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Artificial intelligence primer:

What is needed to maximize AI's economic, social, and trade opportunities

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Executive Summary

Artificial intelligence (AI) has the potential to transform economic growth, commerce, and trade, affecting the types of jobs that are available and skills that are needed. The U.S., China, Japan, Germany, the U.K., France, and others have recognized the opportunity and are supporting AI research and development as well as preparing their workforce.

For AI to develop also requires an enabling environment that includes new regulation in areas such as AI ethics and data access and revisiting existing laws and regulation in areas such as privacy and intellectual property (IP) rights to ensure that they work for AI. In addition, AI development requires an international agenda to avoid unnecessary regulatory heterogeneity that creates barriers to data access and use and impedes the global diffusion of AI products.

A ballpark estimate for AI diffusion across major economies is over the next 5 to 15 years.[1] This is the window during which to address the range of regulatory and broader social concerns associated with widespread deployment of AI. Key here is building trust and understanding of AI.[2] This includes ensuring that AI contributes to building democratic, transparent, and fair societies. Failure to act could lead to a backlash against AI and regulation that is overly burdensome and stifles innovation.

AI: A definition

AI is not a specific technology, but instead is better conceived of as a set of processes that includes data analytics, enabling technology, applications, and software that make existing processes smarter.[3] Thinking of AI in this way underscores its economy-wide application, making tasks quicker, better, and more efficient. Existing applications include self-driving cars, human speech and translation, and more efficient supply chains. Current AI is based on machine learning using large amounts of data and powerful algorithms to develop increasingly robust predictions about the future.[4]

1. Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence, Report of the Study Panel, September 2016; Jacques Bughin et al 2018. “Notes from the AI Frontier, Modeling the Impact of AI on the World Economy”, McKinsey Global Institute Discussion Paper, September 2018.
2. Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence, Report of the Study Panel, September 2016.
3. Kai-Fu Less and Pail Triolo, “China’s Artificial Intelligence Revolution: Understanding Being’s Structural Advantages”, Eurasia Group, December 2017.
4. Stuart Russell, Daniel Dewey and Max Tegmark, “Research Priorities for Robust and Beneficial Artificial Intelligence”, AI Magazine, Winger 2015, p. 106.

The economic impact of AI

AI could add trillions to global output over the next 10 years and will accelerate the transition towards a services-driven economy.[5] Though still in its infancy, AI is already being used in various ways and across economic sectors, including by business to detect and manage risk, to develop autonomous vehicles and increase the efficiency of transportation networks, and to improve medical diagnostics and inform patient care.

Trade and AI

The development of AI will affect international trade in myriad ways, including via macroeconomic impacts. For instance, as AI increases productivity growth, firm competitiveness will rise, creating new opportunities for international trade. As AI increases the value of services in economic growth, this should expand the share of services in international trade.

AI is already directly affecting trade in various ways, including through improved management of risks in supply chains, facilitation of smart manufacturing, and AI language translation services that have increased U.S. exports to non-English speaking countries.[6]

Potential economic and social costs

The developments and diffusion of AI are likely to have economic and social transition costs, which could include increased income inequality and job losses. Such outcomes from AI are not preordained, but will require mitigating policies.

AI may also have mixed impacts for developing countries. For example, by leading on AI adoption, advanced economies will likely erode developing countries' comparative advantage in some manufacturing sectors. A lack of skills in developing countries could further exacerbate the AI divide amongst countries.[7]

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5. Jacques Bughin et al 2018. "Notes from the AI Frontier, Modeling the Impact of AI on the World Economy", McKinsey Global Institute Discussion Paper, September 2018; Paul Daugherty and Mark Purdy (2016), "Why AI is the Future of Growth?", https://www.accenture.com/t20170524T055435__w__/ca-en/_acnmedia/PDF-52/Accenture-Why-AI-is-the-Future-of-Growth.pdf.
6. Brynjolfsson, E, X Hui and Meng Liu (2018), "Does Machine Translation Affect International Trade? Evidence from a Large Digital Platform", National Bureau of Economic Research Paper, http://ide.mit.edu/sites/default/files/publications/Machine_Translation_NBER.pdf.
7. M.L. Cummings et al (2018), "Artificial Intelligence and International Affairs", Chatham House Report; Jacques Bughin et al 2018. "Notes from the AI Frontier, Modeling the Impact of AI on the World Economy", McKinsey Global Institute Discussion Paper, September 2018.

