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Before the

U.S. State Congress Joint Economic Committee

On

"Artificial Intelligence and Its Potential to Fuel Economic Growth and Improve Governance."

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Chairman Heinrich, Vice Chairman Schweikert, and distinguished members of the Joint Economic Committee:

My name is Brian Miller, and I practice hospital medicine at the Johns Hopkins Hospital. As an academic health policy analyst, I serve as an Assistant Professor of Medicine and Business (Courtesy) at the Johns Hopkins University School of Medicine and as a Nonresident Fellow at the American Enterprise Institute. My research focuses on how we can build a more competitive and vibrant health sector to make healthcare more efficient, flexible, and personalized for patients. This perspective is based upon my prior regulatory experience at four federal regulatory agencies. Through my current role as a faculty member, I regularly engage with regulators, policymakers, and businesses in search of solutions to help create a better healthcare system for all. Today I am here in my personal capacity, and the views expressed are my own and do not necessarily reflect those of the Johns Hopkins University or the Johns Hopkins Health System, the American Enterprise Institute, or the Medicare Payment Advisory Commission.

In my testimony today, I will focus on three areas:

1. Improving the clinical efficiency of care delivery through labor productivity growth
2. Driving administrative efficiency for delivery systems and insurers
3. Policies to promote the development of new science and new innovation

1. Improving the clinical efficiency of care delivery through labor productivity growth

Over the past 60 years, innovation has driven changes in clinical practice, with the life sciences industry developing over 1,200 new drugs.[1] Today, there are over 20,000 prescriptions drugs approved for marketing, 400 licensed biologic products, and 6,500 FDA-regulated medical device product categories[2] offering patients a variety of benefits including reduced mortality, morbidity, and improved functional status or quality of life. While retail prescription drug spending represents just 9% of national health expenditures,[3] it has driven massive transformations in care for patients and reduced morbidity and mortality. In contrast, the 51% of health care spending representing care delivered in hospitals and clinics largely remains a vast plain yet to be significantly transformed by operational and technological innovation.

It is this arena that automation and artificial intelligence (AI) offers the most promise to transform care. Through a combination of monopoly,[4] legal barriers to competition such as Stark Law,[5] and regulatory policy, current models of care delivery that are ill-suited to patients' needs and clinical efficiency have become encased in policy concrete. Economic measures lend further credence to the challenges of this policy story, with labor productivity in private community hospitals remaining on average flat or negative since at least as far back as 2000.[6] Other economic research suggests that health care suffers from Baumol's cost disease,[7] wherein the sector's wages rise despite a lack of productivity growth due to rising wages in other sectors with high productivity growth, driving rising health care delivery costs without consequential gains for consumer-patients.

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[1] Munos, B. Lessons from 60 years of pharmaceutical innovation. *Nat Rev Drug Discov* **8**, 959–968 (2009). https://doi.org/10.1038/nrd2961

[2] FDA at a Glance. U.S. Food & Drug Administration. October 2019. https://www.fda.gov/media/131874/download

[3] National Health Expenditures 2022 Highlights. Centers for Medicare & Medicaid Services. Dec 13, 2023. https://www.cms.gov/newsroom/fact-sheets/national-health-expenditures-2022-highlights

[4] Testimony of Brian J. Miller, M.D., M.B.A., M.P.H. Before the U.S. Senate Committee on the Judiciary Subcommittee on Competition Policy, Antitrust, and Consumer Rights on "Antitrust Applied: Hospital Consolidation Concerns and Solutions." May 19, 2021. https://www.judiciary.senate.gov/imo/media/doc/Brian%20J%20Miller%20Senate%20Judiciary%20testimony%20for%2005%2019%202021.pdf

[5] Miller BJ, Ehrenfeld JM, Wu AW. Competition or Conflict of Interest—Stark Choices. *JAMA Health Forum*. 2021;2(2):e210150. doi:10.1001/jamahealthforum.2021.0150

[6] Private Community Hospitals Labor Productivity. U.S. Bureau of Labor Statistics. https://www.bls.gov/productivity/highlights/hospitals-labor-productivity.htm

[7] Bates LJ, Santerre RE. Does the U.S. health care sector suffer from Baumol's cost disease? Evidence from the 50 states. *J Health Econ*. 2013;32(2):386-391. doi:10.1016/j.jhealeco.2012.12.003

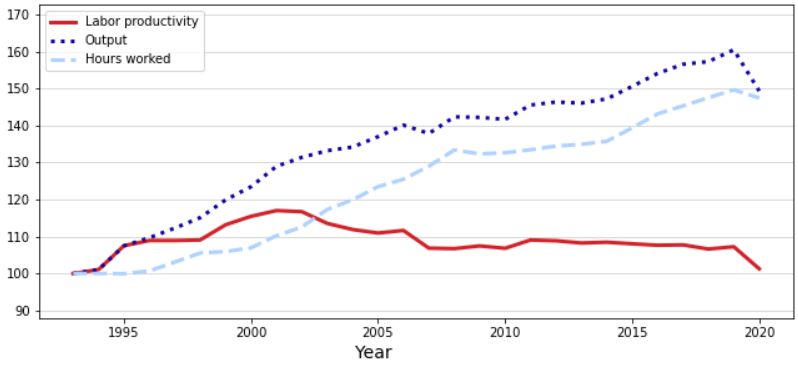

Figure 1: Labor productivity for private community hospitals (Index, 1993 = 100)[8]

The absence of labor productivity growth has created a politically challenging combination of unsustainable spending–totaling $4.5 trillion[9] and growing at an average rate of 4.7% annually[10] – coupled with a growing need for and gap in the skilled labor supply. As care delivery outputs increase without any improvement in labor productivity, the care delivery sector has an ever insatiable appetite for more workers. In a system subject to time lags, financing challenges,[11,12] and varying degrees of state-based occupational regulation[13,14] of the health professions,[15,16,17,18,19] it is no surprise that there are shortages across a wide range of skilled trades, with a projected shortage of 78,610 registered nurses (by 2025),[20] 68,020 primary care physicians (by 2036),[21] and 21,150 adult psychiatrists (by 2030)[22] within the next decade just to name a few, all worsened by the recent COVID-19 pandemic amongst other factors driving burnout.[23,24,25] With Medicare and Medicaid expenditures in 2022 growing at 5.9% and 9.6% year over year

[8] Private Community Hospitals Labor Productivity. U.S. Bureau of Labor Statistics. https://www.bls.gov/productivity/highlights/hospitals-labor-productivity.htm
[9] NHE Fact Sheet. Centers for Medicare & Medicaid Services. https://www.cms.gov/data-research/statistics-trends-and-reports/national-health-expenditure-data/nhe-fact-sheet.
[10] Average Annual Percent Growth in Health Care Expenditures per Capita by State of Residence. Kaiser Family Foundation. August 2022. https://www.kff.org/other/state-indicator/avg-annual-growth-per-capita/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D
[11] Underwood, Bonamici, Horsford Introduce Legislation to Expand Access to Clinical Opportunities for Graduate Nursing Students. Press Release. Office of United States Representative Suzanne Bonamici, 1st District of Oregon. May 25, 2023. https://bonamici.house.gov/media/press-releases/underwood-bonamici-horsford-introduce-legislation-expand-access-clinical
[12] Porat-Dahlerbruch J, Aiken LH, Todd B, et al. Policy Evaluation Of The Affordable Care Act Graduate Nurse Education Demonstration. *Health Aff (Millwood)*. 2022;41(1):86-95. doi:10.1377/hlthaff.2021.01328
[13] Cox C & Foster S. *The Costs and Benefits of Occupational Regulation*. Federal Trade Commission. 1990. https://www.ftc.gov/system/files/documents/reports/costs-benefits-occupational-regulation/cox_foster_-_occupational_licensing.pdf
[14] Prepared Statement of The Federal Trade Commission on Competition and Occupational licensure Before the Judiciary Committee Subcommittee on Regulatory Reform, Commercial and Antitrust Law, United States House of Representatives. September 12, 2017. https://www.ftc.gov/system/files/documents/public_statements/1253073/house_testimony_licensing_and_rbi_act_sept_2017_vote.pdf
[15] Selected Advocacy Relating to Occupational Licensing. Federal Trade Commission. https://www.ftc.gov/policy/advocacy-research/advocacy/economic-liberty/selected-advocacy-relating-occupational-licensing
[16] Timmons EJ, Hockenberry JM, & Durrance CP. More Battles among Licensed Occupations: Estimating the Effects of Scope of Practice and Direct Access on the Chiropractic, Physical Therapist, and Physician Labor Market. *Mercatus Center*. September 28, 2016. https://www.mercatus.org/research/research-papers/more-battles-among-licensed-occupations
[17] Timmons EJ & Wei P. Resolving Roadblocks to Activating Additional Physicians. *Mercatus Center*. May 7, 2020. https://www.mercatus.org/research/policy-briefs/resolving-roadblocks-activating-additional-physicians
[18] Graboyes R & Feldstein M. For Greater Healthcare Access, License Physicians Like Pilots. *Mercatus Center*. September 9, 2021. https://www.mercatus.org/research/policy-briefs/greater-healthcare-access-license-physicians-pilots
[19] Scope-of-Practice Laws. *Mercatus Center*. March 22, 2017. https://www.mercatus.org/research/policy-briefs/scope-practice-laws
[20] Nurse Workforce Projections, 2020-2035. Health Resources & Services Administration. November 2022. https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/Nursing-Workforce-Projections-Factsheet.pdf
[21] State of the Primary Care Workforce, 2023. Health Resources & Services Administration. November 2023. https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/data-research/state-of-primary-care-workforce-2023.pdf
[22] Behavioral Health Workforce Projections, 2016-2030: Psychiatrists (Adult), Child and Adolescent Psychiatrists. Health Resources & Services Administration. https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/data-research/psychiatrists-2018.pdf
[23] Martin B, Kaminski-Ozturk N, O'Hara C, Smiley R. Examining the Impact of the COVID-19 Pandemic on Burnout and Stress Among U.S. Nurses. *J Nurs Regul*. 2023;14(1):4-12. doi:10.1016/S2155-8256(23)00063-7
[24] Shanafelt TD, West CP, Dyrbye LN, et al. Changes in Burnout and Satisfaction With Work-Life Integration in Physicians During the First 2 Years of the COVID-19 Pandemic. *Mayo Clin Proc*. 2022;97(12):2248-2258. doi:10.1016/j.mayocp.2022.09.002
[25] Fact Sheet: Nursing Shortage. American Association of Colleges of Nursing. October 2022. https://www.aacnnursing.org/Portals/0/PDFs/Fact-Sheets/Nursing-Shortage-Factsheet.pdf

respectively and comprising 15% and 13% respectively of the federal budget,[26] crowding out discretionary spending, and industry stakeholders suggesting that we subsidize our way out of labor shortages[27,28] now is the time to think differently.

Various policy experts including the Congressional Budget Office have enumerated policy options to promote either separately or simultaneously[29,30] cutting spending[31] and increasing taxes[32] as a way out of our health care cost problem. Spending cuts invariably cut someone's revenue, a politically fraught exercise with large incumbent hospital[33] and physician lobbies,[34] while taxes reduce profits of individuals and businesses, both large and small, thereby discouraging investment.[35,36,37] Yet, a tax and spend approach does not address the inherent labor productivity problem and leaves Baumol's cost disease unsolved.

Instead, automation and AI offer us the opportunity to use our existing human capital more efficiently and treat Baumol's cost disease.[38] AI can be defined amongst multiple frames of reference, including system type, types of intelligence, or mechanism of learning:

System Type	Types of Intelligence	Learning
Reactive	Artificial Narrow Intelligence	Reinforcement Learning
Limited Memory	Artificial General Intelligence	Unsupervised Learning
Theory of Mind	Artificial Super Intelligence	Supervised Learning
Self-Aware AI		Deep Learning
		Machine Learning
		Artificial Intelligence

Figure 2: Definitional framings for AI[39,40]

[26] NHE Fact Sheet. Centers for Medicare & Medicaid Services. 2022. https://www.cms.gov/data-research/statistics-trends-and-reports/national-health-expenditure-data/nhe-fact-sheet
[27] AAMC Statement on Senate Reintroduction of GME Expansion Bill. Press Release. Association of American Medical Colleges. April 27, 2023. https://www.aamc.org/news/press-releases/aamc-statement-senate-reintroduction-gme-expansion-bill
[28] AAMC-Supported Letter Calls for Increased CHGME Funding. Press Release. Association of American Medical Colleges. May 24, 2024. https://www.aamc.org/advocacy-policy/washington-highlights/aamc-supported-letter-calls-increased-chgme-funding
[29] Ten Options to Secure the Medicare Trust Fund. Committee for Responsible Federal Budget. June 16, 2022. https://www.crfb.org/blogs/ten-options-secure-medicare-trust-fund
[30] Options for Reducing the Deficit, 2023 to 2032--Volume I: Larger Reductions. Congressional Budget Office. December 7, 2022. https://www.cbo.gov/publication/58164
[31] Williams D, Grabert LM, Miller BJ, Rambur B, & Wilensky GR. Reducing Hospital Costs Without Hurting Patients. *Health Affairs Forefront*. October 20, 2023. DOI: 10.1377/forefront.20231018.935344
[32] Mermin GB, Garrett B, Hunter L, & Steuerle CE. Options for Increasing Medicare Revenues. Tax Policy Center. February 1, 2023. https://www.taxpolicycenter.org/publications/options-increasing-medicare-revenues/full
[33] Pollack R. Setting the Record Straight: Washington Post Editorial on Site-neutral Deeply Flawed and Poorly-timed. American Hospital Association. March 15, 2024. https://www.aha.org/news/blog/2024-03-15-setting-record-straight-washington-post-editorial-site-neutral-deeply-flawed-and-poorly-timed
[34] Joszt L. AMA Continues Call for Medicare Payment System Fix During Interim Meeting. *American Journal of Managed Care*. November 20, 2023https://www.ajmc.com/view/ama-continues-call-for-medicare-payment-system-fix-during-interim-meeting
[35] McBride W. What Is the Evidence on Taxes and Growth?. Tax Foundation. December 18, 2012. https://taxfoundation.org/research/all/federal/what-evidence-taxes-and-growth/
[36] Agostini, C. A. (2007). The Impact of State Corporate Taxes on FDI Location. *Public Finance Review*, 35(3), 335-360. https://doi.org/10.1177/1091142106292491
[37] Mukherjee A, Singh M, Žaldokas A. Do corporate taxes hinder innovation? *Journal of Financial Economics*. 2017/04/01/ 2017;124(1):195-221. doi:https://doi.org/10.1016/j.jfineco.2017.01.004
[38] Pande V. Solving Baumol's Cost Disease, in Healthcare. *Andreessen Horowitz*. December 14, 2020. https://a16z.com/solving-baumols-cost-disease-in-healthcare/
[39] Panch T, Szolovits P, Atun R. Artificial intelligence, machine learning and health systems. *J Glob Health*. 2018;8(2):020303. doi:10.7189/jogh.08.020303
[40] Laviola E. What Types of AI Are Being Used in Healthcare?. *HealthTech*. July 11, 2023. https://healthtechmagazine.net/article/2023/07/types-ai-in-healthcare-perfcon

While the exact boundaries of the definitions of AI can be debated, the principle behind it–automation–can serve to transform care delivery and improve labor productivity. AI has three primary categories of application in health care: 1) automation of the mundane (administrative tasks), 2) augmentation of human-driven clinical practice, and 3) automation of elements of clinical practice.[41] This section will address the potential of the latter two categories of use to improve labor productivity by both automating tasks and simultaneously up-scoping the activities of clinical professionals.

Augmentation of human-driven clinical practice can transform medical care. For example, intelligent warnings such as blind spot monitors, advanced driver assistance systems like Toyota Lane Change Assist, and automated safety systems like Mercedes PRE-SAFE ensure a safer driving experience. Current care delivery modalities are akin to a 747 with analog controls and no autopilot, with AI-driven technology (clinical decision support) and adaptive displays offering the potential to improve clinical practice in acute and critical safety settings for intensivists, anesthesiologists, nurses, and other providers to manage patients more effectively and efficiently while also addressing human factors concerns[42] such as information overload, situational awareness, and task management.[43]

In other clinical settings, automation and AI may improve the efficiency and accuracy of clinical practice, assisting clinicians in diagnostic tasks built upon pattern recognition, such as diagnosis based upon CT scans,[44] mammography interpretation,[45] melanoma diagnosis,[46] or review of pathology slides.[47] Other emerging areas include prognostication in cancer[48] and improving radiation treatment planning,[49] with AI-assisted care likely to become the standard of care in multiple areas. Much of this innovation occurs and will continue to evolve at the bedside as part of clinical practice, as front-line practitioners identify and begin to solve longstanding problems in conjunction with engineers and software developers.

Beyond augmentation, automation of elements of clinical practice can drive increased efficiency. With the time required to provide appropriate guideline-directed primary care estimated at a 26.7 hour workday,[50] it is clear that there is an opportunity to automate clinical tasks in order to better serve patients, improve labor productivity, and not harm the clinical workforce. Autonomous AI-driven care can support service delivery, from screening for diabetic retinopathy to point-of-care digital cytology[51] to interpretation of electroencephalograms[52] with some clinical use cases even revealing higher performance for machine learning when compared to humans.[53] All of these opportunities offer an ability for existing clinicians to devote more time to patient counseling, clinical coordination, procedures, and other tasks, unlocking productivity gains in health care delivery for the first time in decades.

