely from generating necessary compute power.
3. The byproduct of heat from the silicon chips would remain in the kilowatt ranges, necessitating further energy consumption for cooling, and show no sign of slowing down.

Because these companies do not require venture capital investment, deeptech investors should not concern themselves with the emerging silicon advancements. However, researchers and chip manufacturers should greatly consider whether this path towards sustainability is a viable long-term solution, or is merely a band-aid over a growing problem.

Architecture Advancements from Startups

On the other hand, numerous startups involved in the chip sector have converged on a seemingly better solution: redesigning the architecture of chips that are used to train AI. For example, a new type of architecture called neuromorphic-based chip design is growing in popularity and being pursued by various startups, including RainAI and BrainChip. Other companies, such as Groq, are building “language processing units” that are specialized in AI conversing tasks. These approaches address the primary issue regarding sustainable AI development: the inefficiencies that stems from the memory bottleneck. These companies are redesigning how a chip is manufactured in order to bypass the memory bottleneck prevalent in existing chips, and thus creating more energy efficient chips.

Hardware architecture researchers and chip manufacturers should take a greater look at the advantages that are offered through architecture advancements over silicon advancements. Deeptech venture capitalists should also consider these “foreign” or alternative computing technologies within their portfolio, as the size and future growth of the AI market is poised for continued explosive growth, bringing need for these alternative technologies.

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[17] Smirnova, “Reservoir Computing”, 934.

[18] Cai, “Brain Organoid Reservoir Computing”, 1033.

[19] Tang, “Bridging Biological and Artificial”, 1.

Biocomputing Paradigm from Researchers

With advances in bioengineering techniques[17], a new type of computing paradigm known as biocomputing is poised to emerge as an efficient and sustainable solution to the requirements of AI technologies[18]. The foundation of biocomputing involves utilizing cells within the human brain (neurons) for computation, rather than relying on traditional silicon hardware. This approach addresses each of the problems outlined with silicon:

1. Neurons are inherently energy-efficient due to its ability to adapt and learn[19] – a feature notably absent in traditional computing systems, which require pre-defined programming and fixed architectures, which is less energy efficient.
2. Neurons are also environmentally sustainable, as they can be infinitely sourced from biological models, such as self-replicating cells derived from rats[17-18].
3. Neurons bypass the limitations posed by the memory bottleneck prevalent in current silicon systems – important for the data-intensive tasks involved in AI training[19].
4. Neurons do not generate heat as a byproduct[17]. This characteristic eliminates the need for the kilowatts of energy consumed in cooling processes, dramatically reducing the overall energy and carbon footprint of computing operations[19].

The emerging biocomputing paradigm is an extremely promising solution to the current problem of AI sustainability. Already, current biocomputers have been used in rudimentary computer vision[17] and speech recognition tasks[18-19]. 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[19].

This emerging biologics-based approach offers extremely promising results that should attract the interests of researchers, venture capitalists, and chip manufacturers alike:

- AI and materials researchers should consider collaborating with primary neuroscience researchers (and vice versa) to explore this emerging field.
- Deeptech venture capitalists should keep note and analyze the emerging biocomputing industry as a long-term value proposition within their portfolios.
- Chip manufacturers should take the necessary steps to research this alternative computing technology, and if proven viable, be willing to rapidly adjust to this new paradigm through investments into wet-lab space and hiring neuroscientists.

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[17] Smirnova, “Reservoir Computing”, 934.

[18] Cai, “Brain Organoid Reservoir Computing”, 1033.

[19] Tang, “Bridging Biological and Artificial”, 1.

Conclusion: The Current and Future State of AI

There is an urgent necessity for a paradigm shift in AI development to address the unsustainable energy consumption and carbon emissions linked to current silicon-based technologies. This whitepaper advocates strongly for the adoption of biocomputing, a promising and sustainable alternative form of computing. However, the transition to biocomputing also comes with challenges – including technology scaling, neuron maintenance, and supporting bio infrastructure. Addressing these challenges will be extremely challenging to solve, but if researchers, chip manufacturers, and deeptech investors are able to come together and fund research in this next wave of computing innovation, the AI industry can continue its rapid growth trajectory while adhering to environmental imperatives.

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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
- (Given) that climate change is a major problem which is mainly caused by carbon emissions from human activities

Proposition

- (Thus) Achieving AI growth that remains in line with the Paris Agreement requires it to be made more energy efficient.

Reasons & Evidence

1. (Problem, Why) Current silicon chip design should be abandoned in favor of newer technologies
    a. (Because) Silicon chips are not inherently energy efficient due to the memory gap problem
    b. (Because) Silicon is unsustainable as the world enters into a silicon shortage
    c. (Because) Silicon chips requires massively amounts of energy in order to cool
    d. (Because) Silicon technology is reaching the limits of physics and can no longer be advanced at a rate suggested by Moore's Law
2. (Solution, Why) Silicon, Chip Architecture, and Biocomputing are current attempts to solve the problem
    a. (Because) Silicon advancements might offer greater speed, but are hard to attain and are likely unfeasible in the future.
    b. (Because) Chip architecture fixes the main issues with AI training, but still runs into some of the fundamental problems associated with silicon.
    c. (Because) Biologics-based chips do not generate heat and thus use less energy and is a very promising solution for AI training and deployment in the future.

Rhetorical Outline

- Proposition: Thus, achieving AI growth that remains in line with the Paris Agreement requires it to be made more energy efficient.
- Audience: Chip manufacturing 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: Reference expert sources and research, use charts and data to support claims logically, identifying a problem and providing solutions, and then highlighting a single and most promising solution. A call to action that appeals to companies and VCs to make a profit, while also creating a sense of urgency in solving this problem.
- Keywords: AI, climate, energy, biologics-based computing, biocomputing, silicon.

One-on-one peer review of a colleague's Op-Ed

For Shubham Dixit's Op-Ed, reviewed by Maxx Yung (me).

Propositional Content: Mostly meets expectations

- I assume the prop is: As educators and parents... unleash the full potential of VR... its ability to create immersive, interactive... bridge the gap between education…
    - Consider: - Combining into 1 sentence and simplifying. "As educators and parents, we must embrace/adopt VR technology for its ability to create ... that can make learning better?"
- Maybe move the concession/refutation paragraph (the 2nd one?) lower down until after you have stated your points already?

Invention: Mostly meets expectations

- Good mix of sources (Stanford studies, other studies).
- Very timely problem since VR is new and this is definitely a topic of concern in education.
- Consider: Hyperlink references? Anecdotal evidence? It would fit the genre of the op-ed better and anecdotal evidence would give you a "voice" within your op-ed.

Rhetoric: Partially meets expectations

- Your intended call to action is pretty clear. Title defines the op-ed well.
- Tone and voice works well, albeit some suggestions:
    - Make some paragraphs shorter. Especially the 3rd.
    - It doesn't read entirely conversational, almost robotic. I have a feeling it is attributed to phrases like "VR in education is more than just a brief fascination. It is a fast track to a world of opportunity." or "As we chart the course of education's future, let us anchor our decisions in the belief that the integration of VR in early education is a necessary stride toward excellence in learning." Try trimming down the fluff around the sentences that make it sound slightly robotic and monotone.
    - In relation to the above suggestion, you should add more variation to your sentence lengths. Partly why it sounds kinda robotic is the sentences are all generally really really long.

Genre: Partially meets expectations

- I think the social purpose is there: to convince educators (the venue/audience) about the benefits of VR.
- The prop is good and the counterargument makes sense to me. However, some formal features need fixing: add hyperlink references, a more conversational tone by using more first person, varying sentence lengths (overall need shorter sentences), and make some paragraphs shorter.

Presentation: Partially meets expectations

- Easy fixes:
    - Add masthead, by-line, images, and bio?
    - Add hyperlink references?

Aesthetics/Reading Experience: Mostly meets expectations

- It is well written with statistics but doesn't connect at a personal level. Mirroring suggestions provided above: Sentence lengths, shorter paragraphs, more first-person and how you think rather than as a research based op-ed.
- I would very definitely consider removing these long intro phrases throughout your essay: "As we chart the course of education's future, let us anchor our decisions in the belief that the integration of VR in early education is a necessary stride toward excellence in learning." They're very long and monotone sounding. Not sure how to un-monotone it though.

Weighted Average: B-

General Comments: Besides easy fixes like hyperlink references, adding visuals to get a perfect presentation score, some more pressing issues should be: - Rewriting some sentences to be shorter and making some paragraphs split into 2. Consider more first-person, anecdotes, and what you think about the problem, making it more like an op-ed genre than a research based, stating the facts type paper.

A copy of the document you reviewed

Attached below.

Traditional Teaching is Not Enough: Why VR Must Be Integrated Into Early Education

Consider the traditional classroom, a scene that has been confined by standards for decades: rows of desks, the chalky scent of blackboards, and the rustling of paper. These are the hallmarks of learning as we know it. Unfortunately, in this familiar setting, we are failing to harness the true potential of technology. As educators and parents, we must unleash the full potential of Virtual Reality (VR) technology. Its ability to create immersive, interactive learning experiences can bridge the widening gap between education and technological progression.

Skeptics will caution against the deceiving allure of VR. They point to the financial and logistical hurdles, raising concerns about equitable access and the overshadowing of traditional education. While skepticism may be a healthy reflex, it must also be challenged, as it stands in the way of progress. The transformation that VR can bring to education (making difficult concepts accessible and turning passive observation into active participation) is worth our investment. Thanks to Stanford University's Jeremy Bailenson's research which demonstrates how VR can improve empathy and environmental behaviors in students, we now know that it is not just about engagement, but also about shaping responsible global citizens.

VR in education is more than just a brief fascination. It is a fast track to a world of opportunity. Statistics from the U.S. Department of Education suggest that VR can increase retention rates by up to 75%. This is not simply about providing novelty, it is also about cementing knowledge in young minds with clarity. With that being said, let us not gloss over the disparities in access to technology. We must ensure that VR does not become a privilege for the elite but rather a common resource in every classroom, as necessary as the pencil and notebook, bringing rich and diverse perspectives to students who might never have the chance to experience them otherwise. The case for VR in education is supported by numerous pieces of research. Hu-Au and Lee (2018) demonstrated that VR not only bolsters engagement but also fosters deeper learning by connecting students with content in interactive and memorable ways. Bailenson et al. (2008) further support this, finding that VR's immersive nature significantly heightens the sense of presence.

Simply put, while we can acknowledge the concerns over costs and the learning curve associated with new technologies, we cannot allow them to completely immobilize us. Costs will fall as technology advances and becomes more accessible. Training can instill the skills necessary for instructors to successfully integrate VR in their classrooms, guiding their students through virtual forests and galaxies and connecting curriculum to tangible experiences. Additionally, to claim that VR could replace the essential human element of teaching is a misunderstanding of its role. VR should serve as an extension of the teacher's toolkit. It should serve as an enhancement

rather than a replacement. It aims to amplify the sensory experience of learning and to inspire curiosity and insight in ways that a textbook never could.

Looking forward, embracing VR in early education means laying the groundwork for students who are not just tech-savvy but are also equipped with the problem-solving skills and creative thinking that the future demands. It means recognizing that the line between technology and everyday life has already been erased. In the grand scheme of education, let this be the moment where we choose to tap into and invest in the future and embrace the tools that will sculpt the minds of tomorrow.

As we chart the course of education's future, let us anchor our decisions in the belief that the integration of VR in early education is a necessary stride toward excellence in learning. It's time for the torchbearers of education (educators, policymakers, technologists, and society) to unite in this endeavor. Let us boldly step into the reality that VR in early education is not an if, but a when.

On Demand Writing 2

DeliverDine CEO Statement Regarding Recent Changes

To the DeliverDine Community,

I want to first extend my deepest apologies for the confusion and inconvenience that our recent updates have caused. While we aimed to enhance our services with new membership plans and an updated smartphone app, it is clear that our execution did not meet the high standards you expect and deserve from us.

We realize that the changes to our subscription rates and the process required to adjust to our new app have not been as seamless as intended. To address this, we are taking the following immediate steps:

1. Account Adjustments: We are reviewing all complaints on a case-by-case basis to ensure that every member is on the most suitable plan and is fully satisfied with the terms.
2. App Improvements: We acknowledge the difficulties in navigating our new app and are rolling out updates in the coming days to make it more user-friendly.

Going forward, we promise to do better and will be working to restore your trust in our service.

Thank you for your continued support and understanding. Please reach out directly to our support team if you have any concerns or need further assistance. We are here to help and ensure your experience with DeliverDine continues to be pleasant.

Warm regards,

[The DeliverDine CEO name]
CEO, DeliverDine

Op-Ed Pre-Outline - Rhetorical Situation

Proposition: University educators should provide greater opportunities for students to pursue passion projects for self-learning.

Audience: Most likely university staff, including professors, educators, academic advisors, etc. They are most likely interested in helping students learn better, reforming the education system. University students interested in pursuing "better" forms of education for themselves, such as projects or gap year internships may also read.

Genre: An online 600 word editorial in a popular education-based publication targeted towards university staff and students thinking about education reform.

Motive of Author: As someone who wishes to go into engineering and entrepreneurship, both of which are widely regarded as very hands on and cannot be taught in a traditional school-based environment, I wish that Penn and other schools offered their students a greater degree of independent studies and projects that could still fulfill their academic credit limits. As a student myself, I recognize that most students see assignments and the current education system as "broken" and thus aim to game the system and view assignments as grade-focused only instead of learning opportunities. My motive is thus to convince students to pursue independent studies if possible, and for university faculty and administrators to consider a greater degree of supporting independent studies from students. My other motive is to write a compelling editorial that could get me published and all the benefits that come from that.

Motive of Reader: The reader is frustrated with the current educational system, whether they are staff or students, and want to seek ways to either help their students learn better or want to find other opportunities to learn (especially in a hands-on real-world environment). Such readers will be intrigued in my personal experiences with starting a passion project, and from an engineering/entrepreneurship POV, I believe I offer some unique perspectives on this idea.