Seven steps for maximizing the benefits of AI

1. Strengthen AI diffusion within and across countries

Cross-country deployment of AI in all sectors will require significant new investments, reworking business models, and training workers. This is the pattern that previous general-purpose technologies have taken—slow diffusion followed by economy-wide uptake and productivity growth.[8] A lack of technology diffusion is driving a widening performance gap within industries between frontier firms and less productive firms.[9] Some likely reasons are the costs and challenges of developing the tacit knowledge and effectively deploying the capital to take advantage of technologies such as AI. Policies are needed to increase the rates and depth of technology diffusion across the economy. This could include greater labor market flexibility, increased competition, and availability of risk capital.[10]

2. Develop education and skills

Domestic agenda: Education and training will be key if societies are to benefit fully from AI. AI will require science, technology, engineering, and math (STEM) as well as a broader set of skills that enable people to work alongside AI.

International agenda: Skills development will be needed globally, creating an opportunity for governments and industry to develop partnerships in other countries, particularly in the developing world.

3. Establish sound cybersecurity

Domestic agenda: Ensuring cybersecurity will be key to developing the full range of economic and social benefits from AI.[11] Lax cybersecurity in one country can affect cybersecurity outcomes elsewhere. This underscores the need for governments' to develop national cybersecurity strategies. For example, the U.S. National Institute of Standards and Technology (NIST) Framework for Improving Critical Infrastructure Cybersecurity provides a common organizing structure for business

8. Andrew McAfee and Erik Brynjolfsson 2014. "The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies."
9. Andrews, D., C Criscuolo and P.N. Gal, "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", OECD Productivity Working Paper Series, No. 2.
10. Dan Andrews, Chiara Criscuolo, and Peter Gal, "Digital Technology Diffusion: A Matter of Capabilities, Incentives or Both?", Economics Working Papers No. 1476, 8th November 2018.
11. OECD (2012), "Cybersecurity Policy Making at a Turning Point: Analysing a New Generation of National Cybersecurity Strategies for the Internet Economy" OECD Digital Economy Papers, No. 211, OECD Publishing, Paris.

to guide cybersecurity activities and cybersecurity risk assessment and management.[12] The U.K., Japan, Australia, and China, to name a few, have also developed cybersecurity strategies.

International agenda: Cybersecurity standards can create unnecessary barriers to trade in AI. For instance, China is using cybersecurity as a justification to develop China-specific cyber standards and Vietnam requires services to be located domestically for cybersecurity reasons.[13] Appropriate international standards are needed that can form the basis of domestic cybersecurity strategies. Trade agreements should encourage cooperation and use of cybersecurity standards, such as occurs in the U.S.-Mexico-Canada Agreement (USMCA).[14] Capacity building in other countries should also be part of a cybersecurity engagement strategy.

4. Protect the privacy of personal data

Domestic agenda: Strong privacy rules will be required for people to allow their personal data to be used for AI learning. At the same time, privacy rules need to avoid creating unnecessary restrictions on cross-border data flows.

International agenda: As countries and regions develop privacy rules, mechanisms will be needed to ensure interoperability of privacy systems. Trade agreements can play a role here. The following outlines elements of an emerging framework to support cross-border data flows for AI that also addresses underlying privacy concerns[15]:

- Further develop global privacy principles, building on existing principles such as those in the OECD.[16]
- Develop and implement domestic privacy laws and regulations based on global privacy principles.
- Build interoperability among different privacy regimes, such as was achieved in the U.S.-EU Privacy Shield.
- Ensure the global free flow of data, limiting data flows restrictions where necessary to protect domestic privacy standards.

12. Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, National institute of Standards and Technology, April 116, 2018 https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.04162018.pdf.
13. Vietnam Decree No. 27/2018/ND-CP amending and supplementing Decree No. 72/2013/ND-CP on Internet Services and Online Information.
14. USMCA Article 19.15
15. See A. Mattoo and J. P. Meltzer (2018), 'Data Flows and Privacy: The Conflict and Its Resolution', 21(4) *Journal of International Economic Law*.
16. 2013 OECD Privacy Guidelines on the Protection of Privacy and Transborder Flows of Personal Data, https://www.oecd.org/sti/ieconomy/oecd_privacy_framework.pdf.

5. Increase access to government data

Domestic agenda: Governments can facilitate access to publicly held datasets. Sharing data sets across government agencies and with state and local governments as well as with researchers and the private sector require a consistent, transparent, and standardized governance framework. For example, the U.S. federal government has made progress in developing data as a strategic asset, including the development of a Federal Data Strategy, which aims to provide a consistent approach to federal data stewardship, use, and access.[17]

International agenda: International frameworks for access to government data are needed to minimize the costs of accessing government data globally. The OECD is developing a data governance framework[18] and the International Organization for Standardization (ISO) has principles on data governance.[19] The USMCA includes commitments to open data, which future trade agreements should expand.

6. Develop a balanced intellectual property framework

Domestic agenda: AI requires a supportive IP framework, including fair use exceptions to copyright that provide flexibility for copying data for AI training purposes.

International agenda: Fair use exceptions do not exist in many other countries. In the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), the parties took a small step toward agreeing on the need for appropriate copyright exceptions by recognizing the need to achieve "an appropriate balance in its copyright and related rights systems." This call for balance was not replicated in USMCA.[20]

7. Develop AI ethical principles

Domestic agenda: To develop trust in AI will require that AI processes and outcomes are ethical. The need to develop ethical AI has been recognized by the U.S., the EU, and other governments.[21]

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17. https://strategy.data.gov
18. Ubaldi, B. (2013), "Open Government Data: Towards Empirical Analysis of Open Government Data Initiatives", *OECD Working Papers on Public Governance*, No. 22, OECD Publishing, Paris Information technology-Governance of IT-Governance of data-Part1: Application of ISO/IEC 38500 to the governance of data, ISO Standard 38505-1: 2017.
19. Information technology-Governance of IT-Governance of data-Part1: Application of ISO/IEC 38500 to the governance of data, ISO Standard 38505-1: 2017.
20. Comprehensive and Progressive Agreement for Trans-Pacific Partnership, Art 18.66.
21. The National Artificial Intelligence Research and Development Strategic Plan, October 2016; Artificial Intelligence for Europe COM(2018) 237 final.

International agenda: In the absence of international cooperation, AI ethical guidelines might reflect only local standards and norms, with discriminatory impacts on access to data and use of AI. The OECD is developing AI principles. The G-20 could also take up this issue. Even with a common baseline, it will be necessary to determine whether AI systems are built ethically or produce ethical outcomes. This raises trade issues such as in which country testing takes place and to what standards. These process issues should be part of international trade negotiations.

Introduction

AI is already affecting how economies grow, produce jobs, and trade internationally. While the U.S. leads on AI development, other governments recognize AI's potential and have their own strategies to promote AI investment and development. For instance, China, the U.K., and France plan to increase research and development (R&D) funding for AI, as well as education and skills development to expand the pool of workers capable of contributing to AI. The U.S. and the EU also recognize the need to develop ethical frameworks for AI. Some AI strategies have also identified the need for international cooperation on AI.

Creating an enabling environment for AI also will require new regulation in areas such as AI ethics and data access. In other cases, existing law and regulations in areas such as privacy and IP rules will affect how AI develops. In addition, an international agenda is needed to support the development of appropriate AI rules and AI-related economic and social outcomes. Any viable approach should avoid a thicket of regulatory approaches that create barriers to the evolution of AI and to the global diffusion of AI products.

This AI primer outlines the economic and trade opportunities from AI, the key role of regulation in supporting AI, and identifies where international cooperation is needed to maximize the economic and social opportunities from AI.