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[41] Spear J, Ehrenfeld JM, Miller BJ. Applications of Artificial Intelligence in Health Care Delivery. *J Med Syst*. 2023;47(1):121. Published 2023 Nov 17. doi:10.1007/s10916-023-02018-y

[42] Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anesthesia mishaps: a study of human factors. *Anesthesiology*. 1978;49(6):399-406. doi:10.1097/00000542-197812000-00004

[43] Jones, C.P.L., Fawker-Corbett, J., Groom, P., Morton, B., Lister, C. and Mercer, S.J. (2018), Human factors in preventing complications in anaesthesia: a systematic review. *Anaesthesia*, 73: 12-24. https://doi.org/10.1111/anae.14136

[44] Ziegelmayer S, Reischl S, Havrda H, et al. Development and Validation of a Deep Learning Algorithm to Differentiate Colon Carcinoma From Acute Diverticulitis in Computed Tomography Images. *JAMA Netw Open*. 2023;6(1):e2253370. doi:10.1001/jamanetworkopen.2022.53370

[45] Lång K, Josefsson V, Larsson AM, et al. Artificial intelligence-supported screen reading versus standard double reading in the Mammography Screening with Artificial Intelligence trial (MASAI): a clinical safety analysis of a randomised, controlled, non-inferiority, single-blinded, screening accuracy study. *Lancet Oncol*. 2023;24(8):936-944. doi:10.1016/S1470-2045(23)00298-X

[46] Phillips M, Marsden H, Jaffe W, et al. Assessment of Accuracy of an Artificial Intelligence Algorithm to Detect Melanoma in Images of Skin Lesions. *JAMA Netw Open*. 2019;2(10):e1913436. doi:10.1001/jamanetworkopen.2019.13436

[47] Steiner DF, Nagpal K, Sayres R, et al. Evaluation of the Use of Combined Artificial Intelligence and Pathologist Assessment to Review and Grade Prostate Biopsies. *JAMA Netw Open*. 2020;3(11):e2023267. doi:10.1001/jamanetworkopen.2020.23267

[48] Torrente M, Sousa PA, Hernández R, et al. An Artificial Intelligence-Based Tool for Data Analysis and Prognosis in Cancer Patients: Results from the Clarify Study. *Cancers (Basel)*. 2022;14(16):4041. Published 2022 Aug 22. doi:10.3390/cancers14164041

[49] Kawamura M, Kamomae T, Yanagawa M, et al. Revolutionizing radiation therapy: the role of AI in clinical practice. *Journal of Radiation Research*. 2024;65(1):1–9. https://doi.org/10.1093/jrr/rrad090

[50] Porter J, Boyd C, Skandari MR, Laiteerapong N. Revisiting the Time Needed to Provide Adult Primary Care. *J Gen Intern Med*. 2023;38(1):147-155. doi:10.1007/s11606-022-07707-x

[51] Holmström O, Linder N, Kaingu H, et al. Point-of-Care Digital Cytology With Artificial Intelligence for Cervical Cancer Screening in a Resource-Limited Setting. *JAMA Netw Open*. 2021;4(3):e211740. doi:10.1001/jamanetworkopen.2021.1740

[52] Tveit J, Aurlien H, Plis S, et al. Automated Interpretation of Clinical Electroencephalograms Using Artificial Intelligence. *JAMA Neurol*. Published online June 20, 2023. doi:10.1001/jamaneurol.2023.1645

[53] Mercan E, Mehta S, Bartlett J, Shapiro LG, Weaver DL, Elmore JG. Assessment of Machine Learning of Breast Pathology Structures for Automated Differentiation of Breast Cancer and High-Risk Proliferative Lesions. *JAMA Netw Open*. 2019;2(8):e198777. doi:10.1001/jamanetworkopen.2019.8777

Augmentation and automation may also occur in the home or real-world setting to facilitate consumer-driven care, as technology can augment traditional patient-clinician relationships promoting self-management and independence. For example, a closed-loop system consists of insulin pump tied with a continuous glucose monitor with dosing driven by algorithms, tested first in small groups[54] and in broader populations[55] including young children[56] with improved blood glucose control. While a simple example, many chronic conditions such as diabetes, atrial fibrillation, hypertension, and other diseases offer the potential for patient-driven treatment assisted by automation and AI in conjunction with the use of wearables expanding access while reducing the real-life burden on patients of managing disease. Given well-documented care gaps and consequential personal and societal costs for millions of Americans with obesity, diabetes,[57] hypertension,[58] and other conditions due to an inadequate labor supply, maldistribution of clinicians, and inefficient delivery system, the need for scalable, low-cost personalized solutions that operate at a time and in a setting most convenient for patients is critical

2. Driving administrative efficiency for delivery systems and insurers

Automation and AI also offer the opportunity to improve labor productivity through automation of the mundane or administrative tasks. With over half of physicians suffering from burnout[59] frequently driven by administrative tasks and burnout driving quality losses,[60,61] improving labor productivity is both a pragmatic economic and moral imperative. Recent research demonstrates that clinical workers spend a significant fraction of their time on administrative tasks: the average primary care physician spends over 6 hours daily writing note, hospital nurses on medical-surgical units spend 35.3 of their time on documentation as compared to 19.3% on patient care activities,[62] while internal medicine residents spend 13% of their day in face-to-face contact. Agencies such as the Agency for Healthcare Research and Quality have funded successful descriptive research in this arena for over 20 years,[63] providing a clearly measured imperative for action.

Many day-to-day administrative tasks can be automated through AI such as diagnostic coding and billing and charting, freeing up clinical staff inclusive of nurses and physicians to spend more time counseling and directly interacting with patients. For example, companies such as Nuance, DeepScribe, Nabla, and Suki are working on early attempts to use ambient AI to automate clinical notetaking. Eventually clinicians will review, edit and then sign AI-generated notes as opposed to spending time during and between patient encounters to document visits. With over 70,000 ICD-10 diagnosis codes to support billing, AI could save time and reduce physician cognitive burden while simultaneously improving billing and diagnosis coding accuracy (the latter of which would prevent fraud, waste, and abuse in risk-adjusted capitated health benefit programs).

AI can also be prudently deployed to address concerns regarding innumerable challenges and administrative burdens of prior authorizations for both clinicians and health plans. With the average physician reporting filing out 37 prior

[54] Brown S, Raghinaru D, Emory E, Kovatchev B. First Look at Control-IQ: A New-Generation Automated Insulin Delivery System. *Diabetes Care*. 2018;41(12):2634-2636. doi:10.2337/dc18-1249

[55] Brown SA, Kovatchev BP, Raghinaru D, et al. Six-Month Randomized, Multicenter Trial of Closed-Loop Control in Type 1 Diabetes. *N Engl J Med*. 2019;381(18):1707-1717. doi:10.1056/NEJMoa1907863

[56] Wadwa RP, Reed ZW, Buckingham BA, et al. Trial of Hybrid Closed-Loop Control in Young Children with Type 1 Diabetes. *N Engl J Med*. 2023;388(11):991-1001. doi:10.1056/NEJMoa2210834

[57] Najafipour H, Farjami M, Sanjari M, Amirzadeh R, Shadkam Farokhi M, Mirzazadeh A. Prevalence and Incidence Rate of Diabetes, Pre-diabetes, Uncontrolled Diabetes, and Their Predictors in the Adult Population in Southeastern Iran: Findings From KERCADR Study. *Front Public Health*. 2021;9:611652. Published 2021 Nov 1. doi:10.3389/fpubh.2021.611652

[58] Centers for Disease Control and Prevention (CDC). Vital signs: awareness and treatment of uncontrolled hypertension among adults--United States, 2003-2010. *MMWR Morb Mortal Wkly Rep*. 2012;61:703-709.

[59] Shanafelt TD, West CP, Dyrbye LN, et al. Changes in Burnout and Satisfaction With Work-Life Integration in Physicians During the First 2 Years of the COVID-19 Pandemic. *Mayo Clin Proc*. 2022;97(12):2248-2258. doi:10.1016/j.mayocp.2022.09.002

[60] Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and medical errors among American surgeons. *Ann Surg*. 2010;251(6):995-1000. doi:10.1097/SLA.0b013e3181bfdab3

[61] Khullar D. Burnout, Professionalism, and the Quality of US Health Care. *JAMA Health Forum*. 2023;4(3):e230024. doi:10.1001/jamahealthforum.2023.0024

[62] Hendrich A, Chow MP, Skierczynski BA, Lu Z. A 36-hospital time and motion study: how do medical-surgical nurses spend their time?. *Perm J*. 2008;12(3):25-34. doi:10.7812/tpp/08-021

[63] Physician Burnout. Agency for Healthcare Research and Quality. https://www.ahrq.gov/prevention/clinician/ahrq-works/burnout/index.html

authorization forms weekly,[64] the average oncology office having 6 full time staff to manage prior authorization,[65] while an internal survey of an academic dermatology department found that 6.6% of all visits generated a prior authorization.[66] With prior authorization long a topic of policy consternation resulting in the introduction of legislation to implement gold card programs[67] and CMS rulemaking,[68] AI and automation offer the potential to reduce clinician and patient burdens, improving productivity. For example, AI could automate data submission for clinicians, while for health plans at the first level of review where there are clear guidelines, algorithms could be utilized for *approval*. Eventually, frictions in the prior authorization process could be reduced through automation allowing near real-time adjudication during a clinical visit for the first layer of review, freeing up clinicians and health plan employees to focus on either patient care or more complex care management decisions.

Automation and AI can also drive efficiency and good governance for large public benefits programs such as Medicaid. Functions that are not inherently governmental functions can be undertaken by contractors instead of by governmental personnel, as defined by the Federal Activities Inventory Reform Act of 1998, the Office of Management and Budget Circular A-76, and the recent Office of Procurement Policy (OFPP) Policy Letter 11-01.[69] Agencies undertake 2 tests, specifically (1) the nature of function test (i.e. exercise of sovereign power is inherently governmental) and (2) exercise of discretion test. In the context of Medicaid, the procedural determination of Medicaid eligibility and redetermination are ripe for intervention.[70]

There is bipartisan frustration with Medicaid enrollment and eligibility determinations. Recent rules target administrative barriers to entry,[71] while others emphasize the role that eligibility plays in improper payments, where it accounts for account for 73.7% or >$61 billion 2022.[72] Regardless of one's perspective, these challenges highlight the need for process improvement. As part of the 2020 Families First Coronavirus Response Act, Congress increased the federal Medicaid matching funds by 6.2% if states implemented continuous Medicaid coverage for enrollees, with redetermination starting on April 1, 2023. With redetermination for over 20 million Americans ongoing,[73] both initial eligibility and redetermination offer an opportunity to deploy AI and automation, as eligibility is defined in statute leaving little discretion.

Other use cases such as a fraud detection, long a concern in both Medicare and Medicaid, with CMS noting that the improper payment rate in Fee For Service Medicare was 7.38% or $31.2 billion, contrasting with $16.6 billion or 6.01% in Part C.[74] Improving payment accuracy, eligibility, and redetermination all offer an opportunity to reduce fraud, waste and abuse while ensuring that Americans who need these programs can continue to benefit from them.

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[64] Survey quantifies time burdens of prior authorization. American Medical Association. Published January 30, 2017. Accessed July 10, 2023. https://www.ama-assn.org/practice-management/prior-authorization/survey-quantifies-time-burdens-prior-authorizationc

[65] Lin NU, Bichkoff H, Hassett MJ. Increasing Burden of Prior Authorizations in the Delivery of Oncology Care in the United States. *J Oncol Pract*. 2018;14(9):525-528. doi:10.1200/JOP.18.00428

[66] Carlisle RP, Flint ND, Hopkins ZH, Eliason MJ, Duffin KC, Secrest AM. Administrative Burden and Costs of Prior Authorizations in a Dermatology Department. *JAMA Dermatol*. 2020;156(10):1074-1078. doi:10.1001/jamadermatol.2020.1852

[67] Congressmen Gonzalez and Burgess Re-Introduce Bipartisan Bill to Improve Care for Medicare Recipients. Press Release. Office of Congressman Vicente Gonzalez Representing the 34th District of Texas. August 2, 2023. https://gonzalez.house.gov/media/press-releases/congressmen-gonzalez-and-burgess-re-introduce-bipartisan-bill-improve-care

[68] CMS Interoperability and Prior Authorization Final Rule CMS-0057-F. Centers for Medicare & Medicaid Services. January 17. 2024. https://www.cms.gov/newsroom/fact-sheets/cms-interoperability-and-prior-authorization-final-rule-cms-0057-f

[69] Definitions of "Inherently Governmental Function" in Federal Procurement Law and Guidance. Congressional Research Service. December 23, 2014. https://www.everycrsreport.com/files/20141223_R42325_ba76864808b1cfc5b92720461b225702a81ac71d.pdf

[70] Cho T, Miller BJ. Using artificial intelligence to improve administrative process in Medicaid. *Health Aff Sch*. 2024;2(2):qxae008. Published 2024 Jan 29. doi:10.1093/haschl/qxae008

[71] Streamlining the Medicaid, Children's Health Insurance Program, and Basic Health Program Application, Eligibility Determination, Enrollment, and Renewal Processes Final Rule Fact Sheet. Centers for Medicare & Medicaid Services. March 27, 2024. https://www.cms.gov/newsroom/fact-sheets/streamlining-medicaid-childrens-health-insurance-program-and-basic-health-program-application

[72] 2022 Medicaid & CHIP Supplemental Improper Payment Data. Centers for Medicare & Medicaid Services. November 2022. https://www.cms.gov/files/document/2022-medicaid-chip-supplemental-improper-payment-data.pdf-0

[73] Medicaid Enrollment and Unwinding Tracker. Kaiser Family Foundation. May 23, 2024. https://www.kff.org/report-section/medicaid-enrollment-and-unwinding-tracker-national-federal-unwinding-and-enrollment-data/

[74] Fiscal Year 2023 Improper Payments Fact Sheet. Centers for Medicare & Medicaid Services. November 15, 2023. https://www.cms.gov/newsroom/fact-sheets/fiscal-year-2023-improper-payments-fact-sheet

3. Policies to promote the development of new science and new innovation

Policymakers have multiple policy options to promote the use of automation and AI to drive productivity gains in health care delivery. First, policymakers should look to facilitate bottom-up innovation from clinicians and engineers by both streamlining and strengthening FDA oversight. Within FDA product review centers AI can be deployed to undertake basal first layer analysis of clinical trial data, both speeding upon pharmaceutical product and medical device review while allowing FDA staff to undertake more complex analytical questions. Policymakers should consider requiring the FDA to hold public workshops, integrate innovators' and entrepreneurs' feedback, and subsequently issue a strategic plan delineating steps (e.g. guidance, NPRM) to operationalize key regulatory principles in FDA discussion papers on distributed manufacturing and point-of-care manufacturing of drugs (which could reduce product costs for consumers),[75] AI in drug manufacturing,[76] AI in drug and biological products,[77] and uses of AI in medical product centers.[78] In order to both facilitate innovation, the FDA should also delineate areas of device and drug development where applications of AI do not require oversight or necessitate minimal oversight, in accordance with the FDA's own stated principles of risk-based regulation and least burdensome principles.[79]

Recognizing that liability concerns may present barriers to adoption, the FDA should work with entrepreneurs, physicians, patients, and engineers to explore the potential of performance-based regulation for software-driven medical devices and pure software as a medical device. Voluntary alternative pathways[80] in addition to (not in place of) traditional 510(k) and premarket approval (PMA pathways) for FDA approval would strengthen and provide FDA oversight flexibility for a rapidly evolving marketplace. Recognizing that AI and software exist on a rapid cycle improvement model as opposed to discrete innovation in traditional devices, performance-based regulation would promote pragmatic innovation emerging from the exam room and hospitals.

Clinical evidence of safety and efficacy could be generated in a variety of ways, such as meeting technical consensus standards derived from standards development organizations, testing in an accredited third party lab, substantial equivalence, modeling simulations, and other mechanisms. As a first step, policymakers could require the FDA to convene stakeholders and undertake a public workshop to explore best practices in performance-based regulation for medical software. Doing so would build on prior work to adapt the risk-based device regulatory framework such as the predetermined change control software,[81] software as a medical device (SaMD),[82] and precertification program.[83] These actions would facilitate rapid cycle innovation, promoting both stacked incremental innovation and revolutionary innovation.

Recognizing the problems with excessive centralization of standards, clinical evidence of safety and efficacy should be driven by scientific and clinical appropriateness coupled with innovator preferences, and not be tied to any single third party standards organization. The Government Accountability Office (GAO) has long highlighted the problems with standards and certification monopolies, with a 2004 GAO report[84] highlighting challenges with the Joint Commission's certification process to ensure that hospitals meet the Medicare Conditions of Participation, resulting in Congress revoking the Joint Commission's certification monopoly in 2008 as part of the Medicare Improvements

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[75] Distributed Manufacturing and Point-of-Care Manufacturing of Drugs. U.S. Food & Drug Administration. October 2022. https://www.fda.gov/media/162157/download?attachment

[76] Artificial Intelligence in Drug Manufacturing. U.S. Food & Drug Administration. 2023. https://www.fda.gov/media/165743/download?attachment

[77] Using Artificial Intelligence & Machine Learning in the Development of Drug & Biological Products. U.S. Food & Drug Administration. https://www.fda.gov/media/167973/download

[78] Artificial Intelligence & Medical Products: How CBER, CDER, CDRH, and OCP are Working Together. U.S. Food & Drug Administration. March 2024. https://www.fda.gov/media/177030/download

[79] The Least Burdensome Provisions: Concept and Principles. U.S. Food & Drug Administration. February 5, 2019. https://www.fda.gov/media/73188/download

[80] Cho T, Gowda V, Schulzrinne H, Miller BJ. Integrated Devices: A New Regulatory Pathway to Promote Revolutionary Innovation. *Milbank Q*. January 22, 2024. doi:10.1111/1468-0009.12692

[81] Marketing Submission Recommendations for a Predetermined Change Control Plan for Artificial Intelligence/Machine Learning (AI/ML)-Enabled Device Software Functions. U.S. Food & Drug Administration. April 3, 2023. https://www.fda.gov/media/166704/download

[82] Software as a Medical Device (SAMD): Clinical Evaluation. U.S. Food & Drug Administration. December 8, 2017. https://www.fda.gov/media/100714/download

[83] Digital Health Software Precertification (Pre-Cert) Pilot Program. U.S. Food & Drug Administration. September 26, 2022. https://www.fda.gov/medical-devices/digital-health-center-excellence/digital-health-software-precertification-pre-cert-pilot-program

[84] CMS Needs Additional Authority to Adequately Oversee Patient Safety in Hospitals. U.S. Government Accountability Office. July 2024. https://www.gao.gov/assets/gao-04-850.pdf

for Patients and Providers Act of 2008. The FDA would benefit from additional Congressional oversight to ensure that a single standards development organization does not control AI product development.