Author's Goal: To convince the reader that they should pursue passion projects or co-ops or gap year internships (students) or that expanding an independent study program or starting a co-op program is highly beneficial for students (educators), and that the current classroom based learning style is outdated.

Author's Plan: To show the reader several anecdotal examples of learning a lot from passion projects, stats on what industries say about college students (they are ill-prepared) and stats about hiring rates after graduating college, references to other universities co-op or independent study programs.

Rhetorical Strategies: Anecdotes + stats. Emotional + rational appeal!

Op-Ed Pre-Outline - Logical Outline

(Given) A university/college role is to help students learn.
(Given) Educators want to help their students learn the best they can.
(Given) Traditional education has a focus on grading, assignments, and rigid course structure that does not allow for the student to be flexible and take interesting courses.
(Given) A student within a university wants to graduate in 4 years and thus make the most of their time at university to learn and prepare for their future.
(Given) A major role of university is to prepare students for a future career.

(Thus) University staff, educators, and administrators should allow students to pursue project based, independent studies as a core of their course curriculum.

(Because) The college education's rigid course selections may not be in a student's interest.
(For example) Many students complain about General Requirements that are not related to what they want to pursue.

(Because) Traditional courses do not reflect the experiences in a real-world career environment.
(For example) Learning "entrepreneurship" by studying previous case-studies does not teach students to actually launch and run a business and the processes involved in it.

(Because) Students interested in their passion projects will rapidly learn more and provide a better learning experience reflective of a real-world career.
(For example) Personal anecdote of doing research and understanding biology versus a biology class.

(Because) University focuses too much on grading, leading to students achieving the highest grade rather than truly learning.
(For example) The rise of GPT and AI in education proves that assignments are viewed as mundane and unimportant to a student's learning.

(Some may argue that) integrating project-based learning and independent studies into the existing curriculum poses significant logistical complexities, such as the need for specialized faculty expertise. However, many universities are often the greatest talent density in many fields compared to anywhere else.

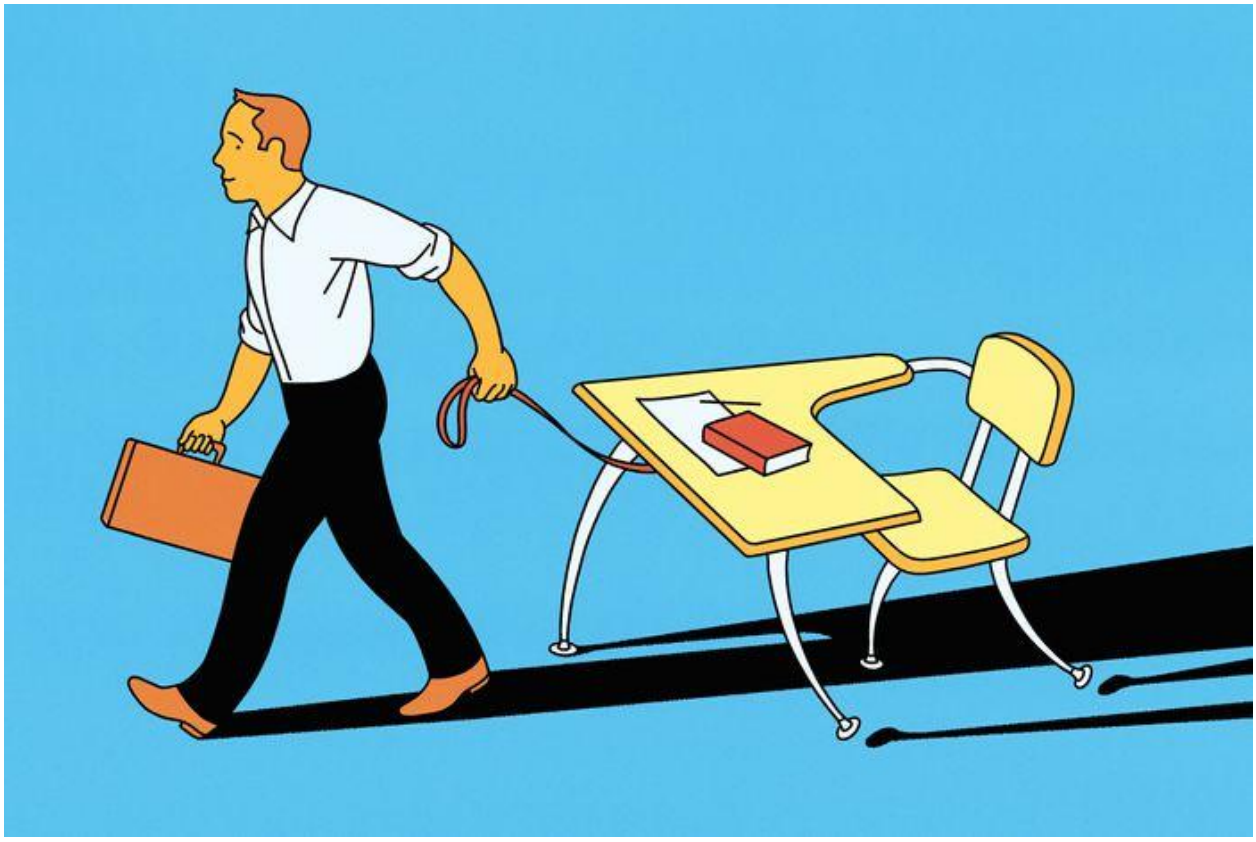
Op-Ed Early Draft

Attached below.

Rethinking Higher Education: Why Independent Student Projects Matter More Than Ever

Maxx Yung
I am a freshman at the University of Pennsylvania.

Apr 09, 2024, 08:25pm EDT



Is a traditional college education really helping students, or is it simply dragging students down in this day and age? Source: WSJ

As my first year at the University of Pennsylvania comes to a close, I find myself drawn towards what Mark Twain once said: "I'll never let my schooling get in the way of my education."

In agreement, I have found that the traditionally-oriented university curriculum that exists at Penn – rigid and inflexible, grade-focused, and lecture-based – to be ineffective for students. Even among my research lab at Penn Medicine, which is ranked as the 3rd best medical school in the world, I have heard countless variations of "Undergrad was pretty useless, I don't even remember what I learned there."

If the main goal of college is to prepare students for a future in their career, I daresay that the traditional college education is failing us. Instead, it is the students, who themselves scour for internships at nights, who themselves learn applicable skills over the weekends, who themselves fit in independent research time in-between the dense walls of blocked time for classes, to be the prime factor in their success. Rather than hindering this, university administrators need to embrace the value of student independence. **Elite universities need to provide greater opportunities for students to pursue independent real-world projects for self-learning.**

One reason is because traditional rigid course structures often fail to align with students' genuine interests and career aspirations, forcing them to slog through irrelevant course requirements. You may assert that your class is important (it likely is!) but for specific students, it may be irrelevant. Countless students nationwide lament how their "chemistry lectures are completely useless for learning computer science," to cite one example. The rigidity of this one-size-fits-all approach dampens enthusiasm for learning, leading to poorer outcomes.

Furthermore, the traditionally common “class lecture followed by dozens of psets” learning approach has been criticized for its inability to prepare students for real-world career experiences. Additionally, with the rise of AI, students have been breezing through those “psets”, particularly in classes deemed irrelevant to their career goals. For example, computer science majors may use AI to complete their chemistry assignments without actually learning the material. After all, is it even relevant to their future careers?

Ironically, universities may be unintentionally fostering this behavior by prioritizing GPA prestige and degree status over genuine education and learning. Imagine a scenario where a student who writes an essay on their own receives a lower grade compared to a classmate who "GPTed" their entire essay. Wouldn't that disparity be demotivating for the student who put in the effort to create original work?

Well, for my friend in Penn's writing seminar, it was. "Why should I put in twenty times the effort if I'm just going to get a lower grade for it?"

It is likely that more students will rely on these tools to navigate through their rigid and inflexible general education requirements, focusing solely on maintaining that perfect 4.0 rather than acquiring true knowledge.

Students need to develop critical thinking and problem-solving skills, but those skills cannot and no longer should be developed by memorizing lecture formulas and coasting through assignments. Rather, educators and professors must encourage and allow students to pursue career related independent projects they are interested in, thereby intrinsically motivating the students to learn for the sake of learning, rather than for a grade.

A major benefit of adopting this learning paradigm is allowing students to actually mirror a real-world experience of their future career. For example, last week I was invited to a dinner with Contrary Venture Capital, a top-tier venture capital firm. We discussed the effectiveness of Penn's Entrepreneurship classes and came to a single conclusion: working on 10 page "business canvas" worksheets is simply not a real-world reflection of what entrepreneurship truly is.

As a student pursuing entrepreneurship through an independent project (running my own startup), I find that I am learning far beyond what traditional lectures coursework could possibly offer. Could a couple of case-studies reviewed from class teach me how to apply oscilloscope measurements to software specific to my company? Could it teach me the design process or the manufacturing process for silicon chips?

Probably not.

Even the simple experience of pitching to hundreds of investors and raising millions in funding isn't taught at all. Sure, one could learn the *theoretical* best way to pitch, but one must pitch to know how to pitch.

By diving head-first into running my startup, I have acquired a diverse, real-world applicable skill set and soft skills that can't be taught through 10 page worksheets: what it feels to "move fast and break things," how to work out cofounder disagreements, or dealing with the stress that inevitably comes when you're weeks away from running out of cash.

Furthermore, allowing students to pursue their own interests can oftentimes lead to a deeper learning experience. When students are given the opportunity to explore topics they are passionate about, they are more likely to take personal initiative and engage in self-directed learning. This approach results in a better education, as students are intrinsically motivated to acquire knowledge and skills relevant to their interests.

In my case, entrepreneurship became not pages of case studies to memorize, or memorizing formulas to calculate churn rates. Rather, it became something I can call my own. It became something I now work on full-time on top of my education – managing interns, 40 hours of manufacturing and R&D a week, raising millions in capital – ultimately learning far more than I would've if I stuck with the traditional way of teaching entrepreneurship in university education.

Some may raise concerns about the logistical complexities involved in weaving project-based learning and independent studies into the traditional educational fabric — pointing out the challenges like the need for faculty with niche expertise and the need for additional funding.

I disagree.

I firmly believe that elite universities are the only institutions uniquely capable to overcome these specific obstacles. The Ivy League and similar caliber universities, arguably, are the deepest reservoirs of unparalleled talent and financial resources, surpassing those found in most other contexts. Furthermore, by forging strategic alliances with the business world, educational institutions can create a symbiotic relationship that serves not only the immediate stakeholders — the schools, the industries involved, and, most importantly, the students — but also the broader community by driving innovation and skill development.

Universities such as Drexel and Northeastern have indeed set a commendable precedent by valuing the role of independent real-world experience in higher education. Their highly acclaimed cooperative education (co-op) programs demonstrate the feasibility of integrating academic study with professional practice. These programs permit students to alternate periods of academic study with terms of full-time, paid professional employment in their field of study, thus providing a seamless blend of theory and practice. This approach not only enriches a student's education, but also significantly enhances employability upon graduation as co-op students regularly accept return offers.

It's a compelling model that enables students to broaden their educational experience while enjoying the merits of independent, real-world learning.

And it's about time for other elite universities to follow suit.

Maxx Yung

I am a freshman studying Materials Science and Engineering with minors in Computer Science and Entrepreneurship at the University of Pennsylvania. After six years of research at SUNY Old Westbury Neuroscience Institute, Stanford Medicine, and Penn Medicine, I have been able to travel the world to present my findings at MIT, Stanford, Regeneron, and the American Academy of Neurology. After founding several small businesses generating over $20,000 yearly revenue, leaving as a cofounder of a $100k pre-seed backed AI startup, I am now leading Nanoneuro Systems, where I am building the future of sustainable AI and paving the way for AGI and biocomputing. Raised over $1.5M in non-equity grants and currently raising a pre-seed round with a valuation of $14M.

Op-Ed Model

Attached below.

How A New Company Uses Machine Learning To Measure Academic Impact

Michael T. Nietzel Senior Contributor
I am a former university president who writes about higher education.
Follow

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Mar 14, 2024, 06:06am EDT

A new company is using machine learning to rank colleges and departments and measure scholarly ... [+] GETTY

Higher education is awash in data. Whether it's the indicators the college rankings industry uses to compare institutions, the metrics faculty and administrators employ to gauge the importance of scholarly work, or the outcomes selected to measure the value of a college education, quantification is the name of the game when evaluating much of academic work.

But how best to harness all that data? How should they be combined and analyzed to yield accurate and meaningful estimates of institutional quality, scholarly influence and social impact?

A relatively new company – AcademicInfluence.com., co-founded in 2020 by Jed Macosko, a Berkeley PhD, professor of physics at Wake Forest University and president of the fledgling startup — believes it has the answer with a novel use of machine learning to measure various aspects of higher education, including college and department rankings, scholarly reputations and publications with the greatest impact. (In full disclosure, I have written two invited articles for the company's website.)

Its approach is based on an algorithm that measures how often a person's work is mentioned in various databases. For example, how often is Richard Phillips Feynman, the Nobel-winning theoretical physicist, mentioned in Wikidata, the text associated with Wikipedia, and in the abstracts, titles, references, keywords in publications found at Crossref and Semantic Scholar. It then extrapolates from those numbers to arrive at cumulative measures of different kinds of impact.

College Rankings

One of Academic Influences' first products was a college ranking system using a methodology based on the premise that the people affiliated with an institution determine its quality.

Using machine-learning technology, originally developed with funding from the Defense Advanced Research Projects Agency, Academic Influence searches open-source data in three massive sources - Wikipedia, Semantic Scholar and CrossRef - for papers, chapters, books, and citations to individuals worldwide. Collectively, these databases contain billions of continually updated data points about millions of individuals' achievements.