Unpacking AI and its component parts

Viewing AI as a set of processes underscores its economy-wide applicability to making myriad tasks more efficient. Current applications include self-driving cars, human speech and translation, and more efficient supply chains. This view of AI is often referred to as "narrow AI" and stands in contrast to "general AI." This latter form of AI raises broader existential concerns, such as how to align the goals of a general AI system with already established rules to prevent catastrophic outcomes.[22] However, general AI remains a technology still to be developed in the distant future.[23]

Narrow AI is based on machine learning, which uses large amounts of data and powerful algorithms to develop increasingly robust predictions about the future.[24] The data used for machine learning can be either supervised—data with associated facts such as labels—or unsupervised learning—

22. See generally https://futureoflife.org/background/benefits-risks-of-artificial-intelligence/, visited 26th November 2018.
23. Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence, Report of the Study Panel, September 2016.
24. Stuart Russell, Daniel Dewey and Max Tegmark, "Research Priorities for Robust and Beneficial Artificial Intelligence", AI Magazine, Winger 2015, p. 106.

raw data which requires the identification of patterns without prior prompting.[25] This includes reinforcement learning—where machine learning algorithms actively choose, and even generate, their own training data. Another key development underpinning narrow AI are Deep Neural Networks (DNN), layers of nonlinear transformation node functions, where the output of each layer becomes an input to the next layer in the network. Each layer is highly modular, making it possible to take a layer optimized for one type of data (e.g., images) and to combine it with other layers for other types of data (e.g., text).[26] DNNs combine multiple machine learning tasks – creating what is referred to as general purpose machine learning (GPML)—which allows AI to effectively live on top of the type of chaotic data that humans are able to digest, such as video, audio, and text. A further component of narrow AI are specific tools such as out-of-sample validation to validate models, stochastic gradient descent for training models on streams of data, and graphical processing units (GPUs)—originally developed for video games but which have proven well-suited to support the types of massive parallel computations needed to train DNNs.[27]

Data and AI

Development of AI requires access to large data sets.[28] Quantity matters because machine learning needs to be able to incorporate into future predictions as many past outcomes as possible. This means that access to the tails of data matter—the less usual and irregular data. This includes access to heterogeneous data, which allows for multi-modality machine learning. For example, real-time route predicting apps used by ride-hailing companies like Uber and Lyft (and eventually self-driving cars) were developed and enabled using AI trained on data sets derived from smartphones, population data sets, satellite data, and digital maps.

Data can be collected in a number of ways. This includes internet search, e-commerce transactions, or the observation of internet activity. For example, Google gathers data from the use of internet search to train its AI translation service. Governments and businesses also collect data from their customers and internal operations. Such data can train AI to improve government and business operations. Data is also collected from observations made by sensors and cameras, which can be used to train AI robots to interact with the environment.

25. Kevin P. Murphy, "Machine Learning: A probabilistic Perspective" (2007), 1-2.
26. Matt Taddy, The Technological Elements of Artificial Intelligence, NBER Working Paper 24301, February 2018.
27. Ibid.
28. Generative adversarial networks or use of digital twins can minimize need for large data sets to train AI.

The economic impact of AI

McKinsey estimates that AI could add around 16 percent or $13 trillion to global output by 2030.[29] According to an analysis by Paul Daugherty and Mark Purdy of the impact of AI on 12 developed economies, including the U.S., AI could double annual economic growth in these countries by 2035.[30] The most powerful potential gains from AI will come from its eventual impact on productivity. Current rates of productivity growth globally are low, due to various possible causes.[31] One reason is that it takes time for an economy to incorporate and make effective use of new technologies, particularly complex ones with economy-wide impacts such as AI.[32] This includes time to build a large enough capital stock to have an aggregate effect and for the complimentary investments needed to take full advantage of AI investments, including access to skilled people and business practices.[33]