Finally, and most importantly, payment policy must deploy automation and AI-driven care to promote competition and lower costs. CMS should not create additional standards for AI tied to Medicare Conditions of Participation,[85] noting that product liability, medical malpractice, state hospital licensing, and finally existing conditions of participation require a lengthy list of quality and safety management programs, which already encompass and address many of the risks of the deployment of software and AI products. Further regulations tied to conditions of participation would restrict access to AI innovation and undermine the FDA's role as a science-based product regulator, thus depriving patients and clinicians of meaningful and tangible productivity improvements.

Instead, policymakers should work to shape the Medicare program to pay for new technology by driving competition. Ideally beneficiaries will be able to choose by which modality to safely and conveniently access care:

1. Audio only
2. Audio/video
3. Audio/video with a remote, technology-assisted exam
4. Automated/AI-driven service either remote or in-person
5. Technology-augmented in-person, human capital-driven medical service
6. Human-driven, in-person service

While Medicare Advantage–the managed care version of Medicare–has the flexibility to cover additional services, policymakers must ensure that beneficiaries in fee for service (FFS) Medicare have equal access to innovative technologies that expand access and lower cost.

Recent history reminds us of the challenges of avoiding innovation, where concerns about induced demand and fraud, waste, and abuse collectively prevented us from meaningfully covering and paying for telehealth for over 20 years. With the Medicare Payment Advisory Commission denoting that over 5 million Medicare beneficiaries using telehealth in 2022 and practitioners developing specialization,[86] telehealth has finally begun to become a routine part of care, a change unfortunately forced by a global pandemic.[87]

Policymakers should avoid repeating this mistake and promote tiered payment for automated/AI-driven service. For example, a modifier that serves as a multiplier could be added to the physician fee schedule in order to reflect resource intensity, varying with the service in question (e.g. 0.1 for audio-only service, 0.5 for automated/AI-driven service, and 1.0 for human-driven, in-person service). This would promote competition between software developers, physicians, and health systems to find the most patient-centric and efficient way to deliver services.

4. Conclusions

Both patients and clinicians are tired of inefficient and expensive care delivery and administration. Statistics enumerate this story well, with the median Emergency Department wait time of 330 minutes in the District of Columbia[88] to a median wait time of 51 days to see a nephrologist at a hospital in North Carolina[89] to 25 years without labor productivity growth. There is more than enough room to use automation and AI to drive efficiency gains.

Together we can deploy AI And automation to cure Baumol's cost disease–a chronic condition that is killing our economy–in healthcare. Policymakers should ensure that regulatory policy facilitates the use of automation and AI, encouraging bottom up innovation from the exam room to ensure that innovation has a chance to augment and automate elements of clinical practice. AI can also improve administrative efficiency reducing waste through

[85] Facilitating Responsible Governance of Healthcare AI Tools: Testimony presented to the U.S. Senate Committee on Finance, February 8, 2024. https://www.finance.senate.gov/imo/media/doc/02082024_mello_testimony.pdf

[86] O'Donnell B & Tabor L. Telehealth in Medicare: Status Report. MedPAC. April 11, 2024. https://www.medpac.gov/wp-content/uploads/2023/10/Telehealth-April-2024-SEC.pdf

[87] Lee JS, Bhatt A, Pollack LM, et al. Telehealth use during the early COVID-19 public health emergency and subsequent health care costs and utilization. *Health Aff Sch*. 2024;2(1):qxae001. doi:10.1093/haschl/qxae001

[88] Bean M. ED visit times, by state. *Becker's Hospital Review*. February 1, 2024. https://www.beckershospitalreview.com/rankings-and-ratings/ed-visit-times-by-state.html

[89] Schettini P, Shah KP, O'Leary CP, et al. Keeping care connected: e-Consultation program improves access to nephrology care. *Journal of Telemedicine and Telecare*. 2019;25(3):142-150. doi:10.1177/1357633X17748350

simplifying prior authorization for patients and physicians or addressing Medicaid improper payments. The FDA can facilitate innovation, while avoiding the ills of standards monopolies and the government placing its finger on the scales of competition. Policymakers can also empower CMS to pay for automation, promoting service delivery innovation and competition. By promoting instead of fearing innovation and facilitating mechanisms to pay for safe and effective rapid cycle innovation, together we can improve our care delivery system.

Testimony of Ayanna Howard, Dean of Engineering, The Ohio State University

U.S. Congress Joint Economic Committee

"Artificial Intelligence and Its Potential to Fuel Economic Growth and Improve Governance"

June 4, 2024

Chairman Heinrich, Vice Chairman Schweikert, and members of the Joint Economic Committee:

Thank you for the opportunity to participate in today's hearing on artificial intelligence and its potential for job growth and improved governance. It's an honor to be with you today.

My name is Ayanna Howard, and I am an innovator, entrepreneur, leader, and international expert in robotics and AI. Currently, I am the Dean of Engineering at The Ohio State University and Monte Ahuja Endowed Dean's Chair. Previously, I served as the Chair of the School of Interactive Computing at the Georgia Institute of Technology. I have also served as the Associate Director of Research for the Institute for Robotics and Intelligent Machines, Chair of the Robotics Ph.D. program, and the Associate Chair for Faculty Development in the School of Electrical and Computer Engineering at Georgia Tech.

From 1993-2005, I was at NASA's Jet Propulsion Laboratory where I held the titles of Senior Robotics Researcher and Deputy Manager in the Office of the Chief Scientist. I hold a degree in engineering from Brown University, a M.S. and Ph.D. in Electrical Engineering from the University of Southern California, and an M.B.A. from the Drucker Graduate School of Management.

After leaving NASA in 2005, I entered academia and started up my own robotics research lab. My research encompasses advancements in artificial intelligence (AI), assistive technologies, and robotics, and has resulted in over 275 peer-reviewed publications. In 2013, I founded Zyrobotics, a university spin-off, which designed AI-powered STEM tools and learning games for children with diverse learning needs.

I regularly consult and sit on the advisory boards of several organizations concerned with robotics, AI, and workforce development. This includes my appointment as a member of the National AI advisory committee which is tasked with advising the President and the National AI Initiative Office on topics related to AI. My work has also been highlighted through a number of awards and articles, including highlights in *Vanity Fair, USA Today*, *Upscale, Black Enterprise*, and *TIME Magazine*, as well as being recognized as one of the 23 most powerful women engineers in the world by *Business Insider* and one of the Top 50 U.S. Women in Tech by *Forbes.*

Needless to say, I am not only a practitioner and developer of AI technologies but I've also been a committed advocate for developing the diverse talent pool that is needed for addressing the future workforce needs involving these advanced technologies.

My comments in this testimony are therefore focused on the national importance of AI literacy and its role in augmenting the current and future workforce talent pool as well as the government's role in enabling this to happen.

While demographics of the United States are changing, these changes are not reflected in the diversity of students pursuing degrees related to AI, engineering, or computer science. According to the 2023 World Economic Forum Future of Jobs Report, AI continues to shift the skills that are needed within the workforce – in some cases creating new jobs, augmenting old jobs, and eliminating other jobs. When I attended the World Economic Forum this past January as an invited speaker in Davos, it was clear that the AI talent shortage is not just a U.S. problem. Buying outside talent is thus no longer a viable option to solve this issue. Too often though, we disregard our untapped talent pools. Organizations tend to over index on hiring new talent with needed skills versus upskilling their current talent.

As an educator, I have witnessed bright students whom, because of gaps in their high school curricula, leave the engineering major because they struggle when they take their first discipline-specific engineering courses. Yet, when we have instituted enrichments programs, such as the PREFACE and ACCELERATE program in the College of Engineering at The Ohio State University, we have seen quantifiable growth in student retention and graduation rates in engineering. There is thus no reason, beyond intentionality (and resources), why organizations, government agencies, and educational institutions cannot institute similar AI training and literacy programs within their own organizational borders. We must provide more mechanisms than currently exist in order to be able to support the diversity of American participation and welcome all into the AI ecosystem.

There has been some movement in Congress to expand the Digital Equity Act into an AI Literacy Act but there needs to be more. We can no longer sit by and not have an unprecedented investment in expanding AI training and literacy, starting from early education through upskilling of the current workforce. Such an investment addresses a looming workforce need, a national security issue, and a major risk to national welfare. If AI is to live up to its potential of providing equitable solutions to enhancing our lives positively, the government should recommit to its fundamental mission of focusing on the public good and providing for the needs of society. We must act now to institute an AI educational transformation that provides every interested mind an equitable seat at the table.

As a technology researcher and college dean, I also dabble a bit in policy with respect to AI and regulations. I've been thinking about technology and trust for much of my career. I wrote an opinion piece about the possibility of regulations around AI back in 2019. I think policy will be critical to building trust. Policies and regulations allow for equal footing by establishing expectations and ramifications if companies or other governments violate them. Now, some companies will disregard the policies and just pay the fines — but there still is some concept of a consequence.

Right now, there's a lot of activity around AI regulations. There's the European Union AI Act, which the Parliament adopted in March 2024. There are draft AI guidelines that were released by

the Japanese government, and slightly different proposals in the United States, including President Biden's AI executive order.

There's state-specific activity, too. Over the past five years, it's been documented that 17 states have enacted 29 bills that focus on some aspect of AI regulations. This year, California introduced Senate Bill 1047, a comprehensive AI Bill with the goal of establishing safe and secure AI innovation. On June 11, I'll be participating in an AI symposium at the Ohio Statehouse, which will bring together academic leaders, policymakers, and industry experts to discuss opportunities and challenges of artificial intelligence for Ohio's universities. This practice of each state coming up with their own rules for regulating AI will continue if policies and AI bills are not being passed at a federal level. And that's a problem. AI doesn't understand the concept of borders and state lines – it's becoming as ubiquitous as the internet. Policies and regulations, when it's done correctly with diverse perspectives and iterative feedback from all impacted stakeholders, can be accomplished smartly without impeding innovation or entrepreneurship.

I believe we have a lot of room for improvement in making sure that people not only understand technology and the opportunities it provides but also the risks it creates. With new federal regulations, more accurate systems, and increased AI literacy training and upskilling for the untapped labor market, this can happen.

The intersection of the country's growing dependence on advanced AI technologies coupled with a clear shortage of AI talent is fast becoming a national security issue that must be addressed urgently.

In an April 30, 2021, speech, Secretary of Defense Lloyd J. Austin III emphasized that sophisticated information technologies, including artificial intelligence, will be key differentiators in future conflicts. The United States though risks not having enough talent trained with sufficient AI literacy that is needed to advance emerging technologies critical to maintaining American leadership.

If we are not careful, we might be living another 1957's Sputnik moment, when the United States suddenly realized the need to invest in science education to avoid losing the space race with the then-Soviet Union. When the Soviet Union launched Sputnik in 1957, the United States launched a bold initiative - the National Defense Education Act of 1958, which legitimatized federal funding for higher education and led to the transformational talent growth of new engineers and scientists. This powered the economy growth of the U.S. and American innovation through the subsequent decades. Today, with nearly every aspect of life evolving to being coupled to artificial intelligence, the United States cannot afford to sit back and wait for an AI-based crisis to hit. We are at a crossroads. The U.S. must make an equivalently bold investment in growing the AI talent pool to help protect democracy, citizens' quality of life, and the overall health of the nation.

Thank you for the opportunity to participate in this important hearing. I appreciate the Committee's attention to this topic. I stand ready to answer your questions and work with you on

moving forward to help create an ecosystem that allows for the democratization of AI technology that ensures no one is left behind as we drive forward American innovation and competitiveness.

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Joint Economic Committee

June 4, 2024

Testimony of Dr. Jen Gaudioso
Sandia National Laboratories[1]

Artificial Intelligence and Its Potential to Fuel Economic Growth and Improve Governance

Chairman Heinrich, Vice Chairman Schweikert, and distinguished members of the Committee, I want to thank you for the opportunity to testify today regarding artificial intelligence (AI) and innovation and specifically for the chance to talk about the role of the national labs in this area.

Summary

This afternoon, I want to make a few key points, and since I am a Sandia National Labs employee, I will use Sandia as an example of the critical role that the Department of Energy (DOE) national labs play in computing and highlight how this provides them with a solid foundation for leading in AI innovations going forward.

The DOE labs have:

- Led in computing breakthroughs throughout the nation's history,
- Addressed critical societal and security challenges through decades of strategic AI research, and
- Accelerated computing innovations through collaboration with universities and the private sector.

Sandia National Laboratories Overview

Sandia is one of three research and development (R&D) labs of the U.S. DOE's National Nuclear Security Administration. We are a multimission laboratory with most of Sandia's employees working in Albuquerque, New Mexico (NM) or at its second principal laboratory in Livermore, California, to deliver innovative and reliable solutions in a changing world. Our roots go back to World War II and the Manhattan Project. The lab was established in 1949 with the goal of advancing U.S. national security by developing science-based technologies. Throughout its 75-year history as a multidisciplinary, national security, engineering laboratory, [2] Sandia's primary mission has been to ensure the U.S. nuclear arsenal is safe, secure, reliable and can fully support our nation's nuclear deterrence (ND) policy, but there is strategic synergy and interdependence between Sandia's ND mission and its capability-based science and engineering foundations because breakthroughs in one area beget discoveries in others in a cycle that pushes boundaries and fuels advancement.

[1] Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. **SAND2024-067400**

[2] https://www.sandia.gov/news/publications/fact-sheets/

Through this cycle, Sandia has: [3]

- Designed a brain-inspired cybersecurity system to detect malicious players 100 times faster, while using less electricity than a standard 60-watt light bulb,
- Developed an ion exchange material that was later used to remove radioactive material from wastewater in Japan's earthquake-damaged Fukushima Daiichi nuclear power plant,
- Developed robots that can reach trapped miners, demilitarize submunitions, and disable Improvised Explosive Devices,
- Created zero-emission fuel cells for marine application that are now powering a passenger ferry in the California Bay Area, and
- Designed and manufactured radiation-hardened microelectronics that enabled the Galileo spacecraft to travel 2.8 billion miles and withstand Jupiter's intense radiation belts.

This cycle also allows Sandia to assist a wide variety of small businesses throughout NM through the New Mexico Small Business Assistance (NMSBA) Program. [4] The NMSBA Program facilitates access for select small businesses to experts at Sandia and Los Alamos national laboratories who can help them gain knowledge and solve challenges utilizing the labs' cutting-edge technologies. In addition, since the NMSBA was established in 2000, 11,116 new jobs have been created and retained in NM through $80.6M in technical assistance to 3,267 New Mexico small businesses, and all 33 NM counties have been supported. Overall, Sandia has contributed over $140 billion to the United States economy through its local, regional, and national partnerships since 2003.

Now, I would like to employ a quote from the past related to new stockpile needs to help our discussion transition into a segment showcasing how Sandia's history of significant contributions in computing position it and other national labs to continue the pivotal ongoing exploration and development of AI technologies.

"We have a 10-year window; if we do not have sufficient computer simulation capabilities by then, we will need to go back to testing and that will probably not be an option. We must succeed. The laboratories will need to change to being experiment- and computer-driven within a 10-year window, rather than test-driven as in the past."
-Dr. Victor Reis, DOE Assistant Secretary for Defense Programs

Dr. Reis' call to action resulted in the Accelerated Strategic Computing Initiative (ASCI), leading the three DOE NNSA national laboratories, Sandia, Lawrence Livermore, and Los Alamos to partner with each other, industry, and academia to quickly develop, deliver, and support the high-performance computational capabilities needed for the U.S. nuclear deterrence mission. ASCI, now known as the Advanced Simulation and Computing (ASC) program, has revitalized the U.S. supercomputing industry through strategic technical leadership and partnership with industry. [5]

[3] https://www.sandia.gov/app/uploads/sites/165/2022/03/70-ways_2019-12801M.pdf
[4] https://www.nmsbaprogram.org/
[5] https://www.hpcwire.com/2018/11/09/how-asci-revolutioned-the-world-of-high-performance-computing-and-advanced-modeling-and-simulation/

Snapshot of Sandia's Role in Computing Innovations

Sandia's legacy in high performance computing (HPC) has brought together experts from various fields—ranging from engineering and physics to computer science—to work collaboratively on improving computing technologies. This teamwork has led to the creation of some of the most powerful computers in the world.

Notably, Sandia developed the first massively parallel processing supercomputer in 1990 and the supercomputer Red Storm in 2006, which enabled nuclear stockpile calculations, modeled the amount of explosive powder needed to destroy an asteroid, and demonstrated how changes in the composition of the Earth's atmosphere affects climate. Peter Ungaro, the CEO of Cray in 2001, reflected on the integral nature of Red Storm and their partnership with Sandia saying, "Literally, this program saved Cray." [6] In addition, Sandia's commitment to improving supercomputing performance earned three R&D 100 Awards[7] in a 10-year period for increasing the efficiency of massively parallel computing across a variety of science and engineering systems.