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By **Kevin Payne** Contributor

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By **Cassidy Horton** Contributor

Then, an institution's influence score is calculated by combining all "mentions" of the individuals who've been associated with it as faculty, administrators or alums. That score is then divided by the school's total number of students so that small and mid-sized schools have an equal chance of competing with larger colleges. A small school with proportionately more influential faculty than a large school, whose absolute influence may be bigger, will nonetheless score higher using what's termed "Concentrated Influence."

To control for various confounds, the data are restricted to the past ten years, and the names of famous politicians, artists, performers, and athletes are suppressed so they don't exert an inordinate, misleading influence on a school's ranking. The University of North Carolina doesn't get a boost from Michael Jordan, and the University of Kentucky receives no advantage from alum and star actress Ashley Judd.

Using its influence calculations, Academic Influence has churned out rankings for all kinds of schools and programs - research universities, global institutions, online MBAs, liberal arts colleges, online institutions, HBCUs, religious institutions and community colleges. It also ranks the best college in each state.

All those lists drive students, parents and other consumers to its website, attracting a growing audience of readers through organic searches. That traffic is critical to the for-profit company's business model — most of its revenue comes from generating applications by prospective students to colleges, which pay the company a fee for each student who expresses interest in applying. Licensing its proprietary ranking algorithm to other sites is another revenue stream for the company.

Since launching its website in August 2020, Academic Influence's traffic has grown from 50,000 to more than 1,000,000 visitors per year, as measured by Clicky.

Scholarly Impact

Academic Influence also ranks the individuals who've had the greatest influence in their respective academic fields using the same logic to that employed for ranking colleges and programs. Think of it as sizing up an academic's intellectual footprint on the web.

Currently, it provides data on scholars in 24 disciplines and approximately 300 sub-disciplines. So if you're interested in finding history's most influential philososophers, or the world's most influential mathematicians currently, you can find them at its website. Those lists are often broken down further by demographic categories — for example, who are the most influential women engineers, or the most influential Black scholars?

Evaluating scholarly impact has become a high-stakes exercise in academia. Universities often contract with services such as Academic Analytics to measure the scholarly impact of faculty members' research products — their grants, papers, journal articles and books - and then include that analysis as part of faculty promotion-and-tenure dossiers.

Counting publications and citations by others to those publications are common measures of scholarly impact. One particularly influential metric is the h-index, named after its originator, physicist Jorge E. Hirsch. It combines the volume of an author's publications with the extent of their citations into a single measure of impact.

Macosko, who serves as the President and Research Director of Academic Influence, believes his company's method of computing influence based on thousands of inputs is an improvement over combining just the h-index's two inputs of publication volume and citation extensiveness.

He points to the fact that persons at the top of Academic Influence's lists often don't have an ultra-high h-index, a fact that points to some of the index's well-known limitations. For example, it does not distinguish between review articles, which are highly cited, and empirical studies, which report original data but get fewer citations. An author who

produced more of the former might earn a higher h-index than the scholar who published an equal number of empirical articles containing important new discoveries.

In addition, the h-index is largely insensitive to publications that receive a large number of citations, thereby possibly understating the impact of a particularly influential contribution.

The quality of academic departments and graduate programs, especially in the sciences, are also often judged by big data-driven impact assessments. Those data are then used by universities to inform strategic decisions such as which academic departments should be strengthened and which should be diminished or which research areas represent an institution's best prospects for more research funding.

As a result of these kinds of consequential applications, faculty are cautious — often even suspicious – of relying on big data to judge the quality of their work. Their critiques need to be taken seriously. No measure of impact is flawless, including those generated by the algorithms at Academic Influence.

As one example, a person could receive many mentions for his or her work largely because it's publicly controversial rather than fundamental or impactful in an academic field. Take the psychologist Jordan Peterson as an example. Currently, he ranks 31st among the world's most influential clinical psychologists, according to Academic Influence. However, among many academic psychologists, Peterson would be viewed critically as more of a cultural figure or a divisive voice, rather than a credible academic.

When I recently asked Macosko about this objection, he told me the example of Peterson shows how his company's measure of influence differs from typical metrics. "Someone like Peterson, or even better, Claude Shannon, the creator of the field of information science, highlights why we think our metric adds value. Claude Shannon, when measured with traditional metrics, rises only to the middle of the pack with an h-index of 66. However, using our metric, he rightly climbs to the top, with a #14 overall ranking and #2 in computer science. Thus, we are giving higher education a new tool that gets at the heart of an academic's influence, and it's a tool that draws from orders of magnitude more datapoints than merely what gets fed into h-index and similar measures."

Academic Influence aims to be a disrupter in the college ranking business and other academic impact analyses. Its founders believe its computational methodology eliminates much of what they call the "gameability" of other approaches – the thumbs-on-the-scale that allow subjective factors to get mixed in with numeric indicators of institutional and scholarly impact. But whether removing most human judgment from those processes eliminates only noise and not also some signal remains a key question.

As with all rankings, it's best for consumers to view those from Academic Influence as one piece in the puzzle rather than a final answer. As Macosko said, right after he mentioned Claude Shannon's ranking, "If an academic department wants to use our algorithm to help with a faculty search or in the tenure and promotion process, they don't have to worry about getting tricked into hiring someone who is merely a culture figure or only a lightning rod for controversy."

only a lightening rod for controversy.

"Obviously, an academic department will want to use our algorithm to help them make a wise decision about candidates they've already vetted," he added. "Our information provides another tool in their toolbox when it comes to doing what departments have always needed to do: find the best people. That's why the algorithm at AcademicInfluence.com always starts with people. It's 'people power' that makes academia the force of good that it has been and can continue to be."

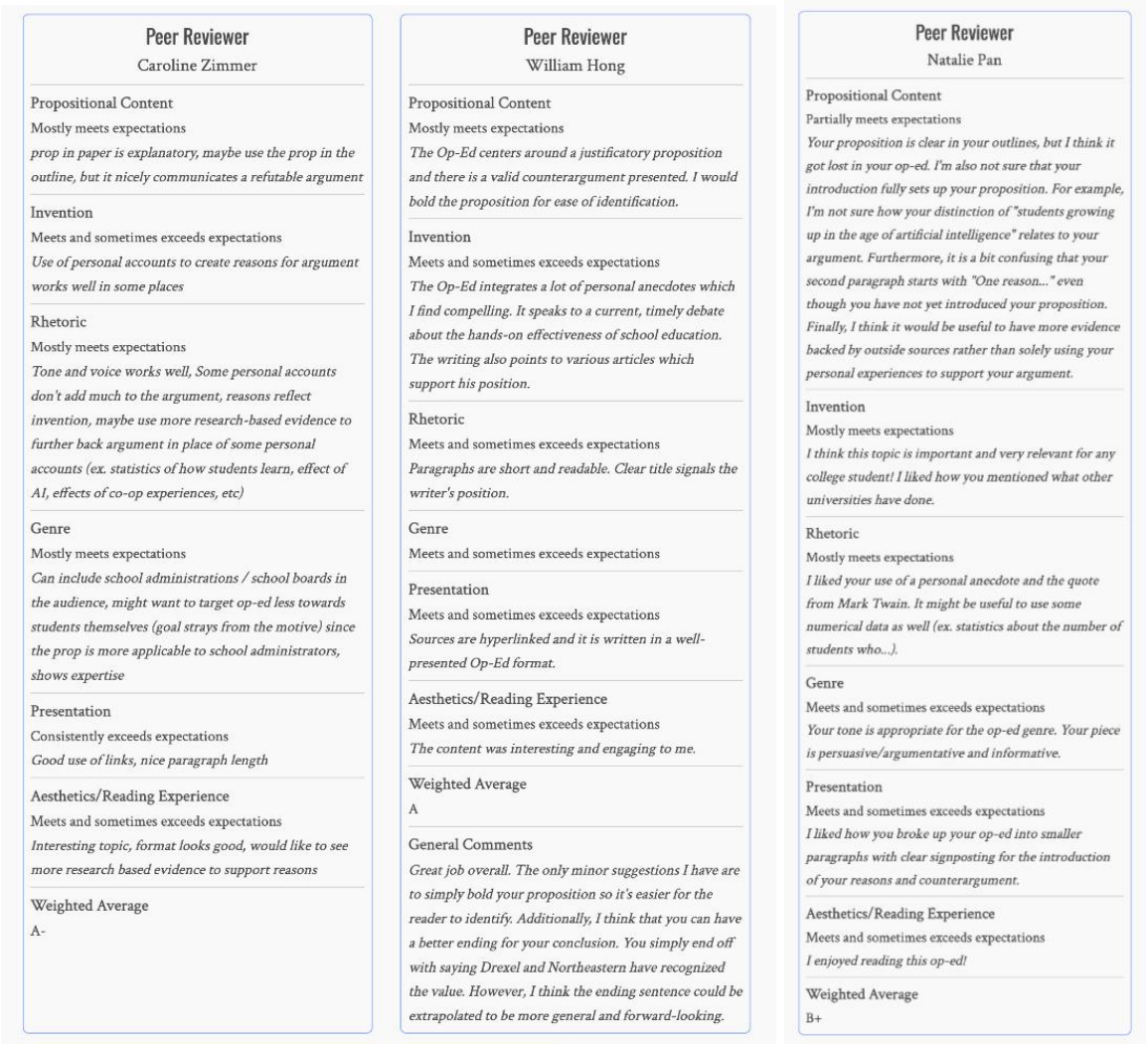
Follow me on Twitter.

Michael T. Nietzel

Follow

I am president emeritus of Missouri State University. After earning my B.A. from Wheaton College (Illinois), I was awarded a Ph.D. in clinical psychology... **Read More**

Your colleagues' Peer Reviews of your Op-Ed (Draft 1)



Peer Reviewer
Caroline Zimmer

Propositional Content
Mostly meets expectations
prop in paper is explanatory, maybe use the prop in the outline, but it nicely communicates a refutable argument

Invention
Meets and sometimes exceeds expectations
Use of personal accounts to create reasons for argument works well in some places

Rhetoric
Mostly meets expectations
Tone and voice works well, Some personal accounts don't add much to the argument, reasons reflect invention, maybe use more research-based evidence to further back argument in place of some personal accounts (ex. statistics of how students learn, effect of AI, effects of co-op experiences, etc)

Genre
Mostly meets expectations
Can include school administrations / school boards in the audience, might want to target op-ed less towards students themselves (goal strays from the motive) since the prop is more applicable to school administrators, shows expertise

Presentation
Consistently exceeds expectations
Good use of links, nice paragraph length

Aesthetics/Reading Experience
Meets and sometimes exceeds expectations
Interesting topic, format looks good, would like to see more research based evidence to support reasons

Weighted Average
A-

Peer Reviewer
William Hong

Propositional Content
Mostly meets expectations
The Op-Ed centers around a justificatory proposition and there is a valid counterargument presented. I would bold the proposition for ease of identification.

Invention
Meets and sometimes exceeds expectations
The Op-Ed integrates a lot of personal anecdotes which I find compelling. It speaks to a current, timely debate about the hands-on effectiveness of school education. The writing also points to various articles which support his position.

Rhetoric
Meets and sometimes exceeds expectations
Paragraphs are short and readable. Clear title signals the writer's position.

Genre
Meets and sometimes exceeds expectations

Presentation
Meets and sometimes exceeds expectations
Sources are hyperlinked and it is written in a well-presented Op-Ed format.

Aesthetics/Reading Experience
Meets and sometimes exceeds expectations
The content was interesting and engaging to me.

Weighted Average
A

General Comments
Great job overall. The only minor suggestions I have are to simply bold your proposition so it's easier for the reader to identify. Additionally, I think that you can have a better ending for your conclusion. You simply end off with saying Drexel and Northeastern have recognized the value. However, I think the ending sentence could be extrapolated to be more general and forward-looking.

Peer Reviewer
Natalie Pan

Propositional Content
Partially meets expectations
Your proposition is clear in your outlines, but I think it got lost in your op-ed. I'm also not sure that your introduction fully sets up your proposition. For example, I'm not sure how your distinction of "students growing up in the age of artificial intelligence" relates to your argument. Furthermore, it is a bit confusing that your second paragraph starts with "One reason..." even though you have not yet introduced your proposition. Finally, I think it would be useful to have more evidence backed by outside sources rather than solely using your personal experiences to support your argument.

Invention
Mostly meets expectations
I think this topic is important and very relevant for any college student! I liked how you mentioned what other universities have done.

Rhetoric
Mostly meets expectations
I liked your use of a personal anecdote and the quote from Mark Twain. It might be useful to use some numerical data as well (ex. statistics about the number of students who...).