AI will also affect the type and quality of economic growth, with international trade implications. For instance, AI is likely to accelerate the transition towards a services economy. AI will also require skilled workers who can work with AI to add value to production and products. This skill-biased transition is already well underway. For instance, in the U.S. manufacturing sector, the share of high-skilled jobs grew from 6 percent in 1930 to 30 percent in 2010 and the share of low-skills jobs fell from 60 percent to 39 percent.[34]

AI will have applicability across most sectors of the economy. Already AI is being used to detect and reduce financial risk,[35] to develop autonomous vehicles and improve transportation including by monitoring safety, improving networks and reducing travel time, resulting in increased efficiency and reduced carbon emissions.[36] AI is also being used to improve health care outcomes. For instance, AI can analyze information from medical journals, textbooks, and clinical practices to inform

29. Jacques Bughin et al 2018. “Notes from the AI Frontier, Modeling the Impact of AI on the World Economy”, McKinsey Global Institute Discussion Paper, September 2018.
30. Paul Daugherty and Mark Purdy (2016), “Why AI is the Future of Growth?”, https://www.accenture.com/t20170524T055435__w__/ca-en/_acnmedia/PDF-52/Accenture-Why-AI-is-the-Future-of-Growth.pdf.
31. Remes Jaana. et al, “Solving the productivity puzzle: the role of demand and the promise of digitization”, McKinsey Global Institute, February 2018; Byrne, David M, J.G. Fernald and M.B. Reinsdorf. 2016. “Does the United States Have a Productivity Slowdown or a Measurement Problem?” *Brookings Papers on Economic Activity,* (Spring) 109.
32. Erik Brynjolfsson et al., “Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics”, NBER Working Paper no. 24001, October 2017 (revised December 2017), p. 10.
33. Ibid.
34. Katz, Lawrence F. and Robert A. Margo. 2014. “Technical Change and the Relative Demand for Skilled Labor” in Human Capital in History: The American Record (ed. Lead Platt Boustan, Carola Frydman and Robert A. Margo) University of Chicago Press.
35. A.S. Koyuncugil and N. Ozgulbas, “Financial early warning systems model and data mining application of risk detection”, Expert Systems with Applications, 39 (2012): 6238-6253.
36. H Kargupta, J. Gama and W. Fan., “The next generation of transportation systems, greenhouse emissions, and data mining”, Proceedings of the 16th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, 2010.

patient care. IBM Watson has demonstrated the ability to improve the diagnosis of cancer,[37] and by scanning millions of cardiac images, AI can assist doctors better diagnose heart disease.[38] AI, along with the Internet of Things (IoT), is being used to provide real-time health care by monitoring vital health signs and signal first responders where needed. AI also has potential applications to education, such as AI tutoring to gauge student progress and work across cultures and languages.

The impact of AI on international trade

The development of AI will affect international trade in myriad ways, including via macroeconomic impacts. For instance, as AI increases productivity growth, firm competitiveness will rise, creating new opportunities for international trade. As AI increases the value of services in economic growth, this should expand the share of services in international trade.

There is also potential for AI regulation to be a barrier to trade in AI products. In many cases, AI will be incorporated into a product that is traded, such as autonomous vehicles, aircraft, the IoT, and services that use AI. Where each country separately develops AI standards, this can lead to unnecessary regulatory heterogeneity and costs to exporters.

AI and global value chains (GVCs)

One area where AI is already having an impact is on the development and management of GVCs. AI helps business better manage complex and dispersed production units, thereby improving the overall efficiency of GVCs. For example, business can use AI to improve warehouse management, better predict consumer demand, and increase the accuracy of just-in-time manufacturing and delivery. Robotics can increase productivity and efficiency in packing and inventory inspection. Business can also use AI to improve physical inspection and maintenance of assets along supply chains.