On behalf of NNSA's ASC Program, the Vanguard program at Sandia continues the commitment to advancing computing technologies. One of the Labs' notable achievements includes the development of the Astra platform, [8] a computer that marked a significant advancement by using technology commonly found in smartphones (ARM processors) to perform complex calculations at unprecedented speeds. This innovation represents a major shift in how powerful computing technologies are built and used. These ARM architectures are now found in NVIDIA's Grace Hopper AI chips.

Industry engagement though the PathForward initiative[9] was also central to helping advance HPC technologies for the DOE Exascale Computing Project. This collaborative effort between U.S. national laboratories and industry partners fostered partnerships with leading tech companies such as AMD, Cray, Hewlett Packard Enterprise, IBM, Intel, and NVIDIA, and accelerated the development of exascale computing systems capable of performing a billion billion calculations per second. To get to this milestone and overcome challenges related to power, consumption, scalability, and reliability, the collaborators had to innovate in hardware, software, and system integration. The initiative overall helped ensure the U.S. remained at the forefront of computational science, facilitating significant scientific, economic, and national security advancements. As Trish Damkroger at HPE said, "Exascale supercomputing has already demonstrated a significant impact on the scientific community, which spans various initiatives across public and commercial sectors…At HPE, we are honored to continue closely collaborating with the U.S. Department of Energy, the Exascale Computing Project, and national laboratories to bring exascale technology to life and into the hands of researchers, scientists, and engineers that are solving problems to advance humanity." [10]

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[6] https://www.datacenterdynamics.com/en/analysis/after-the-storm-the-supercomputer-that-saved-cray/
[7] https://www.sandia.gov/app/uploads/sites/165/2022/03/HighPerformanceComputing_2018.pdf
[8] https://www.sandia.gov/labnews/2018/06/21/arm/
[9] https://www.exascaleproject.org/research-group/pathforward/
[10] https://www.exascaleproject.org/quotes/

Sandia is also exploring new frontiers in computing that mimic the human brain through a partnership with Intel Corp.[11] Earlier this year, Sandia researchers heralded the arrival of Hala Point, a groundbreaking brain-based computing system, housing 1.15 billion artificial neurons within a compact container roughly the size of a microwave oven. This system, believed to be the largest brain-based computing system in the world, is set to revolutionize research efforts by enabling large-scale brain-based computing. This blend of traditional and neuromorphic computing underscores Sandia's unique role in driving AI technologies forward and offering solutions to complex problems while optimizing energy efficiency.

In collaboration with industry leaders like NVIDIA, Sandia, Lawrence Livermore, and Los Alamos are also engaged in developing advanced memory technologies, underscoring NNSA's commitment to pushing the boundaries of computing even further. These partnerships are part of broader efforts to strengthen the U.S.' competitiveness in next-generation computing technologies, ensuring that the nation remains at the forefront of HPC innovation. Through initiatives like these, Sandia and its partners are creating a more robust computing ecosystem through strong engagement with industry, paving the way for future technological breakthroughs that will benefit society.

Innovations extend beyond computing hardware

Open source software, by its very nature, promotes a culture of collaboration and shared creativity. It allows researchers, developers, and organizations across the globe to contribute to and benefit from the collective intelligence of the community. Recognizing the value of open-source software for furthering innovations in computing, DOE established a policy[12] in 2003 requiring its national labs to provide all publicly releasable software as either open-source software or as government software.

To ensure the sustainability of key open-source software, the national labs took initiative to partner with the Linux Foundation and launched the High Performance Software Foundation (HPSF), [13] a key moment in the evolution of open-source software for HPC and AI. These two institutions have been instrumental in recognizing the need for HPSF and driving its creation. Their vision for a collaborative platform that enhances the development, accessibility, and efficiency of high-performance software has been a key catalyst in bringing this initiative to life.

Currently, HPSF is working on a portable core software stack for HPC, which will make high-performance software development more accessible and efficient, and further enable the exploration and implementation of AI solutions. By rallying industry, academia, and government entities around the shared goal of advancing HPC and AI through open-source collaboration, national labs have created a powerful ecosystem for innovation and underscored their commitment to spearheading the next wave of scientific computing and AI advancements that can be used to address complex challenges and pave the way for future technological breakthroughs.

[11] https://newsreleases.sandia.gov/artificial_neuron/
[12] https://science.osti.gov/-/media/ascr/pdf/research/docs/Doe_lab_developed_software_policy.pdf
[13] https://hpsf.io/

AI @ Sandia[14]

Sandia's research in AI can be traced back to the early 1980s, at least. With today's combination of algorithms, data, and computing, Sandia is making significant impacts to national security through AI.

AI revolutionizes the speed in which we model and analyze data to inform decisions. It enables us to handle vastly larger amounts of data than humans can process alone, helps significantly reduce human errors and better complete repetitive tasks. AI's unrealized potential impact on the future of Sandia's mission spaces is vast, and the research we are doing will help realize that future for the benefit of the nation.

In the last few years, leading experts at Sandia have utilized AI and machine learning (ML) to solve complex science problems such as predicting ionic liquid diffusion for renewable energy storage applications,[15] recognizing radar targets quickly and accurately,[16] and designing strong and flexible interlocking metasurfaces for aerospace applications used in extreme environments.[17] Our ground-breaking work in trusted AI and computing co-design also continues to be leveraged in support of national security applications and other mission work.

As we consider the breadth and pace of AI progress by others around the globe, Sandia weighs three factors in focusing our research activities: (1) where we have, or could have, technical strengths in AI; (2) where there is strong mission need for AI solutions for NNSA and other government agencies; and (3) where is industry unlikely to supply the AI tools. As a result, Sandia's differentiated AI strategy focuses on:

- **AI Security & Reliability:** Sandia is developing methods and measures required to produce reliable and trustworthy AI-based solutions for its core nuclear deterrence engineering and design efforts, national security programs, global security, energy and homeland security, and the Labs' underlying advanced science and technology.
- **Scientific Machine Learning:** Sandia is fusing ML with scientific principles to solve scientific and engineering problems.
- **Data-driven AI for Mission Critical Applications:** Sandia is supporting high-consequence national security missions by developing and deploying critical applications enabled by data-driven AI.
- **Generative AI for National Security:** Sandia is engaged in assessing opportunities to deploy safe, reliable, generative AI systems to address national security and advanced manufacturing challenges.
- **Transitioning AI Research into Production:** Sandia is leveraging its depth and breadth of unique expertise to mature robust AI software that meets mission needs.
- **Infrastructure, Policy, & Operations:** Sandia is ensuring that critical infrastructure, computing power, workforce, and responsible AI policies are in place to support our business needs and mission research. We are identifying, developing, and promoting training opportunities to our entire workforce, especially when it comes to increasing the use of AI operationally among non-experts.

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[14] https://www.sandia.gov/research/area/computing-information-science-and-mathematics/ai/
[15] https://www.sandia.gov/news/publications/hpc-annual-reports/article/predict-ionic-liquid-diffusion/
[16] https://www.sandia.gov/news/publications/hpc-annual-reports/article/recognize-radar-targets-quickly-and-accurately/
[17] https://www.sandia.gov/news/publications/hpc-annual-reports/article/design-strong-and-flexible-interlocking-metasurfaces/

Continuing our established practice of partnering to advance computing technologies, Sandia's AI research is making mission impacts through collaborations with academia, other national labs, and the private sector. Two recent examples highlight the diversity of these impacts.

(1) With Lawrence Livermore and Los Alamos, we have embarked on a groundbreaking project[18] with Cerebras Systems to explore the application of the Wafer-Scale Engine technology in advancing simulation and computing applications crucial for the nation's stockpile stewardship mission. The Cerebras Systems AI chip design utilizes an entire wafer of integrated circuits versus current technology which cuts wafers into individual microprocessor cores that become graphics processing units (GPU) or central processing units (CPU).

    This partnership, part of the NNSA's post-Exascale-Computing-Initiative investment portfolio, seeks to sustain technological R&D momentum, fostering a robust domestic high-performance computing ecosystem. The initiative is poised to significantly impact future mission applications by integrating AI and ML techniques into production simulation workloads, marking a pivotal step in enhancing the capabilities of the U.S. in HPC and AI technologies.

(2) Sandia's Materials Learning Algorithms (MALA) project,[19] which received a prestigious R&D 100 award in 2023, is a cutting-edge program using ML to simplify and speed up complex calculations related to the properties of materials. This tool makes it easier for scientists to model materials at different scales, enhancing our understanding and development of new materials. MALA is designed to be user-friendly and open to everyone, allowing for easy use with just a few lines of code. Developed through a partnership between Sandia and the German Center for Advanced Systems Understanding, MALA represents a major leap forward in materials science, making it simpler and faster to explore the microscopic world of materials.

Frontiers of AI for Science, Security, and Technology (FASST Initiative)

Through the DOE FASST Initiative announced several weeks ago at the AI Expo in Washington, D.C., DOE and its national labs seek to dramatically accelerate the pace of R&D and enable scientific capabilities previously thought to be impossible through AI. With all that we have covered using Sandia as a national labs' exemplar, I hope it is easy to see how the national labs will strategically support the FASST Initiative and advance U.S. leadership in AI.

Under the FASST Initiative, as outlined by DOE and NNSA, the national labs will:

- Lead R&D to develop tuned and adapted AI models that solve pressing scientific and national security challenges. They will focus on training, testing, and validating frontier foundation models and other AI tools aligned with robust data sets,

[18] https://newsreleases.sandia.gov/cerebras_research/

[19] J. A. Ellis, L. Fiedler, G. A. Popoola, N. A. Modine, J. A. Stephens, A. P. Thompson, A. Cangi, S. Rajamanickam (2021). Accelerating Finite-temperature Kohn-Sham Density Functional Theory with Deep Neural Networks. Phys. Rev. B 104, 035120 (2021)

- Continue to build on their history of partnering with the private sector and extend these partnerships to focus on the development and construction of next-generation AI platforms, and
- Prioritize the development of tools for efficient, safe, and effective aggregation, generation, curation, and distribution of AI training data sets used across the platforms.
  The national labs are already beginning to jointly create hubs and put together teams that organize data for AI training and evaluation and specifically address DOE mission grand challenges. Collaborations, such as the one exemplified by the envisioned New Mexico AI Consortium (NMAIC), enable the sharing of resources and knowledge, while allowing for the creation of proprietary outcomes that benefit commercial, public, and national security applications.

New Mexico AI Consortium

Mr. Chairman, across NM, we are finalizing the NMAIC—a Consortium envisioning a future where the collaborative power of NM's premier institutions and industrial partners transforms the landscape of AI research, workforce development, and infrastructure. By uniting the strengths of Sandia, Los Alamos, the University of New Mexico (UNM), New Mexico State University (NMSU), New Mexico Institute of Mining and Technology, Central New Mexico Community College (CNM), and our industrial partners, NMAIC will foster an ecosystem of innovation and broaden both academic and community input to shape the future of AI and propel the state and nation forward.

Research: NMAIC is committed to pioneering the advancement of AI through a synergistic approach that integrates hardware, software, numerical methods, data, algorithms, and practical applications. Our consortium aims to ensure that AI research is not only at the forefront of technological progress but will also provide trustworthy solutions directly aligned with the critical needs of our nation and state. By leveraging our collective research expertise and resources, we aim to solve complex challenges, drive economic growth, and enhance the well-being of our communities.

Workforce: NMAIC is dedicated to cultivating a diverse, skilled, and innovative workforce capable of leading the future of technology. Through comprehensive education, training programs, and collaborative initiatives, we aim to equip individuals with the knowledge and skills necessary to excel in the evolving AI landscape. Our consortium is committed to creating opportunities for lifelong learning and career advancement, ensuring that NM remains at the forefront of AI innovation and application. In addition, all the NM universities and colleges are minority-serving and Hispanic-serving institutions and will bring diverse perspectives to AI research and education. Through the NMAIC partnership with UNM, we will pilot an approach to university collaboration, and by utilizing UNM's role in the Alliance of Hispanic-Serving Research Universities (HSRU), we plan to expand these partnerships to other HSRU across the country.

Infrastructure: At the heart of the NMAIC vision is the development of a robust, state-of-the-art infrastructure that supports the ambitious goals of our consortium. NMAIC is focused on building and enhancing the physical and digital frameworks necessary for cutting-edge AI research, education, and commercialization. By investing in high-performance computing facilities, data storage and management systems, and collaborative spaces, we will provide our researchers, students, and industrial partners with the tools they need to succeed.

I would like to highlight a few Sandia examples showcasing the types of foundations that can further be built upon through the NMAIC.

- The ASC Predictive Science Academic Alliance Program[20] is the primary mechanism by which NNSA labs such as Sandia and Los Alamos can collaborate with UNM and numerous universities on advancing science-based modeling and simulation.
- The robust research and internship programs Sandia has with multiple Historically Black Colleges and Universities (HBCU) partners provides a talent pipeline for the national laboratories. Through UNM, we are integrating recruitment efforts that will attract diverse talent seeking to advance their education upon graduating from HBCU. The joint faculty loan agreements currently in place between Sandia, Los Alamos, and UNM enables staff members to teach at the university, thereby introducing students to career paths at the laboratories.
- RS21[21], founded by a former Sandia employee who separated from the laboratory through our Entrepreneurial Separation to Tech Transfer program,[22] integrates AI, data engineering, user experience, and modern software development methods to enable organizations to make data-driven decisions. Through strong collaboration, Sandia and RS21 are utilizing data science and AI to understand and solve complex challenges.

  The NMAIC envisions a future where collaboration, innovation, and excellence in AI drive national progress and prosperity and improve the quality of life for all.

Conclusion

In summary, the DOE laboratories, including Sandia, have historically been at the forefront of technological breakthroughs, particularly in computing innovations. Their pioneering development of advanced supercomputers and engagement in codesign activities have laid a solid historical foundation that should underscore the necessity of their role in driving future AI innovations forward.

Mr. Chairman and Members of the Committee, Sandia and our national lab peers are ready to continue executing in computing excellence and committed to engaging our academic and industry partners in jointly educating the future generation of AI engineers and designers. It will be our privilege to lead the nation's exploration, development, and safe use of AI in the interest of our taxpayers and our national security.

Thank you for convening this hearing, and I look forward to your questions.

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[20] https://psaap.llnl.gov/
[21] https://rs21.io/
[22] https://www.sandia.gov/labnews/2024/05/02/former-sandian-added-to-entrepreneurial-wall-of-fame/

Jennifer Gaudioso, PhD

Director, Center for Computing Research

Jennifer Gaudioso is Director of the Center for Computing Research at Sandia National Laboratories where she stewards the Center's portfolio of research from fundamental science to state—of-the-art applications. The Center's work includes computer system architecture (both hardware and software); enabling technology for modeling physical and engineering systems; and research in discrete mathematics, data analytics, cognitive modeling, and decision support materials. She is also the Program Executive for NNSA's Advanced Simulation and Computing Program at Sandia. Jen also serves on Sandia's AI Board of Directors.

Previously, she served as the Director of the Center for Computation and Analysis for National Security where she oversaw the use of systems analysis, cybersecurity, and data science capabilities to tackle complex national security challenges. In this role, Jen also led Sandia's Homeland Infrastructure Security and Resilience Program which was underpinned by "data to decision" capabilities.

Jen began her Sandia career in 2002 and, in 2010, she moved into management, leading the International Biological and Chemical Threat Reduction Program. Jen's leadership established Sandia as a critical contributor to the U.S. government's response to the Ebola outbreak in West Africa. The team's ground-breaking efforts were also acknowledged with a DOE Secretary of Energy Award. In her role as Senior Manager for Global Strategic Futures, Jen led development of the Global Security Division's mission, science and technology pipeline, and mission-aligned programs. She also led Sandia's contributions to the next-generation Nuclear Command, Control, and Communications (NC3) and coordinated a Sandia-wide emerging non-proliferation initiative at the interface of NA-10, NA-20, NA-80, and DOE-IN, earning a Department of Energy (DOE) Secretary of Energy Award for the team.

Jen served on two National Academies Committees addressing biodefense issues and was an MIT Seminar XXI Fellow. She has a PhD and a master's degree in physical chemistry from Cornell University and a bachelor's degree in chemistry from Bard College. Jen's time at Bard taught her to value diverse perspectives in problem-solving.

SUBMITTED STATEMENT OF

ADAM THIERER
RESIDENT SENIOR FELLOW, TECHNOLOGY AND INNOVATION
R STREET INSTITUTE

BEFORE THE

JOINT ECONOMIC COMMITTEE
UNITED STATES CONGRESS

HEARING ON

"ARTIFICIAL INTELLIGENCE AND ITS POTENTIAL TO FUEL ECONOMIC GROWTH AND IMPROVE GOVERNANCE"

JUNE 4, 2024

Chairman Heinrich, Vice Chairman Schweikert, and members of the Committee:

Thank you for the invitation to participate in this important hearing on "Artificial Intelligence and Its Potential to Fuel Economic Growth and Improve Governance." My name is Adam Thierer, and I am a senior fellow at the R Street Institute, where I focus on emerging technology issues. I also recently served as a commissioner on the U.S. Chamber of Commerce's Commission on Artificial Intelligence Competitiveness, Inclusion, and Innovation.[1]

Today I will discuss three points relevant to this hearing:

1. First, AI and advanced computational technologies can help fuel broad-based economic growth and sectoral productivity while also improving consumer health and welfare in important ways.
2. Second, to unlock these benefits, the United States needs to pursue a pro-innovation AI policy vision that can also help bolster our global competitive advantage and geopolitical security.
3. Third, we can advance these goals through an AI Opportunity Agenda that includes a learning period moratorium on burdensome new AI regulations.

I will address each point briefly, but I have included three appendices to my testimony offering more details.