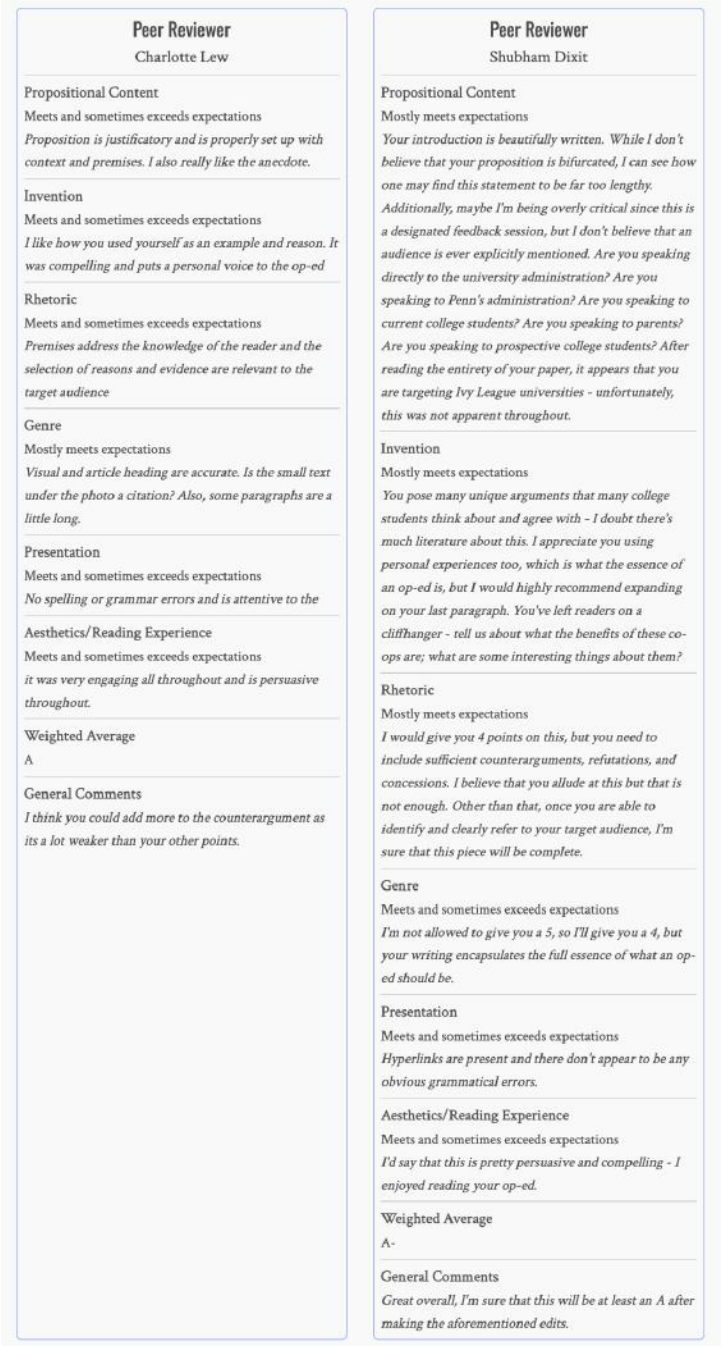
Genre
Meets and sometimes exceeds expectations
Your tone is appropriate for the op-ed genre. Your piece is persuasive/argumentative and informative.

Presentation
Meets and sometimes exceeds expectations
I liked how you broke up your op-ed into smaller paragraphs with clear signposting for the introduction of your reasons and counterargument.

Aesthetics/Reading Experience
Meets and sometimes exceeds expectations
I enjoyed reading this op-ed!

Weighted Average
B+

Your colleagues' Peer Reviews of your Op-Ed (Draft 2)



Peer Reviewer
Charlotte Lew

Propositional Content
Meets and sometimes exceeds expectations
Proposition is justificatory and is properly set up with context and premises. I also really like the anecdote.

Invention
Meets and sometimes exceeds expectations
I like how you used yourself as an example and reason. It was compelling and puts a personal voice to the op-ed

Rhetoric
Meets and sometimes exceeds expectations
Premises address the knowledge of the reader and the selection of reasons and evidence are relevant to the target audience

Genre
Mostly meets expectations
Visual and article heading are accurate. Is the small text under the photo a citation? Also, some paragraphs are a little long.

Presentation
Meets and sometimes exceeds expectations
No spelling or grammar errors and is attentive to the

Aesthetics/Reading Experience
Meets and sometimes exceeds expectations
it was very engaging all throughout and is persuasive throughout.

Weighted Average
A

General Comments
I think you could add more to the counterargument as its a lot weaker than your other points.

Peer Reviewer
Shubham Dixit

Propositional Content
Mostly meets expectations
Your introduction is beautifully written. While I don't believe that your proposition is bifurcated, I can see how one may find this statement to be far too lengthy. Additionally, maybe I'm being overly critical since this is a designated feedback session, but I don't believe that an audience is ever explicitly mentioned. Are you speaking directly to the university administration? Are you speaking to Penn's administration? Are you speaking to current college students? Are you speaking to parents? Are you speaking to prospective college students? After reading the entirety of your paper, it appears that you are targeting Ivy League universities - unfortunately, this was not apparent throughout.

Invention
Mostly meets expectations
You pose many unique arguments that many college students think about and agree with - I doubt there's much literature about this. I appreciate you using personal experiences too, which is what the essence of an op-ed is, but I would highly recommend expanding on your last paragraph. You've left readers on a cliffhanger - tell us about what the benefits of these co-ops are; what are some interesting things about them?

Rhetoric
Mostly meets expectations
I would give you 4 points on this, but you need to include sufficient counterarguments, refutations, and concessions. I believe that you allude at this but that is not enough. Other than that, once you are able to identify and clearly refer to your target audience, I'm sure that this piece will be complete.

Genre
Meets and sometimes exceeds expectations
I'm not allowed to give you a 5, so I'll give you a 4, but your writing encapsulates the full essence of what an op-ed should be.

Presentation
Meets and sometimes exceeds expectations
Hyperlinks are present and there don't appear to be any obvious grammatical errors.

Aesthetics/Reading Experience
Meets and sometimes exceeds expectations
I'd say that this is pretty persuasive and compelling - I enjoyed reading your op-ed.

Weighted Average
A-

General Comments
Great overall, I'm sure that this will be at least an A after making the aforementioned edits.

Your multiple reviews of classmates' Op-Ed work (Draft 1)

For Natalie Pan

Propositional Content: Meets and sometimes exceeds expectations
Prop is justificatory and very clear and concise. Counter-argument is valid and related to the prop. - My initial reaction would be to USE AI regardless of its current accountability concerns, because it offers greater accuracy in certain scenarios, and would save lives. Have you considered which POV argument works better for your case?

Invention: Meets and sometimes exceeds expectations
Lots of evidence (but little anecdotal evidence), but the topic at hand speaks to a very current and timely debate. The sources provided are relatively new, and the argument being presented is somewhat unique in its view: better accountability (ethical) policies for AI prior to AI. - Perhaps add additional anecdotal evidence.

Rhetoric: Mostly meets expectations
Short sentences and paragraphs, and a clear title that signals your position. The background is solid as it is aware of what the readers generally know about AI and its use in medicine. I would recommend a clearer or genre specific call to action, which I feel is missing in your op-ed.

Genre: Meets and sometimes exceeds expectations
Solid understanding of the op-ed genre. One recommendation to better hone into that genre is: - A better call to action, or a clearer one is needed in the conclusion is my rec, such that the conclusion is not simply just a rehash of the entire op-ed. The conclusion is also a built in counter-argument, which may be confusing. - Try splitting the conclusion into a counter argument and a proper call to action conclusion.

Presentation: Meets and sometimes exceeds expectations
Short paragraphs and sentences. Hyperlinked references. Not much comments but: - Fix some grammar and spelling, such as "lysis" instead of "analysis"?

Aesthetics/Reading Experience: Mostly meets expectations
Overall persuasive, but does not personally connect with the readers. - I think it is hard for a reader to feel very personally connected with AI and medical malpractice. It seems very foreign. Perhaps you could present a theoretical scenario... "how would you feel if ..." and add an example related to AI and medical diagnosis. - Text is enjoyable to read, but perhaps try to make the text read less like a formal academic article? Still shorter sentences in some areas, more distinct style of writing that isn't like a formal academic paper, etc

Weighted Average: A

For Caroline Zimmer

Propositional Content: Mostly meets expectations
Assuming this is the prop: In order to counteract this growing issue, schools must implement structured, effective nutrition education programs in primary and secondary schools to instill foundational knowledge of healthy nutrition in children. I'm not sure if you have to: 1. replace must with should 2. it reads justificatory 3. it might be logically incoherent/more so hard to argue, as you need to argue "structured" vs "effective", why in both "primary and secondary schools", and possibly what "foundational knowledge" entails. I think the counter argument could be expanded more: - You could also tie in how better nutrition can significantly improve mental health of students (? unknown), and argue that if students are hungry, they don't learn as effectively anyways. - Maybe reference Japan which has an amazing nutrition system and still supports the other things mentioned. But I think the counter-argument is a valid counter-argument (it's what I thought about too).

Invention: Partially meets expectations
It's hard for me to think of actionable advice to increase the "invention" of your paper. I feel that many of the arguments made here are similar to articles you can find online - that is, without a unique take. Regardless, some advice: - Is there a way to tie in personal anecdote with "why" you are writing this or the relevance of this work to you and your audience? - The reasons and evidence are standard, but there are a lot of reasons and evidence (but no anecdotal ones!), which is good. If you could approach it from a new angle, such as tying in a potential rise in misinformation among the internet or something. - But the problem you are addressing does speak to a timely and current debate as misinformation rises + growing number of eating disorders.

Rhetoric: Meets and sometimes exceeds expectations
I think overall good rhetoric: - Easy to read, expects a reasonable amount of information from what the readers might know or believe. - Writing style is varied and not simply long sentences. However, some paragraphs could be broken down, especially starting with "nutrition education doesn't..." - Possibly a more substantial counterargument needed? - Shorter paragraphs in some areas. Particularly "nutrition education doesn't..." Some sentences should be shorter (the counterargument graph is 2 very long sentences). - Clear title, no comments.

Genre: Mostly meets expectations
- Unsure if your prop should be rephrased with "should" instead of "must". They are both justificatory to me though. - Conclusion should be more in align with an op-ed in my opinion, not simply a summary of the article but more of a call to action. - Lots of good examples and sources but since you have a personal experience with this topic, perhaps tie in anecdotal evidence to not make it sound like an academic essay?

Presentation: Meets and sometimes exceeds expectations
- Sources are hyperlinked. - Fix some grammar and spelling and extra spaces: "an effective" or "addresses"

Aesthetics/Reading Experience: Meets and sometimes exceeds expectations
Text is persuasive and compelling and not a boring read based on the evidence provided, but I feel that it does not cause the reader to personally connect with the idea presented in the text. - I would say try an anecdotal evidence if possible? - Have a better clearer actionable call to action that allows a reader to connect and understand the ideas you are trying to push. - Maybe be more in tune with the readers' reading experience, such as adding rhetorical questions for engagement.

Weighted Average: B+

General Comments: Overall very nice and only a few minor and quick corrections in my opinion to make this op-ed engaging and clear.

Your multiple reviews of classmates' Op-Ed work (Draft 2)

For Shubham Dixit

Propositional Content: Mostly meets expectations
I assume the prop is: As educators and parents... unleash the full potential of VR... its ability to create immersive, interactive... bridge gap between education... Consider: - Combining into 1 sentence and simplifying. "As educators and parents, we must embrace/adopt VR technology for its ability to create ... that can make learning better?" - Maybe move the concession/refutation paragraph (the 2nd one?) lower down until after you stated your points already?

Invention: Mostly meets expectations
- Good mix of sources (Stanford studies, other studies). - Very timely problem since VR is new and this is definitely a topic of concern in education Consider: - Hyperlink references? - Anecdotal evidence?

Rhetoric: Partially meets expectations
Your intended call to action is pretty clear. Title defines the op-ed well. Tone and voice works well, albeit some suggestions: - Make some paragraphs shorter. Especially the 3rd. - It doesn't read entirely conversational, almost robotic. I have a feeling it is attributed to phrases like "VR in education is more than just a brief fascination. It is a fast track to a world of opportunity." or "As we chart the course of education's future, let us anchor our decisions in the belief that the integration of VR in early education is a necessary stride toward excellence in learning." - In relation to the above suggestion, you should add more variation to your sentence lengths. Partly why it sounds kinda robotic is the sentences are all generally really really long.

Genre: Partially meets expectations
I think the social purpose is there: to convince educators (the venue/audience) about the benefits of VR. The prop is good and the counterargument makes sense to me. However, some formal features need fixing: - Hyperlink references as mentioned before - More informal and conversational tone, possibly done by using more first person, varying sentence lengths (overall need shorter sentences), and make some paragraphs shorter.

Presentation: Partially meets expectations
Easy fixes: - Add masthead, by-line, images, and bio? - Add hyperlink references?

Aesthetics/Reading Experience: Mostly meets expectations
It is well written with statistics but doesn't connect at a personal level. Mirroring suggestions provided above: - Sentence lengths, shorter paragraphs, more first-person and how you think rather than as a research based op-ed. - I would very definitely consider removing these long intro phrases throughout your essay: "As we chart the course of education's future, let us anchor

our decisions in the belief that the integration of VR in early education is a necessary stride toward excellence in learning." They're very long and monotone sounding. Not sure how to un-monotone it though.

Weighted Average: B-
General Comments: Besides easy fixes like hyperlink references, adding visuals to get a perfect presentation score, some more pressing issues should be: - Rewriting some sentences to be shorter and making some paragraphs split into 2. - Consider more first-person, anecdotes, and what you think about the problem, making it more like an op-ed genre than a research based, stating the facts type paper.

For Charlotte Lew

Propositional Content: Meets and sometimes exceeds expectations
Assuming your prop is: The effects of human-caused climate change is undeniable and it is time for animal agriculture corporations to take responsibility for their environmental impact by implementing sustainable practices. - I would split the first half. I think it is easy to do something like: The effects of human-caused climate change is undeniable. It's time for animal agriculture corporations to take responsibility for their environmental impact by implementing sustainable practices. The prop is well-written and clear. Your concession makes sense. No further comments there.

Invention: Meets and sometimes exceeds expectations
Very densely inter-linked references with a heavy focus on stat evidence over anecdotal. Which makes sense. Topic is also timely. The synthesis of your references and your assumptions from it make a lot of sense, especially "Despite the fact that these methods can reduce emissions up to 60% and are easy to implement, no large corporations are making changes due to loose policies and loopholes."

Rhetoric: Meets and sometimes exceeds expectations
Clear awareness of targeted readers who are concerned about the env while not knowing much of the factory farming industry. Suggestions: - Some sentences and paragraphs are quite long.

Genre: Mostly meets expectations
Social purpose is fine - audience via venue is clear and the call to action is clear. For the formal features, consider: - More informal and conversational tone. What do you think about the solution, rather than presenting it as a research based paper? It is your opinions after all. - Shorter sentences and paragraphs overall. - Perhaps try using more first-person? - Might not be significant, but what is the call to action? I think a lot of people, myself included, understand that climate change and the farming industry to be env damaging, but this seems to not have a defined call to action. Which again can be fine, but might want to consider. Revise conclusion if so.

Presentation: Consistently exceeds expectations
No fixes. You have all the visuals required. Aesthetic suggestions below.