The development of GVCs will be affected by a broader trend whereby AI is used to develop smart manufacturing. For instance, the German-led conception of "Industry 4.0" is based on sensors, the IoT, and cyber-physical systems that connect machines, material, supplies, and customers. This will include capacity at the factory level of predictive machines and self-maintenance, complete communications between companies along the supply chain, and the ability to manufacture according to customer specifications, even in small or single batches.[39] Such developments could strengthen

37. Esteva A, Kuprel B, Novoa RA, et al. Dermatologist-level classification of skin Cancer with deep neural networks,. Nature 2017; 542.
38. Dilsizian SE. Siegel EL. Artificial Intelligence in medicine and cardiac imaging: harnessing big data and advanced computing to provide personalized medical diagnosis and treatment. *Curr Cardiol Rep* 2014: 16: 441.
39. Qin J, Ying, Liu and Roger Grosvenor, "A Categorical Framework of Manufacturing for Industry 4.0 and Beyond", Procedia CIRP 52 (2016) 174.

and extend GVCs. For example, smart manufacturing, with its emphasis on connectivity, could open up GVCs to more specific participation by specialized service suppliers in areas such as R&D, design, robotics and data analytics tailored to discrete supply chain tasks.

Yet, AI could also create trends towards on-shoring of production. Broader automation opportunities, as well as scaling of 3D printing, could reduce the need for extended supply chains—particularly those that rely on large pools of low-cost labor. The result could accelerate the process Dani Rodrik describes as premature industrialization in developing countries.[40]

Trade using digital platforms

Another area where AI is already being deployed is on digital platforms such as eBay. For small business, in particular, digital platforms have provided an unprecedented opportunity to go global. In the U.S., for instance, 97 percent of small businesses using eBay export their offerings overseas compared to 4 percent of offline peers.[41] Moreover, as a result of eBay's AI developed machine translation service, eBay based exports to Spanish-speaking Latin America increased by 17.5 percent (equivalent in value terms to 13.1 percent).[42] To put this growth into context, a 10 percent reduction in the distance between countries is correlated with increased trade revenue of 3.5 percent—so a 13.1 percent increase in revenue from eBay's machine translation is equivalent to reducing the distance between countries by over 35 percent.

Trade negotiations

AI also has the potential to be used to improve the outcomes from international trade negotiations. For instance, AI could be used to better analyze the economic trajectories of each negotiating partners' position under different assumptions. This could include outcomes contingent on trade negotiation (growth pathways under various forms of trade liberalization), how these outcomes are affected in a multiplayer scenario where trade barriers are adjusted down at different rates, as well as predicting the trade response from countries not party to the negotiation. Already Brazil has established an Intelligent Tech & Trade Initiative that includes using AI to improve trade negotiations.[43]

40. Dani Rodrick 2015. "Premature Industrialization", NBER Working Paper 20935, February 2015.
41. eBay 2015. "Empowering People and Creating Opportunity in the Digital Single Market" An eBay report on Europe's potential, October 2015.
42. Brynjolfsson, E, X Hui and Meng Liu (2018), "Does Machine Translation Affect International Trade? Evidence from a Large Digital Platform", National Bureau of Economic Research Paper, http://ide.mit.edu/sites/default/files/publications/Machine_Translation_NBER.pdf.
43. Intelligent Tech & Trade Initiative, www.itti-global.org

AI's potential economic and social costs

As the transition to AI ramps up, it may have economic and social costs. These could include increased income inequality and job losses. Such outcomes are not pre-ordained, but will require mitigating policies. For instance, AI is likely to continue the trend towards skill-biased jobs. While only about 9 percent of jobs are at risk of being entirely replaced by AI, low-skill jobs are most at risk.[44] The OECD estimates that 44 percent of U.S. workers with less than a high school degree hold jobs that are highly automatable, whereas only 1 percent of jobs held by people with a bachelor's degree or higher are automatable. Moreover, to the extent these low-skill jobs still exist in the future, they will likely pay even lower wages.[45]

AI's impact on developing countries

AI may also have mixed impacts for developing countries. For one, the higher cost of labor in developed countries is likely to create the incentives to adopt AI and to automate, which could reduce developing countries' comparative advantage in some manufacturing sectors. This knock-on effect, along with developments in additive manufacturing, could lead to on-shoring of manufacturing in developed countries.