AI Could Drive Economic Growth, Increase Sectoral Productivity, and Improve Human Well-Being

AI is set to become the "most important general-purpose technology of our era," and AI could revolutionize every segment of the economy in some fashion.[2] The potential exists for AI to drive explosive economic growth and productivity enhancements.[3] While predictions vary, analysts forecast that AI could deliver trillions in additional global economic activity and

[1] Commission on Artificial Intelligence Competitiveness, Inclusion, and Innovation, *Commission on Artificial Intelligence Competitiveness, Inclusion, and Innovation: Report and Recommendations*, U.S. Chamber of Commerce, March 2023. https://www.uschamber.com/assets/documents/CTEC_AICommission2023_Report_v6.pdf.

[2] Erik Brynjolfsson and Andrew McAfee, "The Business of Artificial Intelligence," *Harvard Business Review*, July 18, 2017. https://hbr.org/2017/07/the-business-of-artificial-intelligence.

[3] Tom Davidson, "Could Advanced AI Drive Explosive Economic Growth?," Open Philanthropy, Research Report, June 25, 2021. https://www.openphilanthropy.org/research/could-advanced-ai-drive-explosive-economic-growth; Ege Erdi and Tamay Besiroglu, "Explosive growth from AI automation: A review of the arguments," Arxiv, Oct. 1, 2023. https://arxiv.org/abs/2309.11690.

significantly boost annual GDP growth.[4] This would be over and above the $4 trillion of gross output that the U.S. Bureau of Economic Analysis says the U.S. digital economy already accounted for in 2022.[5] [*See* Appendix I]

But what really matters is what AI means for every American personally. AI is poised to revolutionize health outcomes, in particular. AI is already helping with early detection and treatment of cancers, strokes, heart disease, brain disease, sepsis, and other ailments. AI is also helping address organ failure, paralysis, vision impairments, and much more. The age of personalized medicine will be driven by AI advancement. [*See* Appendix 2]

AI can help make government more efficient, too.[6] Ohio Lt. Gov. Jon Husted recently used an AI tool to help sift through the state's code of regulations and eliminate 2.2 million words' worth of unnecessary and outdated regulations.[7] California Gov. Gavin Newsom just announced an effort to use generative AI tools to improve public services and cut 8 percent from the state's government operations budget.[8] And regulators are using AI to facilitate compliance with existing policies, such as post-market medical device surveillance.[9]

AI also holds the potential to achieve administrative savings for federal health insurance programs or, better yet, reduce the number of people dependent on them by identifying and treating ailments earlier.[10]

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[4] Jacques Bughin, et al., "Notes from the AI Frontier: Modeling the Impact of AI on the World Economy," McKinsey Global Institute, Discussion Paper, Sept. 4, 2018. https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy.

[5] U.S. Bureau of Economic Analysis, "U.S. Digital Economy: New and Revised Estimates, 2017–2022," Dec. 6, 2023. https://apps.bea.gov/scb/issues/2023/12-december/1223-digital-economy.htm.

[6] Richard Williams, "Can AI Help with Forever Regulations?," *Public Health Without Politics,* April 18, 2024. https://fixingfood.substack.com/p/can-ai-help-with-forever-regulations.

[7] Ned Oliver, "Ohio uses AI to eliminate unnecessary words in state administrative code," *Axios*, April 29, 2024. https://www.axios.com/local/columbus/2024/04/29/artificial-intelligence-ai-ohio-state-administrative-code-husted.

[8] Sophia Bollag, "Newsom announces $27.6 billion budget deficit — after state already cut $17 billion," *San Francisco Chronicle,* May 10, 2024. https://www.sfchronicle.com/politics/article/newsom-may-budget-19447474.php.

[9] Jessica Karins, "FDA Draws On AI For First-Ever Proactive Postmarket Surveillance Of Devices," *Inside Health Policy*, May 14, 2024. https://insidehealthpolicy.com/daily-news/fda-draws-ai-first-ever-proactive-postmarket-surveillance-devices.

[10] Mariam Baksh, "Sen. Rounds argues case for spending big on AI-enabled weapons systems, health care," *Inside AI Policy*, May 24, 2024. https://insideaipolicy.com/ai-daily-news/sen-rounds-argues-case-spending-big-ai-enabled-weapons-systems-health-care.

Computational Freedom Is Important for America's Geopolitical Competitiveness and Security

There is an important connection between AI and broader national objectives. A strong technology base is a key source of strength and prosperity, so it is essential that we do not undermine innovation and investment as the next great technological race gets underway with China and the rest of the world.[11]

Luckily, U.S. AI innovators are still in the lead. Had a Chinese operator launched a major generative AI model first, it would have been a "Sputnik moment" for America. Still, China has made its imperial ambitions clear with a goal to become the global leader in advanced computation by 2030, and it has considerable talent, data, and resources to power those ambitions.[12] Experts argue that "China's whole-of-society approach is challenging America's traditional advantages" in advanced technology.[13]

We need a pro-innovation national AI policy that will not only strengthen our economy and provide better products and jobs, but also bolster national security and allow our values of pluralism, personal liberty, individual rights, and free speech to shape global information platforms and markets.[14]

If fear-based policies impede America's AI development and diffusion, then China wins.[15]

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[11] James Pethokoukis, "What's Really at Stake If We Get AI Regulation Wrong," *Faster, Please!* Oct. 30, 2023. https://www.aei.org/articles/whats-really-at-stake-if-we-get-ai-regulation-wrong; American Edge Project, "American Innovation Under Siege: Venture Capital Data Reveal Risks From Rising Global Regulatory Overreach," April 2024. https://americanedgeproject.org/wp-content/uploads/2024/04/AEP-and-PitchBook-Study-March-2024.pdf.

[12] Paul Scharre, *Four Battlegrounds: Power in the Age of Artificial Intelligence* (New York: W. W. Norton & Company (2023); Mariano-Florentino Cuéllar and Matt Sheehan, "AI Is Winning the AI Race," *Foreign Policy*, June 19, 2023. https://foreignpolicy.com/2023/06/19/us-china-ai-race-regulation-artificial-intelligence; Remco Zwetsloot et al., "China is Fast Outpacing U.S. STEM PhD Growth," Center for Security and Emerging Technologies, *CSET Data Brief*, August 2021, https://cset.georgetown.edu/wp-content/uploads/China-is-Fast-Outpacing-U.S.STEM-PhD-Growth.pdf; "Just how good can China get at generative AI?," *The Economist*, May 9, 2023. https://www.economist.com/business/2023/05/09/just-how-good-can-china-get-at-generative-ai; Emerging Technology Observatory, "The state of global AI research," May 2, 2024. https://eto.tech/blog/state-of-global-ai-research.

[13] Graham Allison, et al., "The Great Tech Rivalry: China vs the U.S.," Harvard Kennedy School Belfer Center for Science and International Affairs, *Paper*, December 2021. https://www.belfercenter.org/sites/default/files/GreatTechRivalry_ChinavsUS_211207.pdf.

[14] Loren B. Thompson, "Why U.S. National Security Requires A Robust, Innovative Technology Sector," Lexington Institute, Oct. 8, 2020. https://www.lexingtoninstitute.org/why-u-s-national-security-requires-a-robust-innovative-technology-sector.

[15] Keegan McBride, "The Threat of "AI Safety" to American AI Leadership," *National Interest*, April 28, 2024. https://nationalinterest.org/blog/techland/threat-"Cai-safety"-american-ai-leadership-210780.

Protect the Freedom to Innovate with an "AI Opportunity Agenda"

To achieve the benefits AI offers and meet the rising global competition, America needs an AI Opportunity Agenda.

An AI Opportunity Agenda begins by reiterating that the freedom to innovate is the cornerstone of American technology policy and the key to unlocking the enormous potential of our nation's entrepreneurs and workers.[16]

As part of this Agenda, Congress should craft a learning period moratorium on new proposals, such as new AI-specific bureaucracies, licensing systems, or liability schemes, all of which would be counterproductive and undermine our nation's computational capabilities. [*See* Enclosure I]

In addition, this moratorium should preempt burdensome state and local regulatory enactments that conflict with our national AI policy framework.[17]

Next, Congress should require our government's existing 439 federal departments to evaluate their current policies toward AI systems with two purposes in mind. First, to ensure that they are not over-burdening algorithmic systems with outdated policies, and second, to determine how existing rules and regulations are capable of addressing the concerns that some have raised about AI. Taking inventory of existing rules and regulations can then allow policymakers to identify any gaps that Congress ought to address using targeted remedies.

Finally, an AI Opportunity Agenda requires an openness to new talent and competition.[18] With experts finding that a "talent war is brewing between the US and China," and that China is moving ahead in some important ways, we must take steps to attract and retain the world's best and brightest data scientists and computer engineers.[19]

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[16] Adam Thierer, "Flexible, Pro-Innovation Governance Strategies for Artificial Intelligence," *R Street Policy Study* No. 283 (April 20, 2023). https://www.rstreet.org/research/flexible-pro-innovation-governance-strategies-for-artificial-intelligence.

[17] Adam Thierer, "State and local meddling threatens to undermine the AI revolution," *The Hill*, Jan. 21, 2024. https://thehill.com/opinion/4420144-state-and-local-meddling-threatens-to-undermine-the-ai-revolution.

[18] Tina Huang and Zachary Arnold, "Immigration Policy and the Global Competition for AI Talent," Center for Security and Emerging Technology, June 2020. https://cset.georgetown.edu/publication/immigration-policy-and-the-global-competition-for-ai-talent; Connor O'Brien and Adam Ozimek, "Foreign-born skilled workers play a critical role in strategically significant industries," Economic Innovation Group, *Analysis*, April 2, 2024. https://eig.org/hsi-in-strategic-industries; Pierre Azoulay, et al., "Immigration and Entrepreneurship in the United States," American Economic Review, 2020. https://www.nber.org/papers/w27778.

[19] Isobel Asher Hamilton, "The Next Big US-China Trade War is Over AI Talent," *The Daily Upside*, May 17, 2024. https://www.thedailyupside.com/technology/artificial-intelligence/the-next-big-us-china-trade-war-is-over-ai-talent; Stuart Anderson, "AI Commission: Immigrants Key To America's Tech Competitiveness," *Forbes*, March 3,

Conclusion

In sum, America's AI policy should be rooted in patience and humility instead of a rush to over-regulate based on hypotheticals and worst-case thinking.[20] We are still very early in the AI lifecycle, and there is still no consensus on how to define the term, let alone legislate beyond establishing definitions.[21]

To ensure America leads this next great technological revolution, Congress must once again uphold the freedom to innovate and craft a flexible, risk-based AI policy vision to ensure we can meet global competition, advance economic opportunity, and improve the well-being of every citizen.

Thank you for holding this hearing and for your consideration of my views. I look forward to any questions you may have.

See pages 6-12 for Appendix 1, "How AI Could Drive Economic Growth and Sectoral Productivity."

See pages 13-21 for Appendix 2, "AI's Potential for Improving Medicine and Health Outcomes."

See pages 22-25 for Enclosure 1, "Getting AI Policy Right Through a Learning Period Moratorium," R Street Institute, May 29, 2024. https://www.rstreet.org/commentary/getting-ai-policy-right-through-a-learning-period-moratorium.

2021. https://www.forbes.com/sites/stuartanderson/2021/03/03/ai-commission-immigrants-key-to-americas-tech-competitiveness.

[20] Adam Thierer, "A balanced AI governance vision for America," *The Hill*, April 16, 2023. https://thehill.com/opinion/congress-blog/3953916-a-balanced-ai-governance-vision-for-america.

[21] U.S. Government Accountability Office, "Artificial Intelligence: Emerging Opportunities, Challenges, and Implications," *Technology Assessment*, GAO-18-142SP, (March 28, 2018), p. 15. https://www.gao.gov/products/gao-18-142sp.

Appendix 1: How AI Could Drive Economic Growth and Sectoral Productivity

Over the past half century, there have been waves of both great excitement and disillusionment about the prospects for AI advancement.[22] AI historians often speak of the many AI "springs" and "winters"—what one might think of as AI booms and busts—that have come and gone.[23]

It did not help that some of AI's early pioneers over-exuberantly predicted that powerful "superintelligence" would be with us in short order. In the late 1960s, for example, noted AI researchers confidentially predicted that "machines will be capable, within twenty years, of doing any work a man can do," (Herbert A. Simon), and that "[i]n from three to eight years we will have a machine with the general intelligence of an average human being" (Marvin Minsky).[24] Such exuberance was replaced by pessimism in the 1970s, resulting in a "winter" period for AI research and investment.

Today, however, AI is generally thought to be in the midst of another spring as enthusiasm grows around specific capabilities and applications. Economists predict that AI is set to become the "most important *general-purpose technology* of our era."[25] General-purpose technologies will become intertwined with almost every other economic sector and used ubiquitously throughout society.[26] These developments are coming about because we live in an era of rapid-fire *combinatorial innovation* in which new technologies are building on top of one another in a symbiotic fashion, further accelerating their development and sophistication.[27]

Improving Many Sectors, Including Government

The power of algorithmic technologies is all around us in products and services such as speech and image recognition tools on our smartphones and the recommender systems many media providers and other companies use to tailor goods, services, and content to our interests. AI will be used by almost all organizations to help improve analytics and marketing, enhance customer

[22] Robert D. Atkinson, "'It's Going to Kill Us!' and Other Myths about the Future of Artificial Intelligence," Information Technology and Innovation Foundation, June 2016. http://www2.itif.org/2016-myths-machine-learning.pdf.

[23] Melanie Mitchell, "Why AI is Harder Than We Think," April 28, 2021. https://arxiv.org/pdf/2104.12871.pdf.

[24] Gil Press, "A Very Short History Of Artificial Intelligence (AI)," *Forbes*, Dec. 30. 2016. https://www.forbes.com/sites/gilpress/2016/12/30/a-very-short-history-of-artificial-intelligence-ai.

[25] Erik Brynjolfsson and Andrew McAfee, "The Business of Artificial Intelligence," *Harvard Business Review*, July 18, 2017. https://hbr.org/2017/07/the-business-of-artificial-intelligence.

[26] Timothy F. Bresnahan and M. Trajtenberg, "General Purpose Technologies 'Engines of Growth'?," *Journal of Econometrics* 65:1 (1995), pp. 83-108.

[27] Hal R. Varian, "Computer Mediated Transactions," *American Economic Review* 100:2 (May 2010). https://www.aeaweb.org/articles?id=10.1257/aer.100.2.1.

service, and boost sales or performance in various new ways. And it will completely upend the way production and work is done in countless fields and professions.

AI and ML capabilities are operating behind the scenes to help with fraud and spam detection, computer virus filtering, content management/moderation,[28] mapping/navigation,[29] travel planning,[30] weather forecasting and natural disaster prediction,[31] warehouse automation/inventory management,[32] supply chain management,[33] and various other logistics.[34] For example, in 2021, McKinsey & Company estimated that "[s]uccessfully implementing AI-enabled supply-chain management has enabled early adopters to improve logistics costs by 15 percent, inventory levels by 35 percent, and service levels by 65 percent, compared with slower-moving competitors."[35] These productivity enhancements will likely accelerate as algorithmic techniques are further refined.

AI and ML capabilities also power most of the devices that make up the so-called *Internet of Things* and various connected "smart" devices, including many wearable technologies and other devices with embedded sensors.[36] Another related term here is *ambient computing*[37] or *ubiquitous computing*, which essentially means "using computers without knowing that you are

[28] Alex Feerst, "The Use of AI in Online Content Moderation," American Enterprise Institute (September 2022). https://platforms.aei.org/the-use-of-ai-in-online-content-moderation.

[29] Arianna Johnson, "You're Already Using AI: Here's Where It's At In Everyday Life, From Facial Recognition To Navigation Apps," *Forbes*, April 14, 2023. https://www.forbes.com/sites/ariannajohnson/2023/04/14/youre-already-using-ai-heres-where-its-at-in-everyday-life-from-facial-recognition-to-navigation-apps/?sh=1996a1f927ac.

[30] Jacob Passy, "Expedia Wants ChatGPT to Be Your Travel Adviser," *The Wall Street Journal*, April 4, 2023. https://www.wsj.com/articles/expedia-chatgpt-ai-travel-app-22ffd00.

[31] Robin Fearon, "AI Tools Help to Predict Extreme Weather and Save Lives," *Discovery*, Aug. 2, 2022. https://www.discovery.com/science/ai-tools-help-to-predict-extreme-weather; "Deep learning can predict tsunami impacts in less than a second," *Phys.org*, Dec. 27, 2022. https://phys.org/news/2022-12-deep-tsunami-impacts.html; "NASA-enabled AI Predictions May Give Time to Prepare for Solar Storms," NASA, March 30, 2023. https://www.nasa.gov/feature/goddard/2023/sun/nasa-enabled-ai-predictions-may-give-time-to-prepare-for-solar-storms.

[32] "How AI-Powered Robots Fulfill Your Online Orders," *Last Week in AI*, Jan. 25, 2022. https://lastweekin.ai/p/robot-picking.

[33] Christopher Mims, "How to Build AI That Actually Works for Your Business," *The Wall Street Journal*, July 23, 2022. https://www.wsj.com/articles/how-to-build-ai-that-actually-works-for-your-business-11658548830.

[34] Cem Dilmegan, "Top 15 Use Cases and Applications of AI in Logistics in 2022," July 9, 2020, updates, May 29, 2022. https://research.aimultiple.com/logistics-ai.

[35] "Succeeding in the AI Supply-chain Revolution," *Article*, April 30, 2021. https://www.mckinsey.com/industries/metals-and-mining/our-insights/succeeding-in-the-ai-supply-chain-revolution.

[36] Adam Thierer, "The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation," *Richmond Journal of Law and Technology* 21:6 (2015). http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2494382.

[37] Christopher Mims, "Why the Future of the Computer Is Everywhere, All the Time," *The Wall Street Journal*, Oct. 29, 2022. https://www.wsj.com/articles/computer-technology-ambient-computing-11666992784.

using one," or using smart systems without explicitly calling them computers.[38] These technologies have powerful health and medical applications, among other things.