Aesthetics/Reading Experience: Mostly meets expectations
The content was interesting and engaging to me. Suggestions: - Pretty information dense. - Remove accidental double spaces " " between words. - Why do some paragraphs have spacers and others don't? - It's hard to connect on a personal level when its purely factual/based on statistical research. This can be totally fine and may be graded without this concern in mind, but

just letting you know. - Your conclusion falls off. I would recommend straight up removing "In conclusion." The phrase "the time is now" or "now is the time" is repeated 3 times in similar ways, which seems repetitive.

Weighted Average: A

General Comments: Very minor fixes, overall very good. - Probably change conclusion a bit - Shorter paragraphs and sentences - More informal and conversational tone.

Op-Ed Revision Plan(s)

Draft 1

I think a lot of suggestions revolved around fitting my prop earlier in the argument and adjusting it to be shorter and more concise, which is what I want to do. Now, it should be more clear what I am trying to argue for.

A lot of people have said that my anecdotal evidence was very compelling (something that is working well); however they wanted to see more numbers based evidence. For my next revision, I would include my statistics, but I don't want to overdo it because it should be an op-ed with my voice and opinions, and I would want to keep it that way.

My presentation seems to be pretty good - it was engaging, interesting, and had nice paragraph lengths. I will keep it that way for the next revision.

For my future revisions, based on some feedback, I would remove some of my anecdotes that are less related with what I am arguing for (such as the AP Bio example), and I would remove AI from the proposition since that confuses the readers and make it more complex than necessary.

Draft 2

Regarding my prop, my reviewers agree that the prop is well set up with the context and premises.

However, my target reader and audience were not as well established. For my next revision, I would explicitly mention my audiences and who I am targeting. That would be university administrators specifically. I would also cater my language more towards university administrators over university students.

My paragraphs also got slightly longer, so I will need to split them up or remove them to keep my op-ed shorter.

The anecdotes continue to be doing well, people find it engaging and give my op-ed a unique voice rather than a bunch of statistics. This is something I will continue to do.

Finally, there is a general consensus to expand on my conclusion and counterarguments, which is what I will do for my next draft. I will add more about what Drexel and Northeastern is already doing with their co-op programs, and end with a call to action on how universities should be following Drexel and Northeastern in how they implement co-op learning to allow students to pursue independent and real-world projects.

White Paper Pre-Outline - 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 Pre-Outline - 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

(How) Current silicon chip design should be abandoned in favor of newer technologies

- Because Silicon chips are not inherently energy efficient due to the memory gap problem
- Because Silicon is unsustainable as the world enters into a silicon shortage
- Because Silicon chips requires massively amounts of energy in order to cool
- Because Silicon technology is reaching the limits of physics and can no longer be advanced at a rate suggested by Moore's Law

(How) Focusing on massive clean-energy supplying technologies is a long-term goal that will make AI training more climate friendly

- Because Developments in solar and nuclear technologies are decades away from feasible scalability
- Because Clean energy from solar and nuclear technologies will be a long-term solution for supplying clean energy for data centers
- Because 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

(How) Biologics based chips should be developed for AI specific training and deployment

- Because Biologics-based chips are inherently 10000x more efficient than silicon chip
- Because Biologics-based chips uses less silicon and is thus sustainable in the long term future
- Because Biologics-based chips do not generate heat and thus use less energy
- Because Biologics-based chips have undergone 4 billion years of evolution, resulting in both energy efficiencies and fast processing power

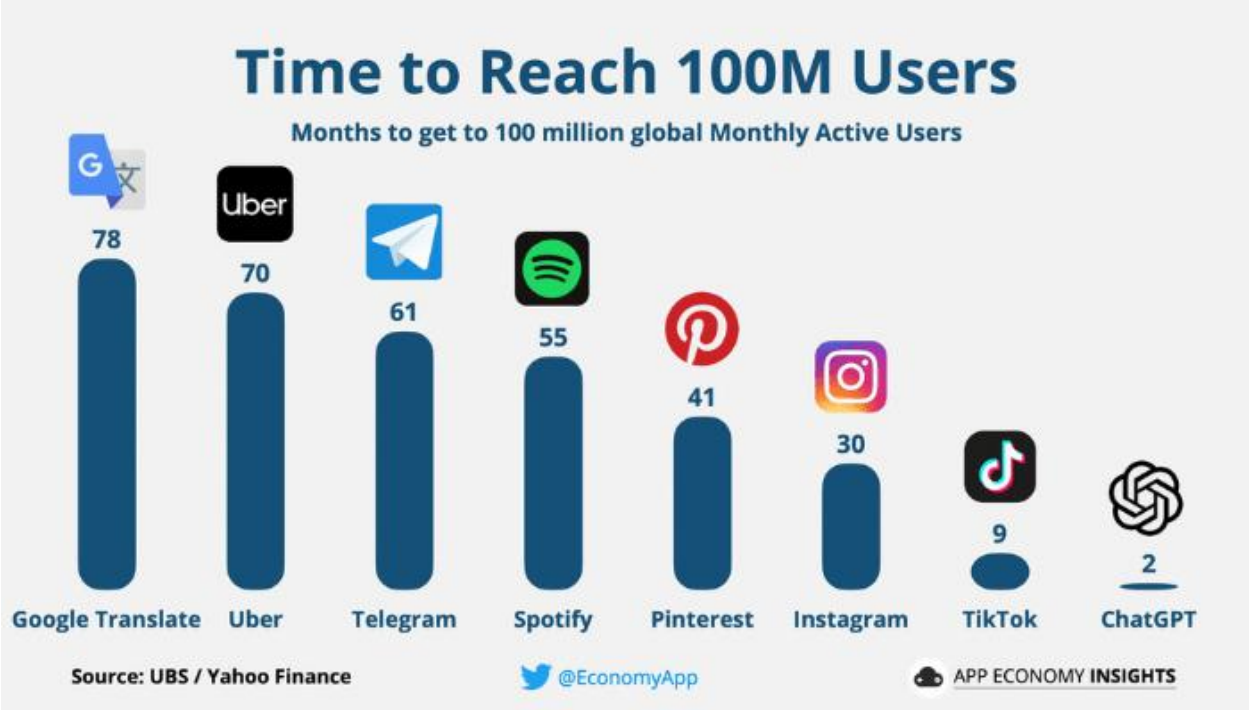
White Paper Early Draft

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

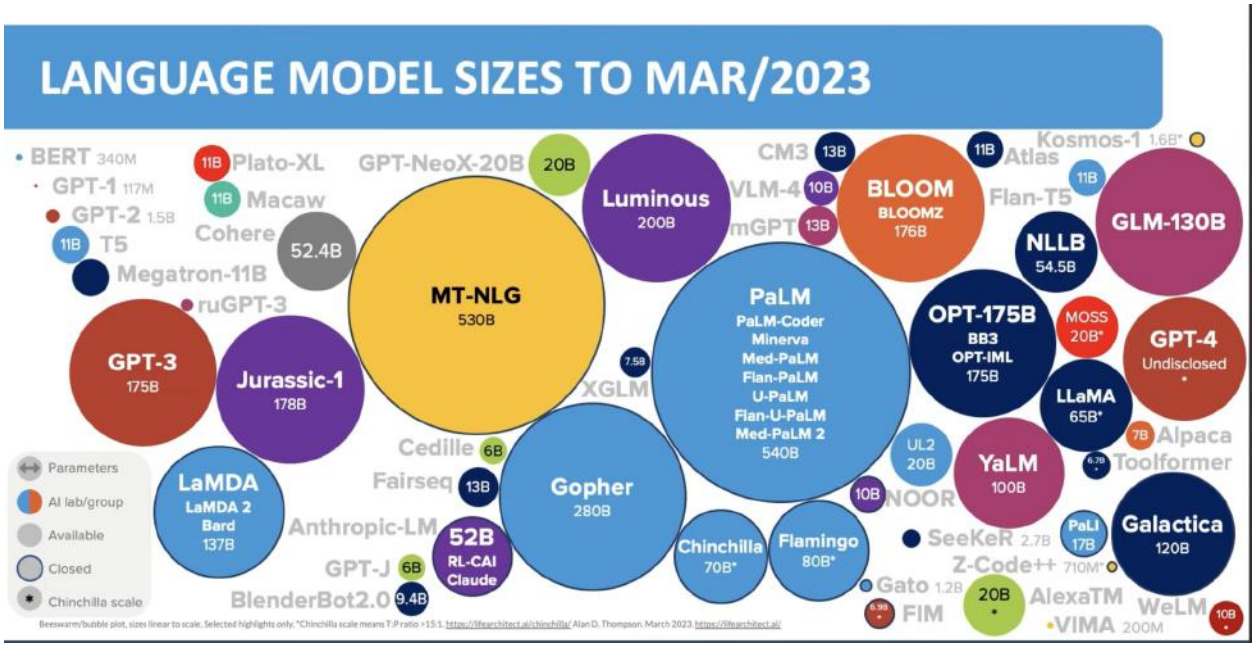
Contrary to mainstream belief, AI research is not a recent development. Breakthroughs in computer science, mathematics, and neuroscience since the 1900s have all served as catalysts

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:

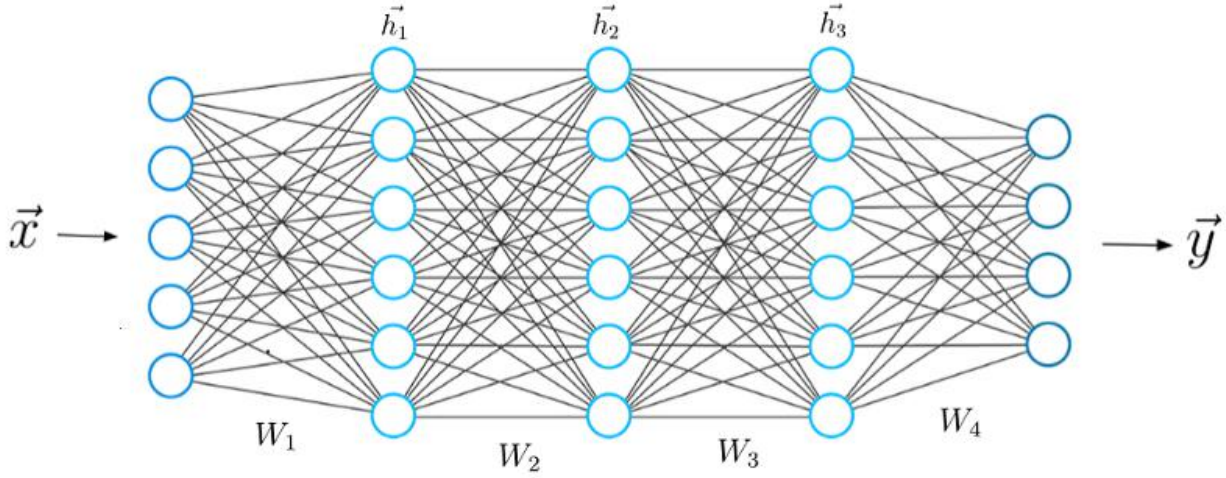
- GPT3, GPT4, GPT4 Vision, GPT4 Turbo, Sora, DALL-E by OpenAI
- Copilot by Microsoft
- Grok by xAI
- PaLM, Bard, Gemini Ultra, Pro, and Nano by Google
- CodeLLaMa, LLaMA and LLaMA 2 by Meta
- Claude 2.0, 2.1, and 3.0 by Anthropic
- Falcon 180B and Falcon 40B by Technology Innovation Institute
- Mistral-7B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

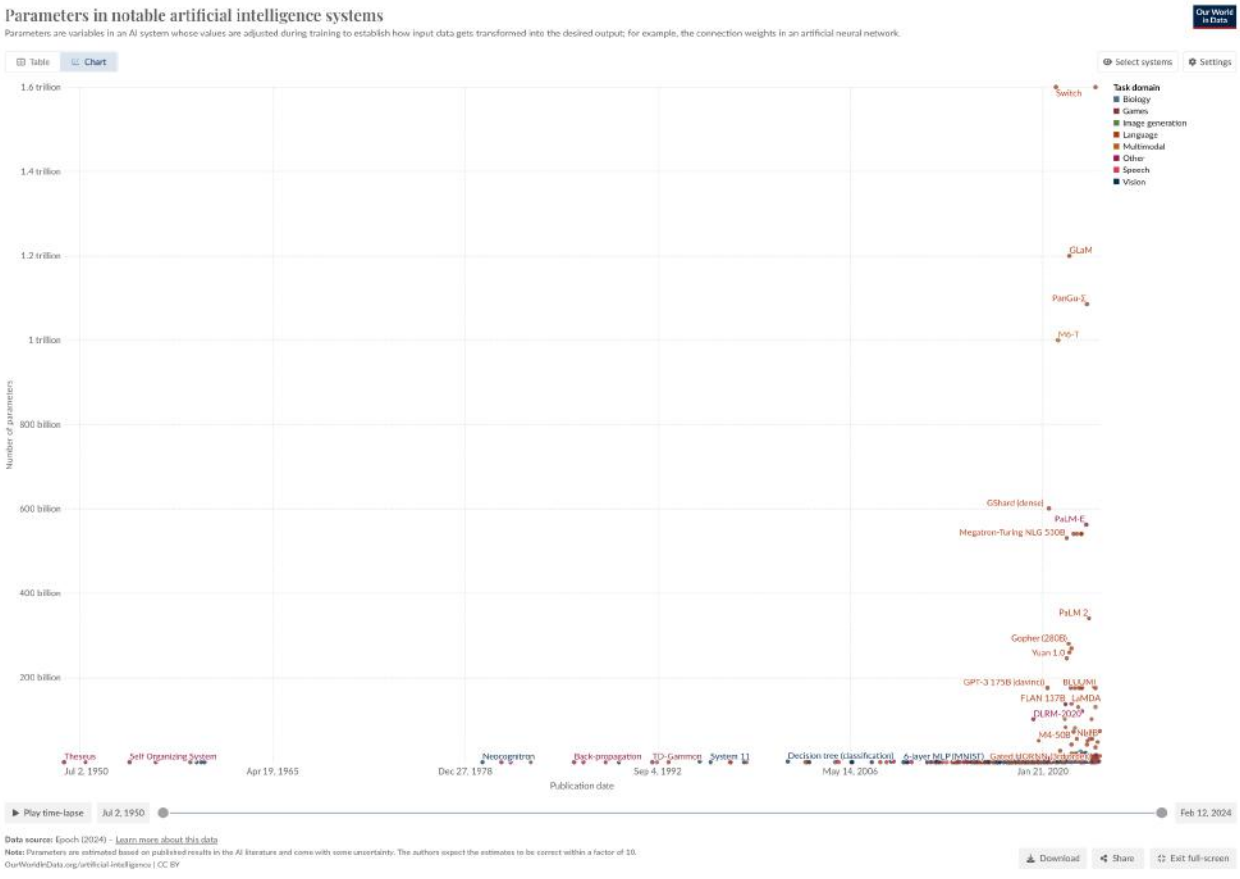
Which means more energy being used.