More generally, the capacity of countries to implement AI will build on other key technology and skills foundations, including in cloud computing, big data, and the IoT. Yet countries currently have different levels of digital readiness and AI development could further exacerbate the digital divide among countries.[46]

44. Melanie Arntz, Terry Gregory and Ulrich Zierhan, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", OECD Social, Employment and Migration Working Papers No. 189, 2016.
45. Austin Goolsbee, "Public Policy in an AI Economy", NBER working Paper Series 24653, May 2018.
46. M.L. Cummings et al (2018), "Artificial Intelligence and International Affairs", Chatham House Report; Jacques Bughin et al 2018. "Notes from the AI Frontier, Modeling the Impact of AI on the World Economy", McKinsey Global Institute Discussion Paper, September 2018.

Policies to regulate and facilitate AI: Seven action areas

The impact of AI on economic growth, jobs, and trade is likely to take some time. Effectively deploying AI across an economy will require significant new investments, reworking business models and training workers. This is the pattern that previous general-purpose technologies have taken—slow diffusion followed by economy-wide uptake and productivity growth.[47] A ballpark estimate for AI diffusion is over the next 5 to 15 years.[48] For example, according to a McKinsey Global Institute report, up to 70 percent of companies in the U.S. may have adopted some form of AI by 2030, up from 33 percent today.[49] This timeframe of 5 to 15 years is the window during which to address the range of regulatory and broader social concerns associated with widespread deployment of AI. Key here is building trust and understanding of AI.[50] This includes ensuring that AI contributes to building democratic, transparent, and fair societies. Failure to act could lead to a backlash against AI and regulation that is overly burdensome and stifles innovation.

Recently, the U.S. White House issued an Executive Order titled "Maintain American Leadership in Artificial Intelligence," which prioritizes investment in AI R&D, making federal data more accessible for AI research, setting AI governance standards, building an AI workforce, and engaging internationally on AI issues. The Executive Order effectively sets out the key areas of focus, though concerns remain as to whether there will be the resources and White House follow-through.[51]

The manner in which AI regulation is developed needs to be mapped onto an international engagement strategy that aims to build regulatory cooperation and avoids unnecessary heterogeneity in AI regulation and standards that create barriers to trade. In many cases, AI will be incorporated into a product that is traded, such as autonomous vehicles, aircraft, the IoT, and services that use AI. AI standards that require AI to be trained in a particular way, to produce or avoid certain outcomes, or to use specific hardware can all present barriers to trade.

47. Andrew McAfee and Erik Brynjolfsson 2014. "The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies."
48. Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence, Report of the Study Panel, September 2016; Jacques Bughin et al 2018. "Notes from the AI Frontier, Modeling the Impact of AI on the World Economy", McKinsey Global Institute Discussion Paper, September 2018.
49. Jacques Bughin et al 2018. "Notes from the AI Frontier, Modeling the Impact of AI on the World Economy", McKinsey Global Institute Discussion Paper, September 2018.
50. Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence, Report of the Study Panel, September 2016.
51. Darrell M. West, "Assessing Trump's artificial intelligence executive order," Brookings TechTank blog, February 12, 2019.

The following seven regulatory issues examine in more detail where AI oversight and regulation is needed. Related to this, a domestic regulatory agenda pursued without consideration of its international impacts risks undermining the global diffusion, even while it aims to encourage the domestic development of AI. International cooperation is thus warranted in several of the seven areas.

1. Strengthen AI diffusion within and across countries

For the full economic opportunity of AI to be realized, adoption must occur across the U.S. and globally. Failure to ensure broad diffusion could lead to AI benefiting only some countries, sectors, and firms, with the gains from AI accumulating unevenly. Partial or patchy uptake would require strengthening of technology diffusion mechanisms and reducing barriers to trade in AI. In the U.S. for instance, sectors such as agriculture, construction, hospitality, health care, and government have low levels of digitization compared to the ICT, media, professional services, financial, and advanced manufacturing sectors.[52]