Meanwhile, various AI-powered robotic technologies are already at work in many industrial sectors.[39] AI, ML, and advanced robotics technologies promise to revolutionize many fields including advertising and marketing,[40] agriculture,[41] archeology,[42] auto safety,[43] aviation,[44] education,[45] endangered species protection,[46] energy and climate solutions,[47] entertainment,[48]

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[38] Ethem Alpaydin, Machine Learning (The MIT Press, 2021), p. 9.

[39] *A Roadmap for US Robotics From Internet to Robotics: 2020 Edition*, Sept. 9, 2020. https://www.hichristensen.com/pdf/roadmap-2020.pdf.

[40] Suzanne Vranica, "How AI Has the Advertising Business Excited—and Worried," *The Wall Street Journal*, June 19, 2023. https://www.wsj.com/articles/ai-advertising-industry-tools-risks-f880420a.

[41] Louis Columbus, "10 Ways AI Has the Potential To Improve Agriculture In 2021," *Forbes*, Feb. 17, 2021. https://www.forbes.com/sites/louiscolumbus/2021/02/17/10-ways-ai-has-the-potential-to-improve-agriculture-in-2021/?sh=454d747a7f3b; Loukia Papadopoulos, "New Farming Robot Uses AI to Kill 100,000 Weeds per Hour," *Interesting Engineering*, April 27, 2021. https://interestingengineering.com/innovation/new-farming-robot-uses-ai-to-kill-100000-weeds-per-hour; Blake Hurst, "As Rural America Declines, There Are Still Plenty of Farmers," *The Wall Street Journal*, March 10, 2024. https://www.wsj.com/articles/as-rural-america-declines-there-are-still-plenty-of-farmers-agricultural-census-3794ce04.

[42] Diego Lopez Marina, "How AI helped archaeologists in Peru discover 4 new Nazca Line geoglyphs," *Peru Reports*, June 14, 2023. https://perureports.com/how-ai-helped-archaeologists-in-peru-discover-4-new-nazca-line-geoglyphs/10165.

[43] Mobility, "Artificial Intelligence Reshaping the Automotive Industry," *Future Bridge*, April 29, 2020. https://www.futurebridge.com/industry/perspectives-mobility/artificial-intelligence-reshaping-the-automotive-industry.

[44] Kelsey Reichmann, "How Is the Aviation Industry Enabling Innovation with Artificial Intelligence?," *Aviation Today*, Dec. 14, 2020. https://www.aviationtoday.com/2020/12/14/aviation-industry-enabling-innovation-artificial-intelligence.

[45] Sara Randazzo, "Can Tech Boost Reading? Literacy Tools Come to Classrooms," *The Wall Street Journal*, Aug. 7, 2022. https://www.wsj.com/articles/literacy-technology-offers-new-ways-to-teach-kids-to-read-11659879846; Frederick M. Hess, "AI and the Future of Schooling," *The Ripon Forum* 57:3 (June 2023). https://riponsociety.org/article/ai-and-the-future-of-schooling.

[46] Justine Calma, "How Machine Learning Could Help Save Threatened Species from Extinction," *The Verge*, Aug. 4, 2022. https://www.theverge.com/23290902/machine-learning-conservation-data-deficient-species-iucn-red-list-extinction-threat.

[47] Franklin Wolfe, "How Artificial Intelligence Will Revolutionize the Energy Industry," Harvard University Graduate School of Arts and Sciences, *Special Edition on Artificial Intelligence*, Aug. 28, 2017. https://sitn.hms.harvard.edu/flash/2017/artificial-intelligence-will-revolutionize-energy-industry; Scott Patterson, "Why AI Is the Next Big Bet for Climate Tech," *The Wall Street Journal*, June 1, 2023. https://www.wsj.com/articles/ai-climate-change-clean-energy-investment-e4242a23; Vidya Nagalwade, "Machine Learning can be used to improve energy use in cities," *TechExplorist*, May 7, 2023. https://www.techexplorist.com/machine-learning-used-improve-energy-use-cities/60013.

[48] Anne Hobson, "Artificial Intelligence is Set to Remake Event Experiences," *The Hill*, Jan. 11, 2017. https://www.rstreet.org/2017/01/11/artificial-intelligence-is-set-to-remake-event-experiences.

financial services,[49] legal services,[50] retail,[51] transportation,[52] and others.[53] Going forward, every segment of the economy will be touched by AI and robotics in some fashion; therefore, it should be equally clear that public policy will be transformed in the process.

AI will affect government processes, too.[54] In April 2024, Ohio Lt. Gov. Jon Husted used an AI tool to help sift through the state's code of regulations and eliminate 2.2 million words' worth of unnecessary and outdated regulations.[55] In May 2024, California Gov. Gavin Newsom announced an effort to use generative AI tools to improve public services and cut 8 percent from the state's government operations budget.[56] AI is also being used by regulators to facilitate compliance with existing policies. For example, the U.S. Food and Drug Administration (FDA) has been using AI for post-market medical device surveillance.[57]

[49] Suparna Biswas, et al., "AI-Bank of the Future: Can Banks Meet the AI Challenge?," McKinsey & Company, Sept. 19, 2020. https://www.mckinsey.com/industries/financial-services/our-insights/ai-bank-of-the-future-can-banks-meet-the-ai-challenge.

[50] Pierre Colombo, et al., "SaulLM-7B: A pioneering Large Language Model for Law," *arXiv*, March 7, 2024. https://arxiv.org/abs/2403.03883v1.

[51] Ben Forgan, "What Robots Can Do for Retail," *Harvard Business Review*, Oct. 1, 2020. https://hbr.org/2020/10/what-robots-can-do-for-retail.

[52] Maria Lopez Conde and Ian Twinn, "How Artificial Intelligence is Making Transport Safer, Cleaner, More Reliable and Efficient in Emerging Markets," International Finance Corporation, *Note* 75 (November 2019). https://www.ifc.org/wps/wcm/connect/7c21eaf5-7d18-43b7-bce1-864e3e42de2b/EMCompass-Note-75-AI-making-transport-safer-in-Emerging-Markets.pdf.

[53] Dan Castro and Joshua New, *The Promise of Artificial Intelligence* (Center for Data Innovation, October 2016). https://datainnovation.org/2016/10/the-promise-of-artificial-intelligence.

[54] Richard Williams, "Can AI Help with Forever Regulations?," *Public Health Without Politics*, April 18, 2024. https://fixingfood.substack.com/p/can-ai-help-with-forever-regulations.

[55] Ned Oliver, "Ohio uses AI to eliminate unnecessary words in state administrative code," *Axios*, April 29, 2024. https://www.axios.com/local/columbus/2024/04/29/artificial-intelligence-ai-ohio-state-administrative-code-husted.

[56] Sophia Bollag, "Newsom announces $27.6 billion budget deficit — after state already cut $17 billion," *San Francisco Chronicle*, May 10, 2024. https://www.sfchronicle.com/politics/article/newsom-may-budget-19447474.php.

[57] Jessica Karins, "FDA Draws On AI For First-Ever Proactive Postmarket Surveillance Of Devices," *Inside Health Policy*, May 14, 2024. https://insidehealthpolicy.com/daily-news/fda-draws-ai-first-ever-proactive-postmarket-surveillance-devices.

AI, Economic Growth, and Productivity Gains

The potential exists for AI to drive explosive economic growth and productivity enhancements.[58] While predictions vary, most analysts believe that "AI will have a significant economic impact."[59]

- According to Grand View Research, a market research and consulting company based in India and the United States, the global AI market was valued at $93.5 billion in 2021 and is projected to expand at a compound annual growth rate of 38.1 percent from 2022 to 2030.[60]
- A 2018 McKinsey study estimated that "AI has the potential to deliver additional global economic activity of around $13 trillion by 2030, or about 16 percent higher cumulative GDP compared with today. This amounts to 1.2 percent additional GDP growth per year."[61] In the summer of 2023, McKinsey released another study estimating that generative AI alone could add up to $4.4 trillion of value to the global economy annually.[62]
- An earlier PwC report forecast a $15.7 trillion potential contribution to the global economy by 2030.[63]
- A 2023 Goldman Sachs report predicted AI could help boost U.S. labor productivity by 1.5 percentage points each year, while Peterson Institute for International Economics estimates AI will add an additional 1.0 percentage points to productivity growth over the

[58] Tom Davidson, "Could Advanced AI Drive Explosive Economic Growth?," Open Philanthropy, *Research Report*, June 25, 2021. https://www.openphilanthropy.org/research/could-advanced-ai-drive-explosive-economic-growth; Ege Erdi and Tamay Besiroglu, "Explosive growth from AI automation: A review of the arguments," Arxiv, Oct. 1, 2023. https://arxiv.org/abs/2309.11690; Aden Barton, "The case for—and against—rapid AI-driven growth," *Understanding AI*, Jan. 30, 2024. https://www.understandingai.org/p/the-case-forand-againstrapid-ai-driven.

[59] Marcin Szczepański, "Economic Impacts of Artificial Intelligence (AI)," European Parliamentary Research Service, *Briefing* PE 637.967 (July 2019), p. 3. https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/637967/EPRS_BRI(2019)637967_EN.pdf.

[60] Grand View Research, "Artificial Intelligence Market Size Report, 2022-2030," GVR-1-68038-955-5, April 2022. https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-market.

[61] Jacques Bughin, et al., "Notes from the AI Frontier: Modeling the Impact of AI on the World Economy," McKinsey Global Institute, *Discussion Paper*, Sept. 4, 2018. https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy.

[62] Michael Chui, et al., "The economic potential of generative AI: The next productivity frontier," McKinsey Global Institute, June 2023. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#introduction; James Manyika and Michael Spence, "The Coming AI Economic Revolution: Can Artificial Intelligence Reverse the Productivity Slowdown?," *Foreign Affairs*, (November/December 2023). https://www.foreignaffairs.com/world/coming-ai-economic-revolution.

[63] PwC, "Sizing the prize: What's the real value of AI for your business and how can you capitalise?," 2017. https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html.

2025-2028 timeframe.[64] Goldman also says generative AI could drive a 7 percent (or almost $7 trillion) increase in global GDP over a 10-year period.[65]

- Another leading economist with a specialization in technology argues that AI will double productivity in the coming decade.[66]

Even if AI's economic impact falls far short of those estimates, it would still generate enormous growth opportunities across many segments of the economy. AI is also invigorating new types of tech competition, especially from open-source players and platforms.[67] It also promises to benefit small businesses by creating new products and jobs. A U.S. Chamber of Commerce report finds that 87 percent of small businesses reported increased efficiency due to new technology platforms and that one in four small businesses are already using AI.[68]

The Past Can Be Prologue

If this potential for explosive growth still sounds outlandish, consider that, in 1998, Nobel Prize-winning economist Paul Krugman infamously predicted that the internet's impact on the global economy would be "no greater than the fax machine's."[69] President Bill Clinton thought differently, predicting that the internet's potential was "nothing short of revolutionary" and that "[i]n just a few years, it will generate hundreds of billions of dollars in goods and services."[70]

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[64] Joseph Briggs and Devesh Kodnani, "The Potentially Large Effects of Artificial Intelligence on Economic Growth," Goldman Sachs, *Global Economics Analyst*, March 26, 2023. https://www.gspublishing.com/content/research/en/reports/2023/03/27/d64e052b-0f6e-45d7-967b-d7be35fabd16.htmlhttps://www.gspublishing.com/content/research/en/reports/2023/03/27/d64e052b-0f6e-45d7-967b-d7be35fabd16.html; Adam Posen, "The Keynote Economic Forecast by Dr. Adam Posen, Peterson Institute - Endowments & Foundations Roundtable West 2024," *Institutional Investor*, Feb. 8, 2024. https://iinetworks.com/content/keynote-economic-forecast-dr-adam-posen-peterson-institute-endowments-foundations.

[65] Goldman Sachs, "Generative AI could raise global GDP by 7%," April 5, 2023. https://www.goldmansachs.com/intelligence/pages/generative-ai-could-raise-global-gdp-by-7-percent.html.

[66] Geoff Colvin, "A top economist who studies AI says it will double productivity in the next decade: 'You need to embrace this technology and not resist it,'" *Fortune*, Sept. 26, 2023. https://fortune.com/2023/09/26/ai-economist-erik-brynjolfsson-productivity-boom-labor.

[67] Betsy Masiello and Derek Slater, "Will Open Source AI Shift Power from 'Big Tech'? It Depends," *Tech Policy Press*, June 16, 2023. https://techpolicy.press/will-open-source-ai-shift-power-from-big-tech-it-depends; Belle Lin, "Open-Source Companies Are Sharing Their AI Free. Can They Crack OpenAI's Dominance?," *The Wall Street Journal*, March 21, 2024. https://www.wsj.com/articles/open-source-companies-are-sharing-their-ai-free-can-they-crack-openais-dominance-26149e9c.

[68] U.S. Chamber of Commerce, "Empowering Small Business: The Impact of Technology on U.S. Small Business (Second Edition)," Sept. 14, 2023. https://www.uschamber.com/small-business/smallbusinesstech.

[69] David Emery, "Did Paul Krugman Say the Internet's Effect on the World Economy Would Be 'No Greater Than the Fax Machine's'?," *Snopes*, June 7, 2018. https://www.snopes.com/fact-check/paul-krugman-internets-effect-economy.

[70] The White House, "Remarks by the President in Announcement of Electronic Commerce Initiative," July 1, 1997. https://clintonwhitehouse4.archives.gov/WH/New/Commerce/remarks.html.

Clinton's optimism was vindicated. Electronic commerce exploded, and digital innovation became the foundation of significant economic growth, new jobs, and boundless speech opportunities. According to the U.S. Bureau of Economic Analysis, in 2022, the U.S. digital economy accounted for over $4 trillion of gross output, $2.6 trillion of value added (translating to 10 percent of U.S. GDP), $1.3 trillion of compensation, and 8.9 million jobs.[71]

These astonishing results came about thanks to wise bipartisan public policies formulated by the Clinton administration and a Republican-led Congress.[72] Freedom to innovate was America's policy default for digital services, and burdensome state regulations (and even taxes) were preempted to a degree.[73] Federal policymakers made a firm break with the old regulatory models of the analog era, which had constrained competition. The results speak for themselves. In addition to generating remarkable economic output and opportunity, this approach resulted in global dominance of digital technology markets. Today, 18 of the 25 largest digital companies in the world are U.S.-based, and it is difficult to name any from Europe.[74] In essence, as a recent *Wall Street Journal* headline observed, the European Union now "regulates its way to last place" on digital technology.[75]

This should serve as a cautionary tale for U.S. policymakers. America got policy right for the internet, but the sort of approach adopted for AI remains to be seen. If we want U.S. firms to once again lead the world—and help counter China's looming influence on AI markets in particular—it is essential for policymakers to strike the right policy balance once again.[76]

[71] U.S. Bureau of Economic Analysis, "U.S. Digital Economy: New and Revised Estimates, 2017–2022," Dec. 6, 2023. https://apps.bea.gov/scb/issues/2023/12-december/1223-digital-economy.htm.

[72] "The Framework for Global Electronic Commerce," The White House, July 1997. https://clintonwhitehouse4.archives.gov/WH/New/Commerce.

[73] Adam Thierer, "Getting AI Innovation Culture Right," *R Street Policy Study* No. 281 (March 30, 2023). https://www.rstreet.org/research/getting-ai-innovation-culture-right.

[74] "Largest tech companies by market cap," Companies Market Cap, last accessed Feb. 1, 2024. https://companiesmarketcap.com/tech/largest-tech-companies-by-market-cap.

[75] Greg Ip, "Europe Regulates Its Way to Last Place," *The Wall Street Journal*, Jan. 31, 2024. https://www.wsj.com/economy/europe-regulates-its-way-to-last-place-2a03c21d.

[76] Daniel Gouré, "The New Arsenal of Democracy: The U.S. Commercial High-Tech Industry's Role In Countering The China Threat," Lexington Institute, June 24, 2022. https://www.lexingtoninstitute.org/the-new-arsenal-of-democracy-the-u-s-commercial-high-tech-industrys-role-in-countering-the-china-threat.

Appendix 2: AI's Potential for Improving Medicine and Health Outcomes

AI is already revolutionizing the field of healthcare and the practice of medicine.[77] Increasingly powerful algorithmic systems—often combined with new wearable technologies—are already helping many people better monitor their health and fitness.[78] Generative AI tools will also supplement remote medicine with virtual health care assistants.[79] More sophisticated AI tools are allowing doctors and scientists to create highly personalized care options and develop new medical treatments tailored to the unique needs of each patient.[80] As two medical experts and authors of *The Age of Scientific Wellness* have noted, "those who fold these systems into their practices will be doing their patients (and themselves) a great service" because "they are akin to having not one expert but thousands upon thousands, all working together at top speed. Because AI is generally inexpensive to run once it has been developed, the potential for optimizing care and making it radically cheaper is striking."[81]

AI and ML-enabled technologies are already having a profound impact on public health. Machine learning refers to the processes by which a computer can train and improve an algorithm or computer model without step-by-step human involvement.[82]

In 2022, for example, an AI technology from Google DeepMind called AlphaFold was able to model the structure of nearly all known proteins, representing "a significant advance in biology that will accelerate drug discovery and help address problems such as sustainability and food insecurity."[83] Researchers from the Fundamental AI Research Team at Meta have a competing

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[77] J. Hunter Young, et al., "How Algorithms Could Improve Primary Care," *Harvard Business Review*, May 6, 2022. https://hbr.org/2022/05/how-algorithms-could-improve-primary-care; PwC, *What Doctor? Why AI and Robotics Will Define New Health* (2017). https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html; Jordan Reimschisel, "The Robot That Saved My Life," *Medium*, April 27, 2017. https://aboveintelligent.com/that-robot-saved-my-life-6499d9a2f384.