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.

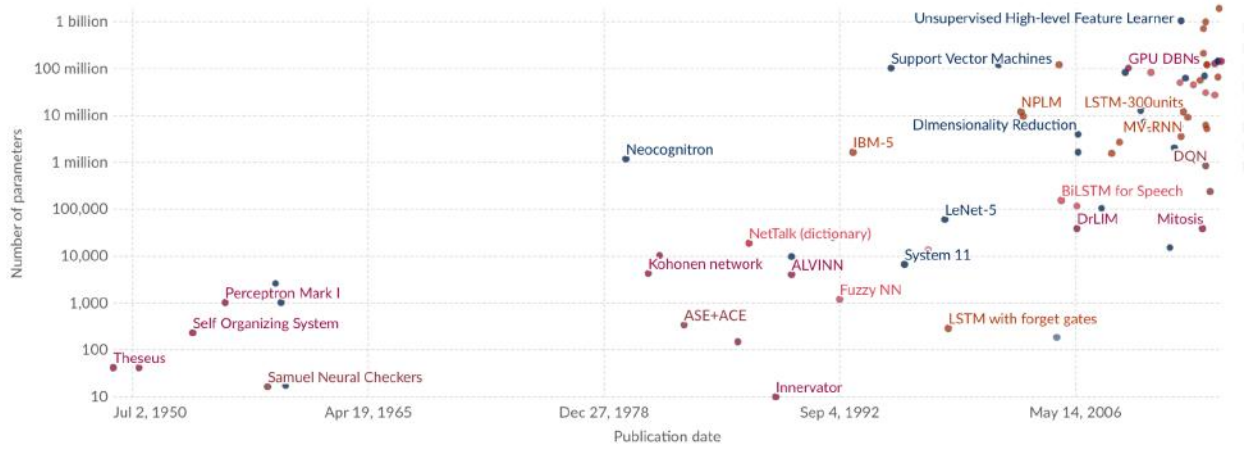
Year	Model	Parameters
2018	GPT1	117M
2019	GPT2	1.5B
2020	GPT3	175B
2023	GPT4	1760B

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

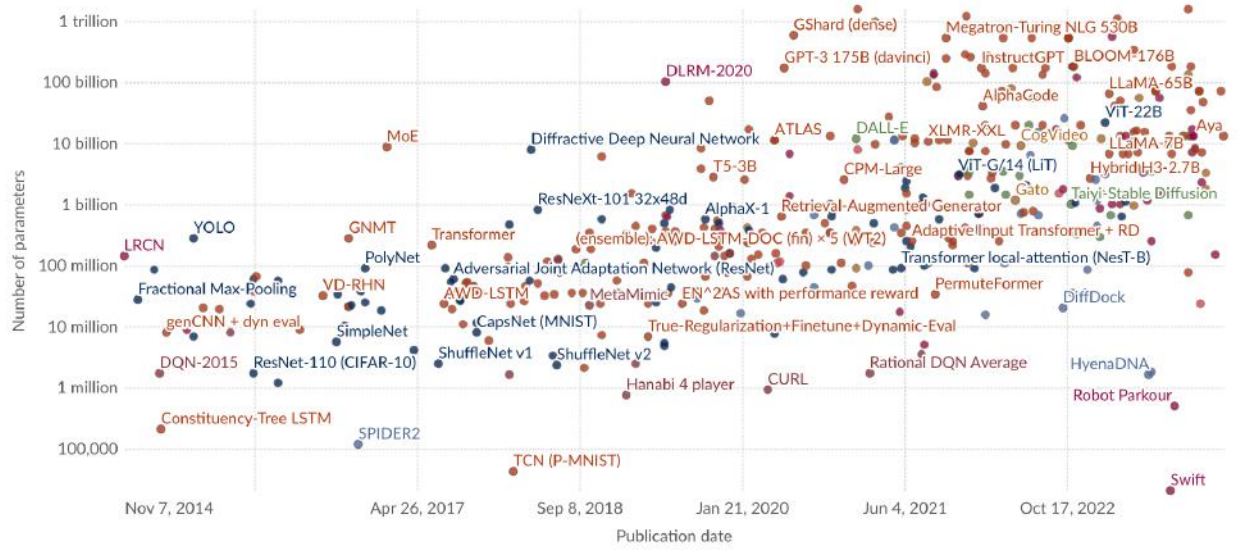


Likewise, in terms of total AI models being trained, it is clear that more and more companies and startups are developing their own.

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

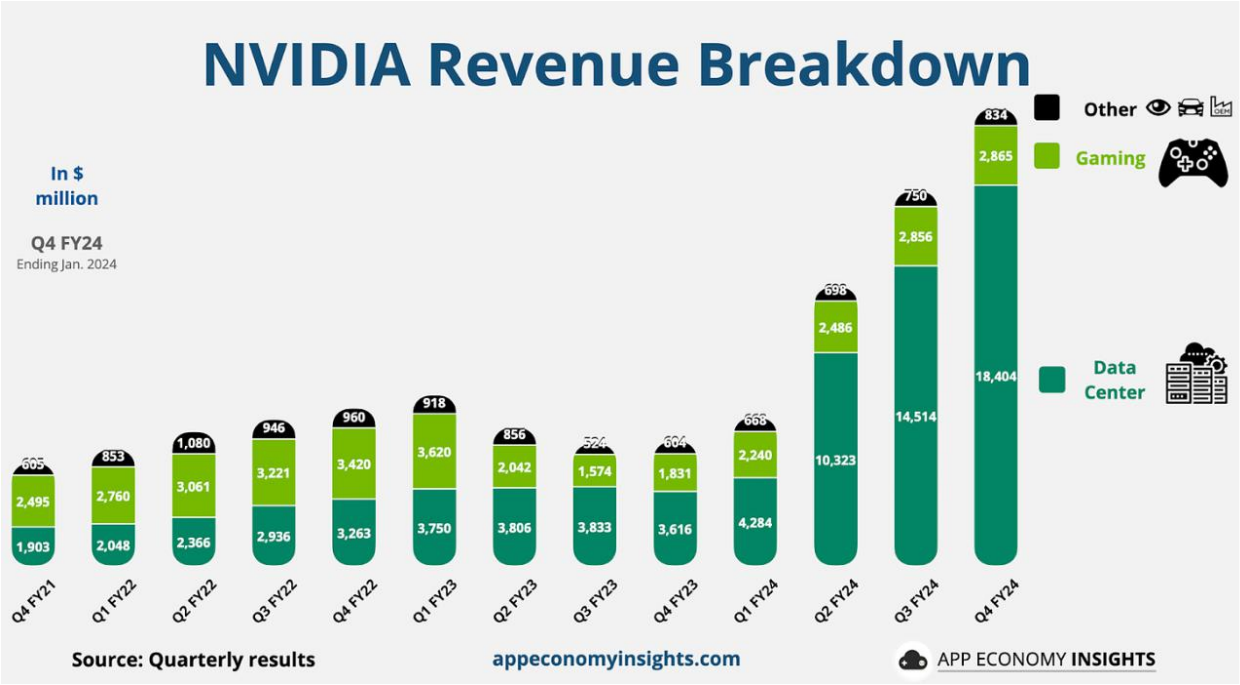


And from 2014 to 2024.



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.

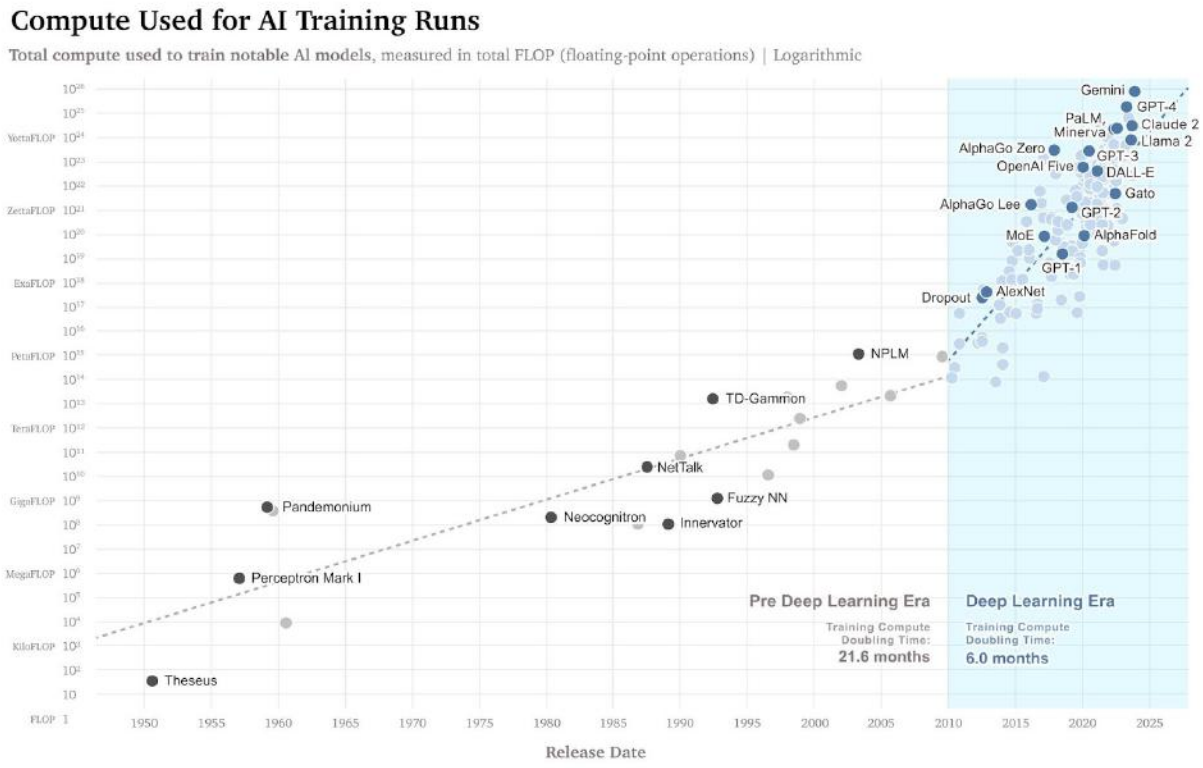
The Impact of AI on Energy and Climate

- 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

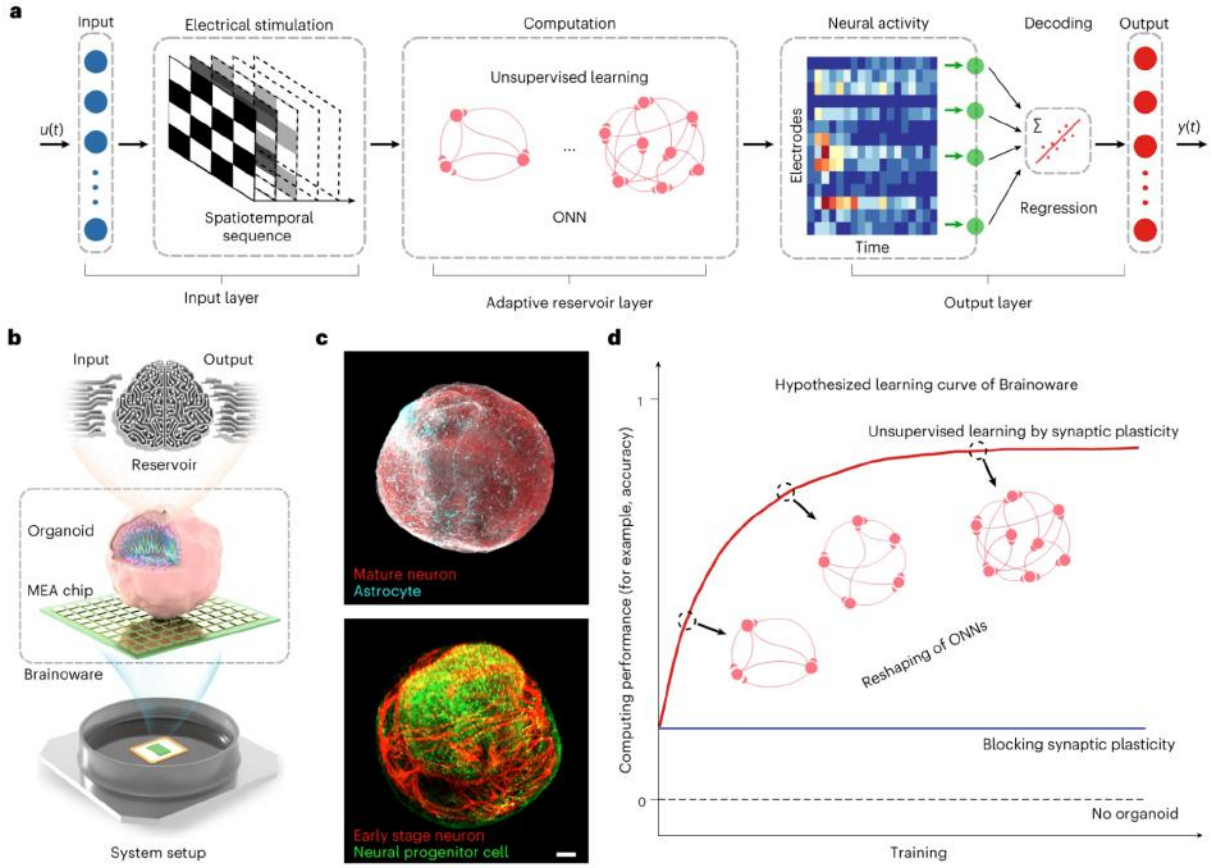
The core architecture of virtually every digital computer has followed a deceptively simple pattern first developed in the 1940s, known as the von Neumann model: store data in one place, do computation in another. Then, shuttle information between memory cells and the processor. Because these currently 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.

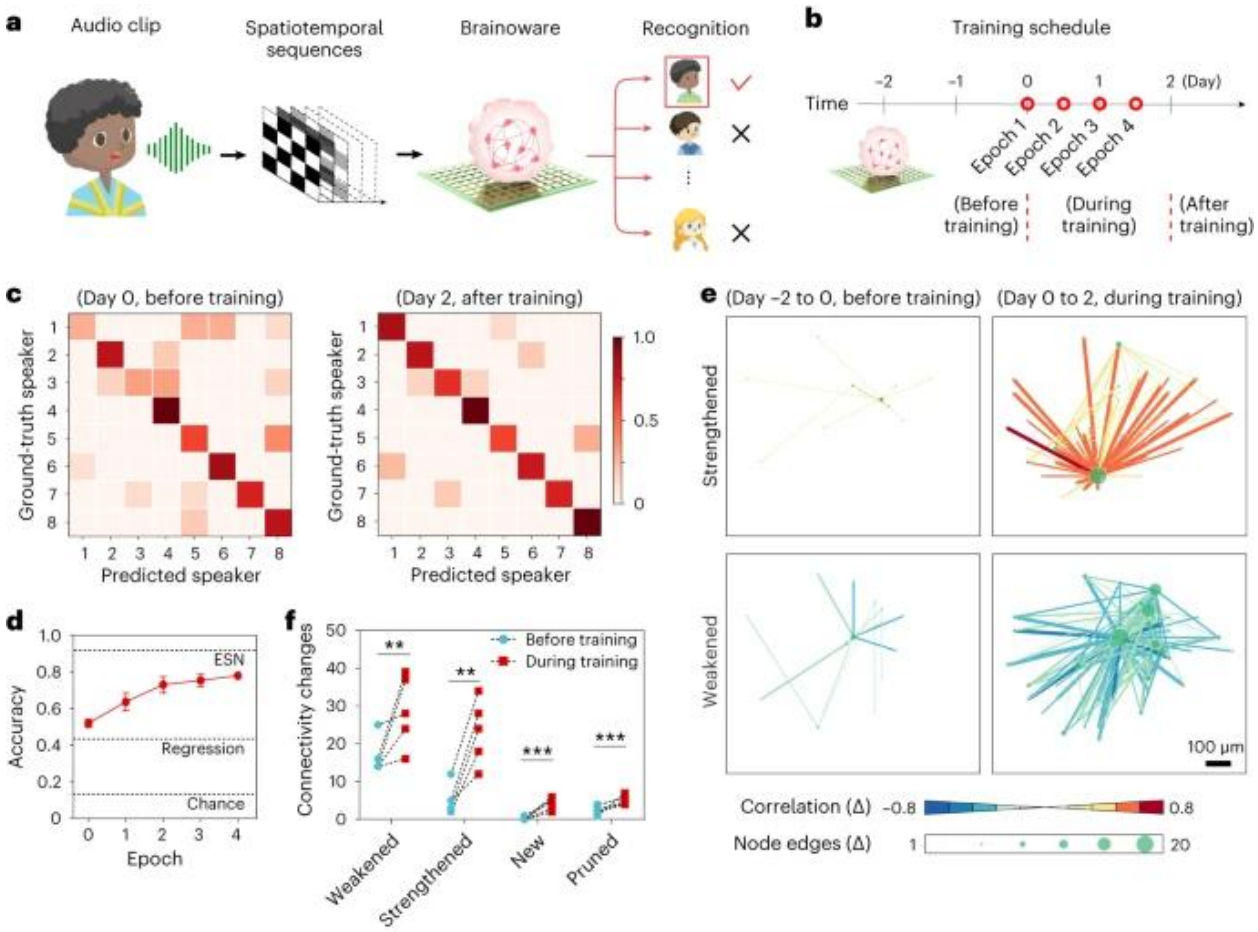
The human brain is a complex, three-dimensional massively parallel network of over 200 billion cells, linked by hundreds of trillions of synapses, and expends only 20 watts while current silicon hardware consumes about 8 million watts to power a comparative ANN model.

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.

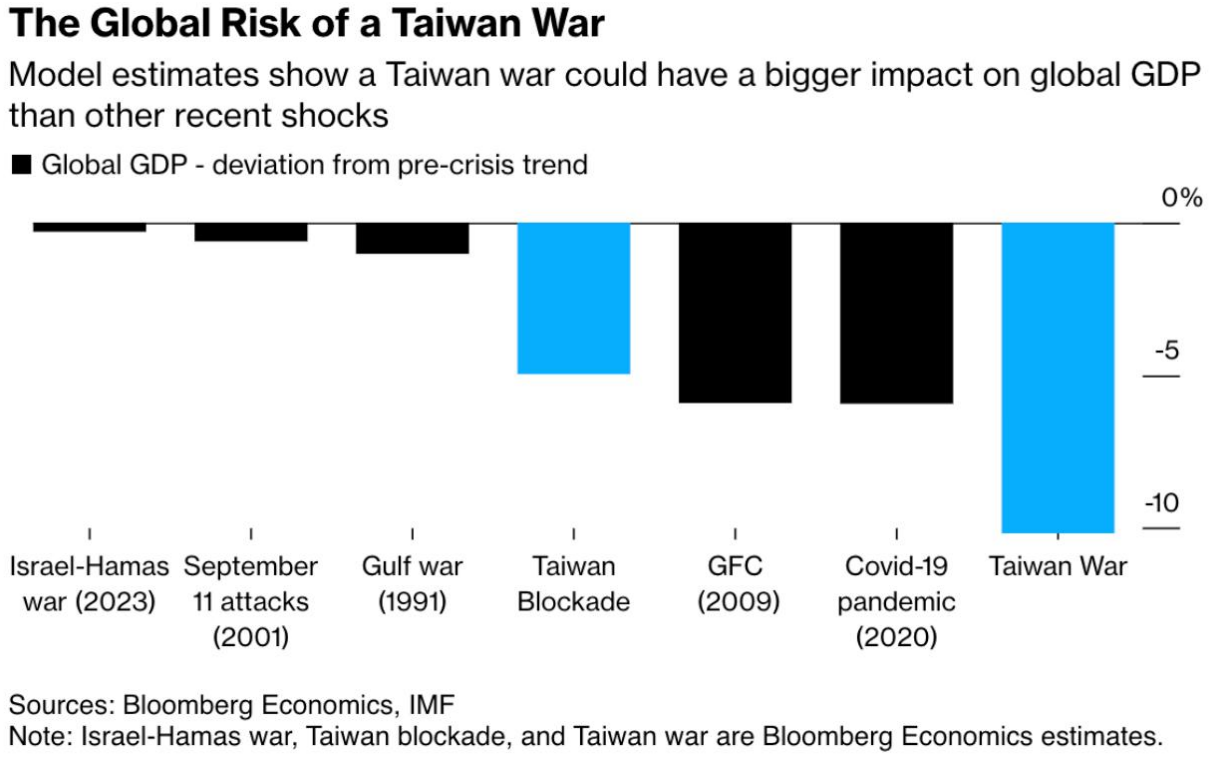
We are implementing new paradigms in ANNs – a Spiking Neural Network (SNNs). SNNs use neuron spiking events to communicate floating point numbers, and information is encoded in the timing and frequency of spikes through event-based processing. The goal is to approach one-shot learning similar to human 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.

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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 Midterm 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].

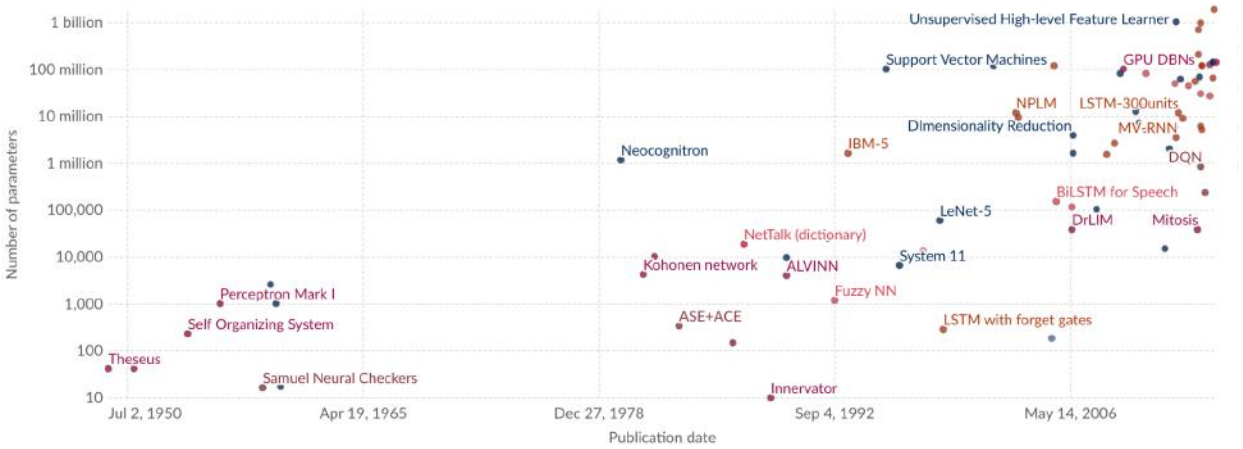

Figure 1. Number of AI Models Trained from 1950 to 2014.

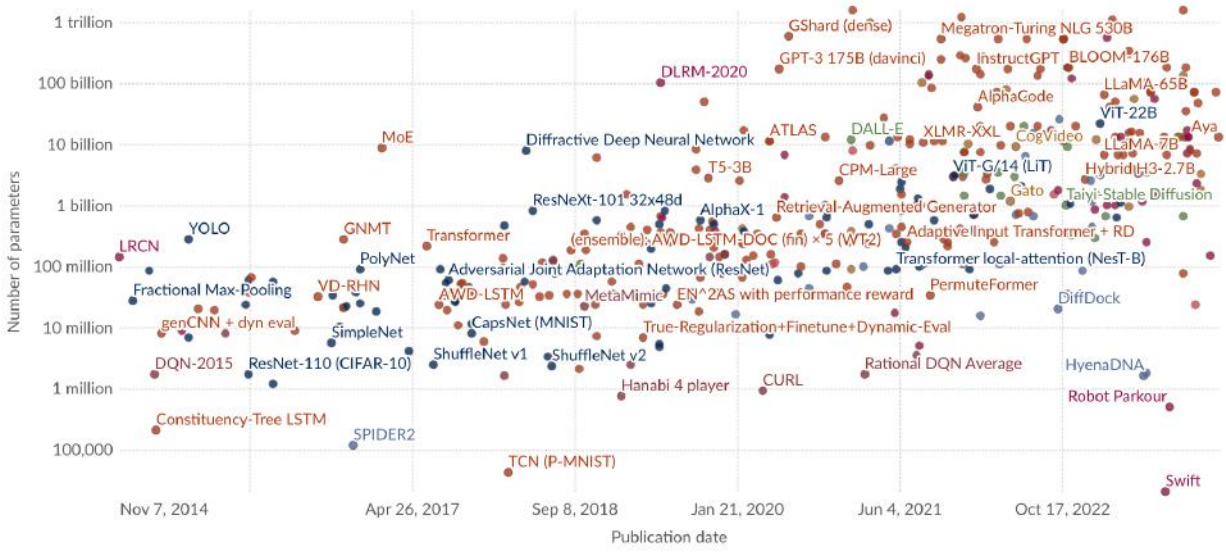

Figure 2. Number of AI Models Trained from 2014 to 2024.

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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].

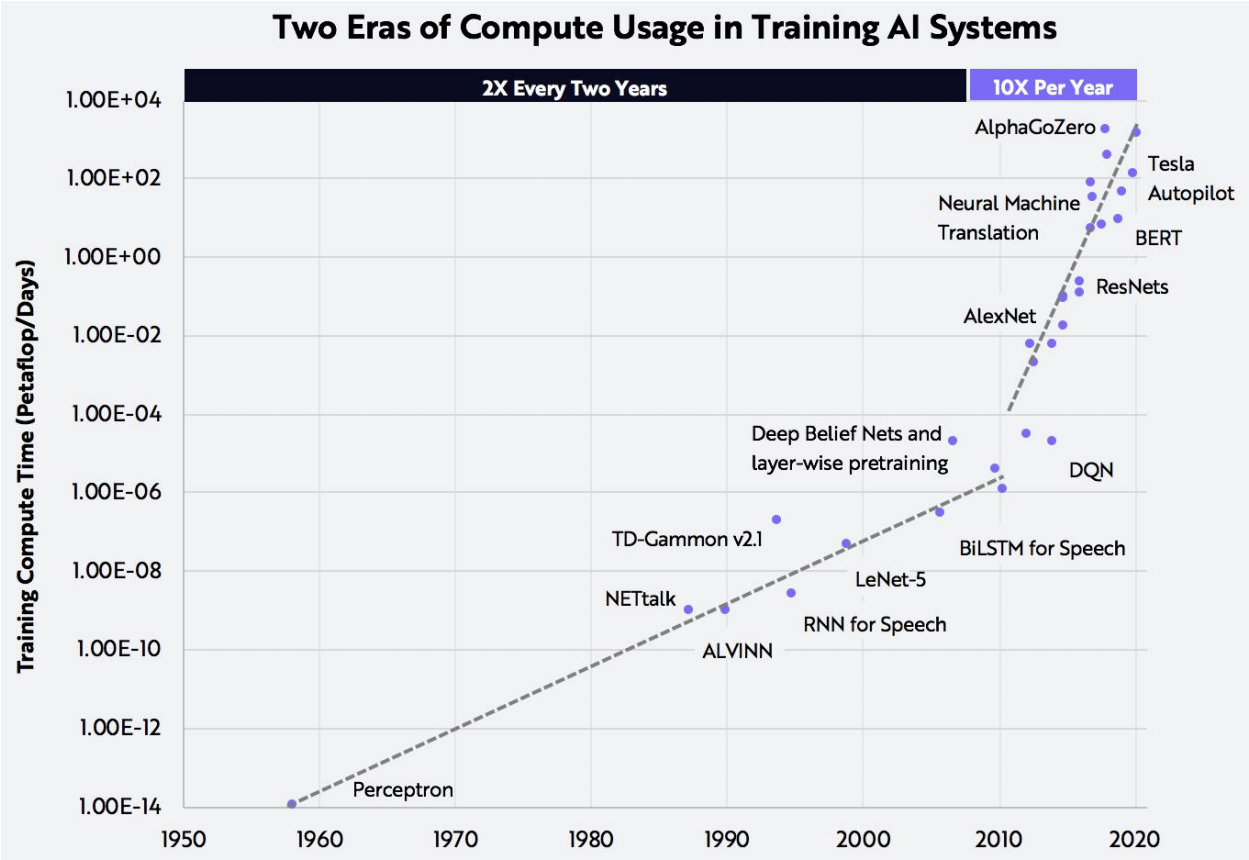

Figure 3. Exponential Growth in Compute Usage for AI Training.