[78] Josh Libertore, "Beyond ChatGPT: How AI Is Transforming Fitness & Human Performance," *Athletetech News* July 18, 2023. https://athletechnews.com/beyond-chatgpt-how-ai-is-transforming-fitness-human-performance.

[79] Soha Rawas and Agariadne Dwinggo Samala, "Generative AI as Virtual Healthcare Assistant for Enhancing Patient Care Quality," *International Journal of Online and Biomedical Engineering* 20(5) (March 2024). https://www.researchgate.net/publication/379001530_Generative_AI_as_Virtual_Healthcare_Assistant_for_Enhancing_Patient_Care_Quality.

[80] Anna Megdell, "Machine Learning Creates Opportunity for New Personalized Therapies," University of Michigan Health Lab, *Lab Notes*, Sept. 27, 2022. https://labblog.uofmhealth.org/lab-notes/machine-learning-creates-opportunity-for-new-personalized-therapies.

[81] Lee Hood and Nathan Price, "The AI Will See You Now," *The Wall Street Journal*, April 7, 2023. https://www.wsj.com/articles/the-ai-will-see-you-now-5f8fba14.

[82] Ethem Alpaydin, *Machine Learning* (The MIT Press, 2021), p. 16.

[83] Steven Rosenbush, "DeepMind AI Lab Predicts Structure of Most Proteins," *The Wall Street Journal*, July 28, 2022. https://www.wsj.com/articles/deepmind-ai-lab-predicts-structure-of-most-proteins-11659048143.

ML-created database of 617 million predicted protein structures.[84] These advances are leading to what some researchers call a "protein design revolution" driving "the next quantum leap in the biotech industry," which could completely transform medicine.[85] This competition continues, as DeepMind announced the latest and more powerful iteration of AlphaFold in April 2024.[86]

A Broad Range of Health Benefits

AI, ML, and robotics are driving many other major medical advances today, becoming a crucial part of early detection of various ailments and diseases.[87] "Artificial-intelligence algorithms are processing vast troves of data in electronic medical records, searching for patterns to predict future outcomes and recommend treatments," notes a *Wall Street Journal* medical reporter.[88] "They are creating early-warning systems to help hospital staff spot subtle but serious changes in a patient's condition that aren't always visible or noticed in a busy unit, and predicting which patients about to be discharged from the hospital are at highest risk of being readmitted."[89]

Here are some other specific examples of how AI, ML, and robotics technologies are already advancing medical science and helping improve health outcomes.

- *Organ donation*: In the field of organ donations, "[p]aired kidney donation is one of the great success stories of artificial intelligence," helping doctors and patients by taking "an incredibly complex problem and solves it faster and with fewer errors than humans can, and saving more lives as a result."[90]
- *Heart attack detection and treatment*: AI and ML tools are helping detect and treat heart disease and heart attacks, a leading cause of death globally.[91] Scientists at Cedars-Sinai

[84] Justin Jackson, "Predicting protein folding from single sequences with Meta AI ESM-2," *Phys.org*, March 23, 2023. https://phys.org/news/2023-03-protein-sequences-meta-ai-esm-.html.

[85] Sidney P Walker, et al., "Arming Yourself for The In Silico Protein Design Revolution," *Trends in Biotechnology* 39:7 (July 2021), pp. 651-664. https://pubmed.ncbi.nlm.nih.gov/33139074; Ewen Callaway, "AI tools are designing entirely new proteins that could transform medicine," *Nature*, July 2023. https://www.nature.com/articles/d41586-023-02227-y.

[86] James O'Donnell, "Google DeepMind's new AlphaFold can model a much larger slice of biological life," *MIT Technology Review*, May 8, 2024. https://www.technologyreview.com/2024/05/08/1092183/google-deepminds-new-alphafold-can-model-a-much-larger-slice-of-biological-life.

[87] Sumathi Reddy, "How Doctors Use AI to Help Diagnose Patients," *The Wall Street Journal*, Feb. 28, 2023. https://www.wsj.com/articles/how-doctors-use-ai-to-help-diagnose-patients-ce4ad025.

[88] Laura Landro, "How Hospitals Are Using AI to Save Lives," *The Wall Street Journal*, April 10, 2022. https://www.wsj.com/articles/how-hospitals-are-using-ai-to-save-lives-11649610000.

[89] Ibid.

[90] Corinne Purtill, "How AI Changed Organ Donation in the US," *Quartz*, Sept. 10, 2018. https://qz.com/1383083/how-ai-changed-organ-donation-in-the-us.

[91] "Researchers Use AI to Triage Patients with Chest Pain," *Science Daily*, Jan. 23, 2023. https://www.sciencedaily.com/releases/2023/01/230117110422.htm; Paul McClure, "Machine learning algorithm a

developed an algorithmic tool in 2022 that can quantify coronary plaque buildup in five to six seconds compared to at least 25 to 30 minutes before.[92] This will greatly improve the ability to predict who will have a heart attack. Other researchers have developed AI tools to help improve personalized treatment for women who have had heart attacks.[93] Women who suffer a heart attack have a higher mortality rate than men, often because their symptoms are not properly understood or diagnosed. Meanwhile, the British National Health Service recently started using a new AI tool that can detect heart disease in just 20 seconds while patients are in an MRI scanner, compared with the 13 minutes or more it usually takes doctors to analyze images manually after performing a scan.[94]

- *Cancers*: President Richard Nixon declared a national "war on cancer" over 50 years ago.[95] More recently, the Obama and Biden administrations pushed for a "cancer moonshot."[96] Unfortunately, cancers remain the second leading causes of death in the United States,[97] claiming 602,350 lives in 2020 alone.[98] AI and ML-enabled technologies are poised to help reduce that staggering death toll. Mayo Clinic researchers have shown how ML models can help diagnose and treat pancreatic cancer at an earlier stage.[99] Pancreatic cancer is the third leading cause of cancer deaths, claiming 46,774 lives in 2020.[100] British scientists have recently reported on new AI software that can spot signs of pre-cancer during endoscopies in 92 percent of patients, which could significantly lower deaths from esophageal cancer.[101] AI/ML techniques are also helping with early

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fast, accurate way of diagnosing heart attack," *New Atlas*, May 15, 2023. https://newatlas.com/health-wellbeing/code-acs-machine-learning-algorithm-accurate-heart-attack-diagnosis.

[92] Cedars-Sinai, "Artificial Intelligence Tool May Help Predict Heart Attacks," March 22, 2022, https://www.cedars-sinai.org/newsroom/artificial-intelligence-tool-may-help-predict-heart-attacks.

[93] University of Zurich, "Artificial Intelligence Improves Treatment in Women with Heart Attacks," *ScienceDaily*, Aug. 29, 2022. www.sciencedaily.com/releases/2022/08/220829112918.htm.

[94] Tammy Lovell, "NHS rolls out AI tool which detects heart disease in 20 seconds," *Health Care IT News*, March 16, 2022. https://www.healthcareitnews.com/news/emea/nhs-rolls-out-ai-tool-which-detects-heart-disease-20-seconds.

[95] Colin Farrelly, "50 years of the 'war on cancer': lessons for public health and geroscience," *Geroscience* 43:3 (June 2021), pp. 1229-1235. https://pubmed.ncbi.nlm.nih.gov/33860442.

[96] "Cancer Moonshot," The White House, last accessed June 5, 2023. https://www.whitehouse.gov/cancermoonshot.

[97] National Center for Health Statistics, "Leading Causes of Death," last accessed June 5, 2023. https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm.

[98] Centers for Disease Control and Prevention, "An Update on Cancer Deaths in the United States," Feb. 28, 2022. https://www.cdc.gov/cancer/dcpc/research/update-on-cancer-deaths.

[99] Shania Kennedy, "Mayo Clinic ML Can Predict Pancreatic Cancer Earlier than Usual Methods," *Health IT Analytics*, July 19, 2022. https://healthitanalytics.com/news/mayo-clinic-ml-can-predict-pancreatic-cancer-earlier-than-usual-methods.

[100] Centers for Disease Control and Prevention. https://www.cdc.gov/cancer/dcpc/research/update-on-cancer-deaths.

[101] Cameron Henderson, "UK Scientists Invent an Artificial Eye Which Can Pick up Early Oesophageal Cancer," *Daily Mail*, July 23, 2022. https://www.dailymail.co.uk/health/article-11041985/British-scientists-invent-artificial-eye-pics-deadly-throat-cancer.html.

detection and treatment of lung cancer,[102] breast cancer,[103] brain cancer,[104] cervical cancer,[105] and many other types of cancer[106] (including undiagnosable cancers[107]), aided by increasingly personalized screening techniques.[108] The FDA has started approving more AI-powered medical devices that can help facilitate early detection of the most prevalent cancers.[109] AI-enabled cancer detection tools can help alleviate some of the workload that human radiologists and other cancer doctors face.[110]

- *Sepsis and superbugs:* Recent medical studies have also documented how AI-powered monitoring systems are helping detect antibiotic-resistant "superbugs"[111] and sepsis,[112]

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[102] Elizabeth Svoboda, "Artificial Intelligence is Improving the Detection of Lung Cancer," *Nature*, Nov. 18, 2020. https://www.nature.com/articles/d41586-020-03157-9; Berkeley Lovelace Jr., et al., "Promising new AI can detect early signs of lung cancer that doctors can't see," NBC News, April 11, 2023. https://www.nbcnews.com/health/health-news/promising-new-ai-can-detect-early-signs-lung-cancer-doctors-cant-see-rcna75982.

[103] Erin McNemar, "Artificial Intelligence Advances Breast Cancer Detection," *Health IT Analytics*, Oct. 7, 2021. https://healthitanalytics.com/news/artificial-intelligence-advances-breast-cancer-detection; Georgina Torbet, "Google's AI can detect breast cancer more accurately than experts," *Engadget*, Jan. 1, 2020. https://www.engadget.com/2020-01-01-googles-ai-can-detect-breast-cancer-more-accurately-than-expert.html; Adam Satariano and Cade Metz, "Using A.I. to Detect Breast Cancer That Doctors Miss," *The New York Times*, March 6, 2023. https://www.nytimes.com/2023/03/05/technology/artificial-intelligence-breast-cancer-detection.html; Ava Sasani, "New AI tool can help treat brain tumors more quickly and accurately, study finds," *The Guardian*, July 7, 2023. https://www.theguardian.com/science/2023/jul/07/brain-tumors-gliomas-ai-tool.

[104] National Cancer Institute, "Artificial Intelligence Expedites Brain Tumor Diagnosis during Surgery," *Cancer Currents Blog*, Feb. 12, 2020, https://www.cancer.gov/news-events/cancer-currents-blog/2020/artificial-intelligence-brain-tumor-diagnosis-surgery; Christine Fisher, "Intel and Penn Medicine are developing an AI to spot brain tumors," *Engadget*, May 11, 2020. https://www.engadget.com/intel-penn-medicine-brain-tumor-ai-151105509.html.

[105] Jon Fingas, "Microsoft AI helps diagnose cervical cancer faster," *Engadget*, Nov. 10, 2019. https://www.engadget.com/2019-11-10-microsoft-ai-diagnoses-cervical-cancer-faster.html.

[106] Benjamin Hunter, et al., "The Role of Artificial Intelligence in Early Cancer Diagnosis," *Cancers (Basel)* 14:6 (March 2022), p. 1524. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8946688; Jon Fingas, "NVIDIA and Medtronic are building an AI-enhanced endoscopy tool," *Engadget*, March 21, 2023. https://www.engadget.com/nvidia-and-medtronic-are-building-an-ai-enhanced-endoscopy-tool-161532723.html.

[107] Bendta Schroeder, "Using Machine Learning to Identify Undiagnosable Cancers," *MIT News*, Sept. 1, 2022. https://news.mit.edu/2022/using-machine-learning-identify-undiagnosable-cancers-0901.

[108] Rachel Gordon, "Seeing Into the future: Personalized Cancer Screening with Artificial Intelligence," *MIT News*, Jan. 21, 2022. https://news.mit.edu/2022/seeing-future-personalized-cancer-screening-artificial-intelligence-0121.

[109] "FDA Clearance Granted for First AI-Powered Medical Device to Detect All Three Common Skin Cancers (Melanoma, Basal Cell Carcinoma and Squamous Cell Carcinoma)," *BusinessWire*, Jan. 17, 2024. https://www.businesswire.com/news/home/20240117116417/en/FDA-Clearance-Granted-for-First-AI-Powered-Medical-Device-to-Detect-All-Three-Common-Skin-Cancers-Melanoma-Basal-Cell-Carcinoma-and-Squamous-Cell-Carcinoma.

[110] Sharon Worcester, "AI-Supported Breast Screens May Reduce Radiologist Workload," *Medscape*, Aug. 2, 2023. https://www.medscape.com/viewarticle/995081.

[111] Peter Ruegg-Eth Zurich, "AI Spots Antibiotic Resistance 24 Hours Faster than Old Methods," *Futurity*, Jan. 18, 2022. https://www.futurity.org/antibiotic-resistance-artificial-intelligence-2682392-2.

[112] "Better than humans: Artificial intelligence in intensive care units," Vienna University of Technology. *ScienceDaily*, May 11, 2023. https://www.sciencedaily.com/releases/2023/05/230511164553.htm; Laura Cech-Jhu,

saving thousands of lives each year as a result. Roughly 1.7 million adults develop sepsis each year in the United States, and more than 250,000 of them die.[113] Researchers find that the use of AI "dramatically cuts the time it takes to sort through thousands of promising compounds" to fight drug-resistant pathogens.[114]

- *Paralysis*: The Christopher & Dana Reeve Foundation has estimated that nearly 1 in 50 people in the United States are living with paralysis.[115] The combination of AI and robotic technologies holds promise for helping paralyzed individuals regain certain motor functions.[116] In May 2023, a Dutch man paralyzed from the waist down for more than a decade regained his ability to walk thanks to brain and spine implants and an AI-enabled thought decoder that helped him translate electrical brain signals into muscle movement.[117] He is now able to walk around his own home and get in and out of a car on his own. A paralyzed American man regained his sense of touch and mobility thanks to similar AI-enabled brain implants.[118] AI and ML capabilities are powering other brain-machine implants that are helping address disabilities in other ways, including regaining the ability to speak after a stroke.[119] And *The New York Times* recently documented how a woman who lost her arm in an accident is now able to control her new prosthetic robotic arm thanks to advances in AI and sensors embedded in her body.[120]

"AI Could Prevent Thousands of Sepsis Deaths Yearly," *Futurity*, July 22, 2022. https://www.futurity.org/sepsis-artificiall-intelligence-hospitals-deaths-2771192-2; Emily Henderson, "New machine learning model estimates optimal treatment timing for sepsis," *News Medical Life Sciences*, April 6, 2023. https://www.news-medical.net/news/20230406/New-machine-learning-model-estimates-optimal-treatment-timing-for-sepsis.aspx.

[113] Ibid.

[114] Brenda Goodman, "A new antibiotic, discovered with artificial intelligence, may defeat a dangerous superbug," *CNN*, May 25, 2023. https://www.cnn.com/2023/05/25/health/antibiotic-artificial-intelligence-superbug/index.html.

[115] "Paralysis in the U.S.," Christopher & Dana Reeve Foundation, *last accessed* June 11, 2023. https://www.christopherreeve.org/todays-care/paralysis-help-overview/stats-about-paralysis.

[116] Sunil Jacob, et al., "Artificial Intelligence Powered EEG-EMG Electrodes for Assisting the Paralyzed," IEEE Technology Policy and Ethics 4:4 (Sept. 2019), pp. 1-4. https://ieeexplore.ieee.org/document/9778118.

[117] Oliver Whang, "Brain Implants Allow Paralyzed Man to Walk Using His Thoughts," *The New York Times*, May 24, 2023. https://www.nytimes.com/2023/05/24/science/paralysis-brain-implants-ai.html.

[118] Mariella Moon, "AI-enabled brain implant helps patient regain feeling and movement," *engadget*, Aug. 2, 2023. https://www.engadget.com/ai-enabled-brain-implant-helps-patient-regain-feeling-and-movement-073711090.html.

[119] "Artificial Intelligence's impact on the Lives of People with Disabilities," *Analytics Insights*, Sept. 11, 2022. https://www.analyticsinsight.net/artificial-intelligences-impact-on-the-lives-of-people-with-disabilities; Jo Craven McGinty, "Inside the Operating Room: Doctors Test a Revolutionary Brain-Computer Implant," *The Wall Street Journal*, March 22, 2024. https://www.wsj.com/science/inside-the-operating-room-doctors-test-a-revolutionary-brain-computer-implant-f69eb0c2; Alvi Khan, "Artificial intelligence allows paralysis patient to speak for first time in 18 years," *The Ticker*, Sept. 4, 2023. https://theticker.org/11747/science/artificial-intelligence-allows-paralysis-patient-to-speak-for-first-time-in-18-years.

[120] Alice Zoo, "Her A.I. Arm," *The New York Times*, May 26, 2024. https://www.nytimes.com/card/2024/05/26/technology/ai-prosthetic-arm.