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].

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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.

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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

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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].

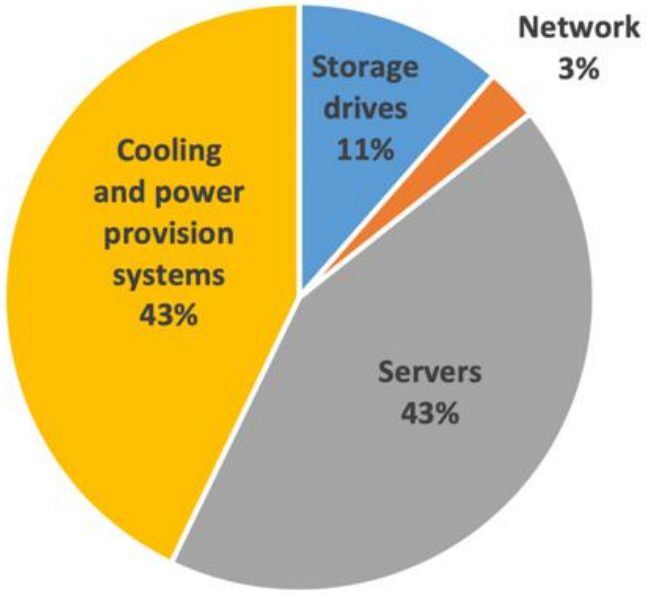

Figure 5. Division of Electricity Consumption in Data Centers.

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].

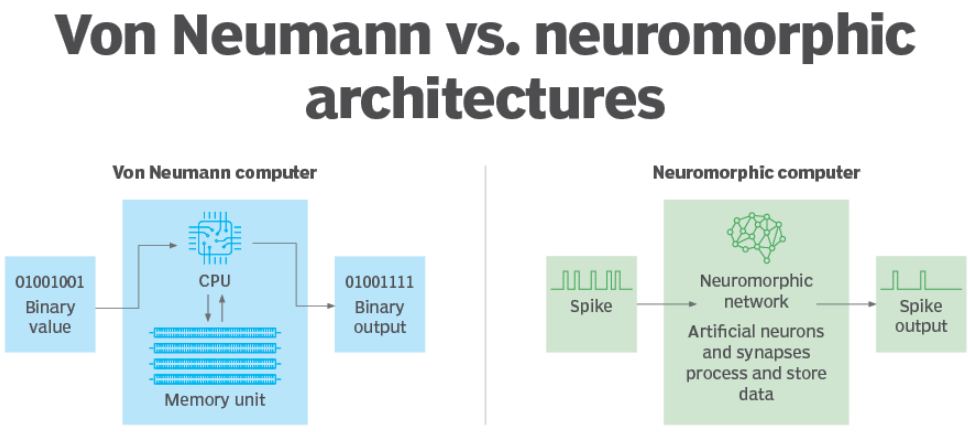

Figure 6. Comparison of von Neuman and Neuromorphic Computing Architecture.

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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.

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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.

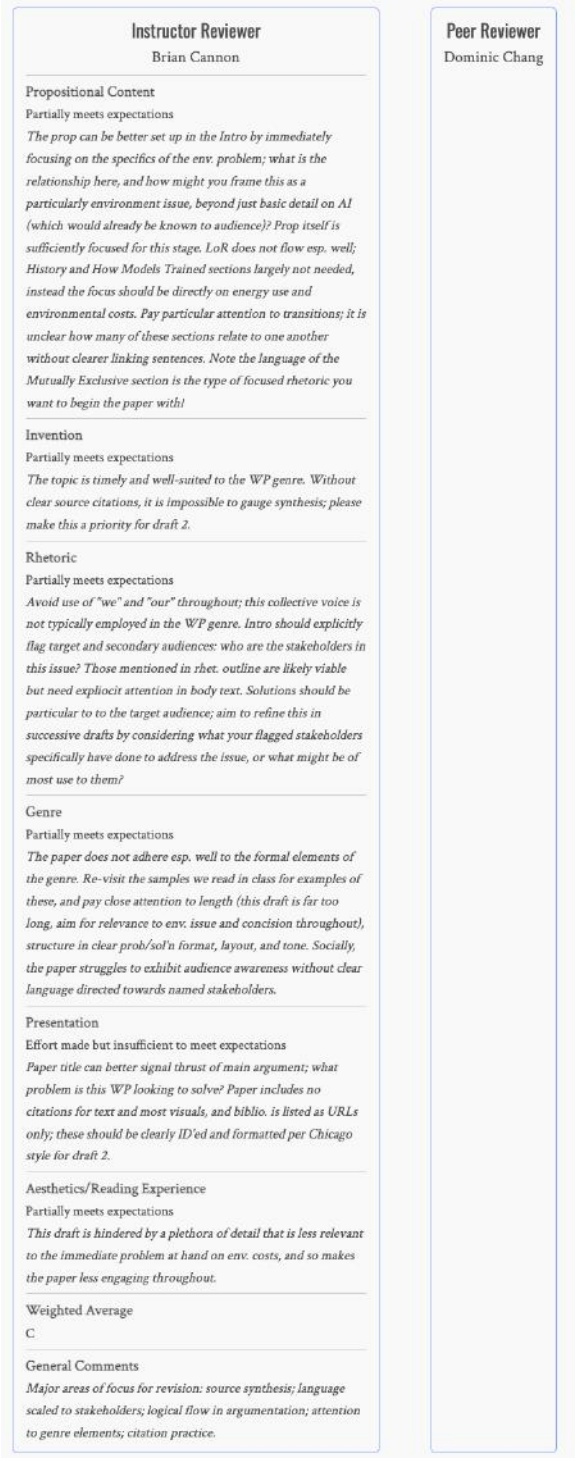
Reasons & Evidence

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

Your colleagues' peer reviews of your White Paper



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 expliocit 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.

Your multiple reviews of colleagues' White Paper work (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.

Your multiple reviews of colleagues' White Paper work (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+

White Paper Revision Plan(s)

Draft 1

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

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.

Resume

Attached below.

Maxx Yung

Website | LinkedIn | Github

myung11@seas.upenn.edu
347-820-1299

Education

- **University of Pennsylvania (3.80 GPA)** 08/2023 - 05/2027
  - BSE in Materials Engineering, Minor in Computer Science and Entrepreneurship.
  - Clubs: Wharton Venture Labs, Wharton Venture Capital and Private Equity Club, Penn Startup Accelerator, Penn Assistive Devices and Prosthetic Technologies.
- **Stanford School of Medicine (3.90 GPA)**: Neuroscience and Neurosurgery 2023 Cohort 07/2023 - 08/2023

Experiences

Nanoneuro Systems Philadelphia, PA
Founder & CEO *10/2023 - Present*

- Leading a deeptech startup to create 10000x more efficient AI training chips using human brain cells.
- Secured collaboration with UPenn's Singh Center for Nanotechnology and $1,000,000 in grant funding.
- Advised by 3 UPenn professors specializing in BioE, CS, and EE & a Wharton entrepreneurship professor.
- Managed a team of 3 student interns and 3 co-founders, driving research and manufacturing initiatives.

S&L Aerospace Metals Flushing, NY
Materials Engineer Intern *01/2024 - Present*

- Led 3 aerospace contracts for landing gears and hydraulic systems for Lockheed, Boeing, and Sikorsky.
- Worked with financial, engineering, and manufacturing teams to ensure accurate delivery of parts.
- Assisted in operational efficiency for the manufacturing of drag beams for Sikorsky Black Hawk models.

Corder Neuroengineering and Computer Science Lab Philadelphia, PA
Undergraduate Researcher *06/2023 - Present*

- Co-developed A-SOiD (published on Nature Methods), the 1st open-source ML and computer vision pipeline for mice brain-to-behavior analytics pipeline with UPenn, Stanford & CMU labs.
- Developed a software pipeline for automated cell identification using OpenCV & Tensorflow, performing on-par wtih HaloAI (which costs $20,000/year) and saving 300+ hours of manual quantification.
- Reduced processing time by 97% for bulk microscopy imaging via pywinauto & pyautogui Python scripts.
- Surgically removed 20+ mice brains, mounted brain tissue, and imaged slices to research pain networks.

Raymond James Financial New York City, NY
Raymond James Electronic Trading (RJET) Extern *12/2023 - 01/2024*

- Engaged in team discussions to analyze government action on M&A activities to revise algo strategies.
- Studied Jet Blue & Spirit Airlines, Nippon Steel & U.S. Steel, and Microsoft & Activision mergers.
- Researched NYSE, NASDAQ, and IEX server colocation strategies used in high-frequency trading algos.

Fiveable Roslyn, NY
Content Writer → AI Content Engineer Intern *05/2023 - 09/2023*

- Designed an AI workflow for the largest US EdTech company, accelerating content output by 800%.
- Onboarded and co-directed a cohort of 100 summer content creators with the AI content workflow.
- Published over 50+ new long-form articles and 1000+ mock AP questions on 2023-2024 AP subjects.

Zhu Neuroscience Lab at SUNY Old Westbury Old Westbury, NY
High School Researcher → Lab Technician *06/2019 - 03/2023*

- Conducted a 5-year study discovering a direct biological link between opioids, diabetes, and Alzheimer's.
- Automated a neuronal analysis protocol with Python, saving 200+ hours of manual quantification labwide.
- Implemented molecular docking and simulation tools for in-silico drug discovery for the lab using Python.

Honors & Awards

- International Regeneron STS Semi-Finalist
- 2023 US AAN Neuroscientist Winner
- Stanford Neuroscience Conference Speaker
- 2x MIT Research Technology Conference Speaker
- Presidential Volunteer Service Award Gold
- NextChapter Startup Scholarship & Fellowship Winner
- Columbia Healthcare Hackathon 3rd Place Winner
- Princeton x Columbia Top 15 Northeast Student Startup

Skills & Interests

- **Skills:** Python (SciPy, Numpy, Scikit-learn, Matplotlib, Tensorflow), Solidworks, SQL, Figma (Design), Advanced Excel.
- **Interests:** Stock Investing, Nanotech, Space & Biotech Startups, Blogging, Badminton, Reef Tanks, Rock Climbing.

Job Cover Letter

Attached below.

04/01/2024
Maxx Yung
3333 Walnut Street, Philadelphia, PA 19104-6193
347-820-1299 | myung11@seas.upenn.edu

Atomic Semi: Interest in the Process Engineering Internship Role

Dear Hiring Officer,

I am writing to apply for the Fall Process Engineering Internship role, and that your colleague Jay recommended that I apply to. As an incoming undergraduate sophomore majoring in Materials Engineering (concentrating in nanotechnology and sub-matriculating into nanotechnology) at the University of Pennsylvania, I believe I am well-suited for this role.

During this spring semester, I was accepted as the sole undergraduate researcher from UPenn to assist the nanofabrication processes that occur at the Singh Nanotech Center (one of the largest Northeastern nanofabrication labs in the United States) – including hands-on end to end wafer processing: from preparing the wafers to following the standard procedures for wafer development, including deposition, etch, and lithography equipment available at the Singh Nanotech Center. And for the summer, I would lead my own project in developing true neuromorphic computing devices by designing my own CMOS multi-electrode arrays.

My previous six summers were also spent researching at Stanford Med, Penn Med, and SUNY Neuroscience Institute, where I led my own research project, read hundreds of papers, analyzed current data, and iterated on experiment methodology towards identifying novel cell processes – leading to various international and national research awards, and pending or associated publications in Neuron and Nature Methods – which has instilled a strong sense of self-sufficiency, but also collaboration in a fast-paced and team-oriented environment.

From speaking with prior and current employees, as Atomic Semi aims to optimize process improvements and prides itself on quick iteration cycles and scrappy efficiency, I highlight my eye for identifying time and cost bottlenecks by leveraging my Python data processing and scripting skills to optimize various processes: automating in-house ML vision cell models to save $20,000/year in costs; reducing microscopy imaging processing time by 97%, developing an AI workflow to accelerate content output by 800%, and streamlining data processing and visualization at SUNY Neuroscience Institute, leading to thousands of saved hours.

I am confident that my prior research experiences and internships, my current research experience at the Singh Nanotech Center, and my self-taught software experience, is a good fit for this position. Thank you for your kind consideration. I am grateful for your time and I look forward to hearing from you.

Sincerely,