- *Mental health and drug addiction*: AI can help identify and address mental health problems through textual analysis, which can supplement human-based analysis at a time when there is a nationwide shortage of health care workers in this area.[121] AI tools are also being tapped to help find novel drugs that can help counter opioid addiction, which has become a chronic problem in recent years.[122]

There are many other current or potential health-related applications for algorithmic technologies, including abnormal chest X-ray detection,[123] AI-powered ultrasounds,[124] new drug and vaccine discovery,[125]and detecting and addressing eye disease and blindness.[126] In April 2024, the National Institutes of Health announced a new breakthrough in AI retinal imaging that produces high-resolution images of cells in the eye 100 times faster and with a 3.5-fold improvement in image contrast.[127] AI and ML will power other advanced learning capabilities that will help doctors and scientific researchers access and understand massive amounts of patient and health data and put it to even better use. These same capabilities will help innovators create new personalized health monitoring and tracking systems for the public.[128]

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[121] Shirley S. Wang, "Can Mental-Health Chatbots Help With Anxiety and Depression?," *The Wall Street Journal*, May 12, 2024. https://www.wsj.com/health/wellness/ai-chatbots-mental-health-5184eca2; Shania Kennedy, "AI Tool Can Detect Signs of Mental Health Decline in Text Messages," *Health IT Analytics*, Oct. 13, 2022. https://healthitanalytics.com/news/ai-tool-can-detect-signs-of-mental-health-decline-in-text-messages; Dhruv Khullar, "Can A.I. Treat Mental Illness?," *The New Yorker*, Feb. 27, 2023. https://www.newyorker.com/magazine/2023/03/06/can-ai-treat-mental-illness; Hazel Tang, "How AI can predict suicide before it's too late," *AIMed*, March 10, 2021. https://ai-med.io/special-report-neurosciences-mental-health/how-ai-can-predict-suicide-before-its-too-late.

[122] "How AI Can Help Design Drugs to Treat Opioid Addiction," *Neuroscience News*, Feb. 18, 2023. https://neurosciencenews.com/ai-opioid-addiction-22531.

[123] "AI accurately identifies normal and abnormal chest x-rays," *Science Daily*, March 7, 2023. https://www.sciencedaily.com/releases/2023/03/230307114414.htm.

[124] Bill Gates, "The future our grandchildren deserve," *GatesNotes*, Dec. 20, 2022. https://www.gatesnotes.com/The-Year-Ahead-2023#ALChapter6.

[125] Neel V. Patel, "Did AI Just Help Us Discover a Universal COVID Vaccine?," *Daily Beast*, March 9, 2023. https://www.thedailybeast.com/did-ai-just-help-us-discover-a-universal-covid-vaccine; Michael Gibney, "AI has secured a footing in drug discovery. Where does it go from here?," *PharmaVoice*, June 20, 2023. https://www.pharmavoice.com/news/ai-artificial-intelligence-machine-learning-biotech-pharma-drug-discovery/653291.

[126] Pearse Keane, "More People Are Going Blind. AI Can Help Fight It," *Wired*, June 26, 2023. https://www.wired.com/story/blindness-eye-disease-artificial-intelligence-scans; Khari Johnson, "AI Could Change How Blind People See the World," *Wired*, July 5, 2023. https://www.wired.com/story/ai-gpt4-could-change-how-blind-people-see-the-world.

[127] "AI makes retinal imaging 100 times faster, compared to manual method," National Institutes of Health,, April 10, 2024. https://www.nih.gov/news-events/news-releases/ai-makes-retinal-imaging-100-times-faster-compared-manual-method.

[128] Mark Gurman, "Apple Plans AI-Powered Health Coaching Service, Mood Tracker and iPad Health App," *Bloomberg*, April 25, 2023. https://www.bloomberg.com/news/articles/2023-04-25/apple-aapl-developing-ai-health-coaching-service-ipados-17-health-app.

AI Will Help Doctors, Nurses, and Scientists Advance Treatments

In 2022, I served as a member of the U.S. Chamber of Commerce's "AI Commission on Competition, Inclusion, and Innovation," a group formed to study AI governance. At a spring 2022 field hearing, our Commission heard remarks from Cleveland Clinic CEO and President Tom Mihaljevic, MD and several of his colleagues.[129] These doctors and scientists highlighted how they were already using AI/ML to improve patient care and save lives. They noted how teams of doctors and researchers are now able to share information from tissue samples with much larger teams of medical experts, who can—with the help of algorithmic systems—work together at a distance to better understand and use all the information at their fingertips. Additionally, along with other medical centers, the Clinic has developed better AI-driven methods to detect irregular heartbeats and strokes and to diagnose degenerative brain diseases like Alzheimer's, dementia, and Parkinson's.[130]

This only scratches the surface of what AI/ML will mean for patient care.[131] Dr. Mihaljevic noted that, when he started practicing medicine in the 1980s, the overall volume of medical information doubled roughly every seven years; today, it doubles every 73 days.[132] Meanwhile, 7,000 medical papers are published *every day*.[133] A recent study in *Science* shows that, in the closely related field of medical robotics, the number of scientific papers has grown exponentially from less than 10 published in 1990 to more than 5,200 in 2020.[134] These numbers align with broader trends in technical and scientific literature. "Since the scientific literature doubles roughly every 12 years, this means that of all scientific work ever produced, half of it has been produced in the last 12 years," note the authors of *The Science of Science*.[135]

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[129] Adam Thierer, "What I Learned about the Power of AI at the Cleveland Clinic," *Medium*, May 6, 2022. https://medium.com/@AdamThierer/what-i-learned-about-the-power-of-ai-at-the-cleveland-clinic-e5b7768d057d.

[130] "Can the AI driving ChatGPT help to detect early signs of Alzheimer's disease?," Drexel University, *ScienceDaily*, Dec. 22, 2022. https://www.sciencedaily.com/releases/2022/12/221222162415.htm; Priyom Bose, "A machine-learning approach for the early diagnosis of Parkinson's disease," *News Medical*, May 11 2023. https://www.news-medical.net/news/20230511/A-machine-learning-approach-for-the-early-diagnosis-of-Parkinsons-disease.aspx.

[131] Cem Dilmegani, "Top 18 Healthcare AI Use Cases in 2022," *AI Multiple*, May 9, 2022. https://research.aimultiple.com/healthcare-ai-use-cases.

[132] Thierer, "What I Learned about the Power of AI at the Cleveland Clinic." https://medium.com/@AdamThierer/what-i-learned-about-the-power-of-ai-at-the-cleveland-clinic-e5b7768d057d.; Peter Densen, "Challenges and Opportunities Facing Medical Education," *Transactions of the American Clinical and Climatological Association* 122 (2011), pp. 48-58.

[133] Gary Marcus and Ernest Davis, *Rebooting AI: Building Artificial Intelligence We Can Trust* (New York: Vintage, 2019), p. 67.

[134] Pierre E. Dupont, "A Decade Retrospective of Medical Robotics Research from 2010 to 2020," *Science Robotics* 6:60 (Nov. 10, 2021). https://www.science.org/doi/full/10.1126/scirobotics.abi8017.

[135] Dashun Wang and Albert-Laszlo Barabasi, *The Science of Science* (Cambridge University Press, 2021), p. 163.

The only way to take full advantage of this explosion of knowledge is with the power of machine-reading and -learning technologies. As the National Cancer Institute summarizes, "what scientists are most excited about is the potential for AI to go beyond what humans can currently do themselves. AI can 'see' things that we humans can't, and can find complex patterns and relationships between very different kinds of data."[136] The authors of *The Age of Scientific Wellness* speak of the rise of 'centaur doctors' who, combining the best parts of human intelligence and AI assistance, will be empowered to make bold medical decisions with far fewer unintended consequences."[137] Further, AI assistants can help address the significant paperwork and filing burdens today's doctors and nurses face, freeing up time for patient care and research.[138]

In the process, AI/ML will also help share medical knowledge across far more institutions and reach more patients as a result. Dr. Mihaljevic estimated that the Cleveland Clinic—one of the most important medical research facilities in the nation—is only able to reach an estimated 1.5 percent of Americans using traditional means of care. ML and AI can change that equation by greatly expanding opportunities for Americans to access the benefits of scientific knowledge and medical care from the Cleveland Clinic and America's many other world-class medical facilities, labs, and universities. Dr. Mihaljevic specifically highlighted AI's key role in improving home-based medical care, which will become an essential way to help a rapidly aging population in the future, regardless of where they live.[139] AI will also become crucial for various surgeries, improving outcomes when operations are necessary (often through robotic-assisted surgery)[140] or, better yet, avoiding the need for invasive procedures altogether.[141] Robotic surgery at a distance is also becoming possible thanks to recent advances.[142]

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[136] Nadia Jaber, "Can Artificial Intelligence Help See Cancer in New, and Better, Ways?," National Cancer Institute, March 22, 2022, https://www.cancer.gov/news-events/cancer-currents-blog/2022/artificial-intelligence-cancer-imaging.

[137] Lee Hood and Nathan Price, "The AI Will See You Now," *The Wall Street Journal*, April 7, 2023. https://www.wsj.com/articles/the-ai-will-see-you-now-5f8fba14.

[138] Geoff Brumfiel, "Doctors are drowning in paperwork. Some companies claim AI can help," NPR, April 5, 2023. https://www.npr.org/sections/health-shots/2023/04/05/1167993888/chatgpt-medicine-artificial-intelligence-healthcare; Steve Lohr, "A.I. May Someday Work Medical Miracles. For Now, It Helps Do Paperwork," *The New York Times*, June 26, 2023. https://www.nytimes.com/2023/06/26/technology/ai-health-care-documentation.html.

[139] "New in-home AI tool monitors the health of elderly residents," University of Waterloo, Science Daily, March 23, 2023. https://www.sciencedaily.com/releases/2023/03/230323103402.htm.

[140] Jonathan Shaw, "The Medical-Robotics Revolution," *Harvard Magazine*, May-June 2022. https://www.harvardmagazine.com/2022/05/features-medical-robotics-revolution.

[141] Shehmir Javaid, "4 Ways AI is Revolutionizing the Field of Surgery in 2022," *AI Multiple*, May 31, 2022. https://research.aimultiple.com/ai-in-surgery.

[142] Joao Medeiros, "The Daring Robot Surgery That Saved a Man's Life," *Wired*, May 18, 2023. https://www.wired.com/story/proximie-remote-surgery-nhs.

Conclusion

Policymakers should not underestimate the importance of AI/ML technology and must work diligently to ensure America remains a leader in this field. While some experts predict another AI winter could be coming following some notable narrow AI disappointments, they oftentimes fail to identify how public policy influences that outcome.[143] The overall amount of innovation we can expect to flow from this space is fundamentally tied up in the question of whether or not America creates the right innovation culture for AI.[144] To achieve its full potential and bring about the "AI revolution in medicine" that some predict, America will need to set its policy defaults in such a way that encourages innovation while addressing the many legitimate concerns about various AI capabilities.[145]

[143] Filip Piekniewski, "AI Winter Is Well on Its Way," Piekniewski's Blog, May 28, 2018. https://blog.piekniewski.info/2018/05/28/ai-winter-is-well-on-its-way.

[144] Adam Thierer, "Getting AI Innovation Culture Right," *R Street Policy Study* No. 281 (March 2023). https://www.rstreet.org/research/getting-ai-innovation-culture-right.

[145] Peter Lee, et al., *The AI Revolution in Medicine: GPT-4 and Beyond* (Pearson, 2023). https://www.amazon.com/AI-Revolution-Medicine-GPT-4-Beyond/dp/0138200130.

Enclosure 1: Getting AI Policy Right through a Learning Period Moratorium

By Adam Thierer
May 29, 2024

While some artificial intelligence (AI) critics want to pause AI development, the pause most needed today is on overzealous regulatory proposals that could kneecap America's lead in computational science and algorithmic technologies. With over 700 federal and state AI legislative proposals threatening to drown AI innovators in a tsunami of red tape, Congress should consider adopting a "learning period" moratorium that would limit burdensome new federal AI mandates as well as the looming patchwork of inconsistent state and local laws.

The time to do so is now, with the race for AI supremacy against China intensifying and other nations investing heavily to counter the United States. Handcuffing our AI innovators with layers of red tape would diminish domestic entrepreneurialism and investment, deny citizens many life-enriching innovations, and limit economic growth. Equally worrisome is how overregulation could undermine our technology base and potentially even our national security.

Mountains of Red Tape

Unfortunately, many lawmakers seem oblivious to these dangers, floating extreme AI proposals premised on far-fetched hypotheticals and dystopian sci-fi plots. Such fear-based thinking has led states to propose far-reaching controls on algorithmic technologies. Colorado just became the first state to advance a comprehensive AI regulatory measure, which Gov. Jared Polis (D) signed even though he worried state regulations like his could create "a complex compliance regime for all developers and deployers of AI" and a patchwork of mandates that will "tamper innovation and deter competition." California is also rapidly advancing a major bill that would impose onerous restrictions on "frontier" AI models and create a new bureaucracy to administer the rules.

Overregulation also looms at the federal level, with more than 100 AI-related measures pending in Congress. The Biden administration is simultaneously pursuing unilateral regulation on AI through its "Blueprint for an AI Bill of Rights," a massive 110+ page executive order, and a litany of new agency directives premised on vague notions of "algorithmic fairness."

Most of these efforts are premised on the notion that government can preemptively legislate "responsible AI" by forcing innovators to run new ideas through a maze of bureaucrats to get a permission slip before innovating. Earlier this year, a top Biden administration tech official called for "a system of AI auditing from the government," and suggested the need for "an army of auditors" to ensure "algorithmic accountability." The resulting layers of technocratic meddling could lead to a death-by-a-thousand-cuts scenario for AI developers.

Undermining a Winning Formula

This is the exact opposite of the more flexible, market-driven approach the Clinton administration and Congress wisely crafted in the 1990s for the internet, digital commerce, and online speech. Rooted in policy restraint, that framework protected the freedom to innovate without first needing some bureaucrat's blessing to launch the next great application or speech platform.

If American innovators and values are to shape today's most important technology, we must not shoot ourselves in the foot as the global AI race heats up. Congress should pause overzealous micromanagement before it is too late. In the past, lawmakers have used forbearance requirements and moratoriums to protect innovation and competition, albeit to varying effect.

The Telecommunications Act of 1996 specified that "[n]o State or local statute or regulation, or other State or local legal requirement, may prohibit or have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service." The law included other specific preemptions of state and local regulation, as well as a provision requiring the Federal Communications Commission (FCC) and state regulators to forbear from regulating in certain instances to enhance competition.

Another portion of the Communications Act meant to "encourage the provision of new technologies and services to the public" specifies that any party who opposes innovations "shall have the burden to demonstrate that such proposal is inconsistent with the public interest" and forces the FCC to make a decision within a year. Sadly, the FCC mostly ignores both this provision and the Telecom Act's forbearance requirements, continuing to overregulate communications and media markets instead.

Federal moratoria have been more effective in protecting new technologies from bureaucratic meddling and excessive taxes. Congress passed the Internet Tax Freedom Act of 1998 (made permanent in 2016) to contain the spread of "multiple and discriminatory taxes on electronic commerce" and internet access. Similarly, the Commercial Space Launch Amendments Act of 2004 made sure federal regulators did not undermine the nascent market for commercial human spaceflight.

How to Structure an AI Moratorium and Preemption

These and other laws could provide a template for how to craft a moratorium or preemption for AI regulation. An AI learning period moratorium should block the establishment of any new general-purpose AI regulatory bureaucracy, disallow new licensing schemes, block open-ended algorithmic liability, and preempt confusing state and local regulatory enactments that interfere with the establishment of a competitive national marketplace in advanced algorithmic services.

An AI learning period moratorium would have many benefits. First, it would create breathing space for new types of algorithmic innovation to grow. This is especially important for smaller AI firms and the open-source AI marketplace, both of which could be decimated by premature overregulation of a still-developing sector.

Second, an AI regulatory moratorium would give policymakers and technology experts the chance to determine what problems deserve greater scrutiny and potential regulation. This pragmatic policy approach would limit damage from rash decisions and help us gain knowledge by testing predictions and policies before advancing new rules.

A learning period moratorium on new AI regulations does not mean zero regulation, however. Many existing laws and regulations already cover any AI-enabled practices that violate civil rights, consumer protections, the environment, intellectual property, and national security. Policymakers can still enforce those policies where harms exist and fill gaps as necessary, or they can use less restrictive approaches like transparency and education-based measures.

A federal AI preemption standard will need to include carve-outs for some areas of traditional state authority including education, insurance, and law enforcement. But regulatory preemption will be challenging because, as the "most important general-purpose technology of our era," AI touches almost every field. For better or worse, some sectors and issues must be left to the province of state and local governments.

Where a national framework proves untenable, state and local governments should craft harmonized light-touch frameworks—perhaps in the form of multistate compacts—to avoid burdening the development of a robustly competitive and innovative national marketplace in AI firms and technologies.

Review Existing Regulatory Capacity

When formulating an AI moratorium, Congress should simultaneously demand that our government's 439 federal departments be required to do two other things. First, agencies should study and review existing policies that might already address algorithmic innovation in their field and consider how AI systems might already be overregulated under current law. Second, agencies should identify additional ways in which AI technologies might help improve government services. (It would be wise for state and local governments to engage in a similar review, although it need not be mandated by federal law).

The Trump administration's Office of Management and Budget (OMB) recommended some of these ideas to agency heads in a November 2020 guidance memo. "Federal agencies must avoid regulatory or non-regulatory actions that needlessly hamper AI innovation and growth," the OMB memo ordered. "Fostering AI innovation and growth through forbearing from new regulation may be appropriate," and "agencies must avoid a precautionary approach that holds AI systems to an impossibly high standard such that society cannot enjoy their benefits and that could undermine America's position as the global leader in AI innovation."

Unfortunately, in the wake of recent Biden administration orders and statements, agencies have instead been encouraged to consider how to expand their regulatory ambitions toward AI, even though Congress has not authorized such actions.

Conclusion

For the United States to remain the global leader in algorithmic technologies and computational capabilities, AI policy must be rooted in patience and humility rather than a rush to overregulate. Policymakers must avoid locking down America's innovative potential and instead pause the panic-based AI regulatory policies under consideration today.

It is essential that our nation get the policy prerequisites of growth and prosperity right by once again embracing an innovation culture that positions us as the global leader in advanced computation as the next great technological race with China and the rest of the world heats up.