There are also gaps in productivity between firms within industries driven by differences in the uptake and use of technologies such as AI.[53] Frontier firms tend to be larger and more capital- and patent-intensive, use data more effectively, have the know-how to innovate and have greater managerial and organizational capacity, which supports greater adoption of digital technologies.[54] Moreover, it is not only that frontier firms that use technology are doing better, but that laggard firms are doing particularly poorly. This suggests a breakdown in the mechanisms that support the uptake and diffusion of technology.[55] Further work is needed to more fully understand the factors slowing technology diffusion, but some likely reasons are the costs and challenges of developing the tacit knowledge and effectively deploying the capital to take advantage of new technologies such as AI.[56] The need to train workers and develop new business models could also slow the pace that laggards adapt.[57] Large firms can exploit data network effects, increasing the challenge of technology

52. McKinsey Global institution (2015), “Digital America: A tale of the haves and have-mores”, December 2015, p. 5.
53. Andrews, D., C Criscuolo and P.N. Gal, “The Best versus the Rest: The Global Productivity Slowdowm, Divergence across Firms and the Role of Public Policy”, OECD Productivity Working Paper Series, No. 2.
54. Jonathan Haskel and Stian Westlake, “Capitalism without Capital: The Rise of the Intangible Economy”, Princeton University Press 2018.
55. Andrew, D., Criscuolo C., and Gal P. N., “The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy”, OECD Productivity Working Papers, 2016-5, OECD Publishing.
56. Chad Syverson, “Macroeconomics and Market Power: Facts, Potential Explanations and Open Questions”, Brookings Economic Studies Paper, January 2019.
57. Dan Andrews, Chiara Criscuolo, and Peter Gal, 2016 “The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy”, OECD Productivity Working Papers, 2016-5, OECD Publishing.

diffusion and catch up.[58] Other factors could include weakening anti-trust enforcement,[59] and patent thickets that increase costs of innovation for small firms.[60] Policies that increase the rates and depth of technology diffusion could include greater labor market flexibility, increased competition, and availability of risk capital.[61]

2. Develop education and skills

Domestic agenda

Providing education and training will be key if societies are to benefit fully from AI. Most governments' AI strategies emphasize the importance of skills development, often with a focus on STEM. AI will require STEM as well as a broader set of skills that enable people to work alongside AI. For instance, doctors working with AI systems might need familiarity with virtual reality or know how to manipulate 3D models. Even with autonomous vehicles, people are still likely to be needed for the last leg from the van to the door, which will require the ability to work with such autonomous systems.

International agenda

Skills development will be needed globally. There is an agenda here for governments and industry to develop partnerships in other countries, particularly in the developing world.

3. Establish sound cybersecurity

Domestic agenda

Ensuring cybersecurity will be key to developing the full range of economic and social benefits from AI.[62] As the OECD observed, the digital environment is a driver of innovation, productivity, and economic growth, but digital security incidences have the potential to jeopardize economic and social prosperity.[63] Moreover, as the internet and data flows link businesses, platforms, applications, and people, lax cybersecurity in one country can affect cybersecurity outcomes elsewhere.

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58. Ufuk Akcigit and Sina T. Ates, "Ten Facts on Declining Business Dynamism and Lessons from Endogenous Growth Theory", NBER Working Paper Series, April 2019.
59. Grullon, Gustavo, Yelena Larkin and Roni Michael, "Are U.S. Industries Becoming More Concentrated?" 2017, mimeo.
60. Hall, Bronwyn H., Christian Helmers and Georg von Graevenitz (2015), "Technology Entry in the Presence of Patent Thickets", 2015. National bureau of Economic Research Working Paper 21455.
61. Dan Andrews, Chiara Criscuolo, and Peter Gal, "Digital Technology Diffusion: A Matter of Capabilities, Incentives or Both?", Economics Working Papers No. 1476, 8th November 2018.
62. OECD (2012), "Cybersecurity Policy Making at a Turning Point: Analysing a New Generation of National Cybersecurity Strategies for the Internet Economy" OECD Digital Economy Papers, No. 211, OECD Publishing, Paris.
63. OECD (2015), Digital Security Risk Management for Economy and Social Prosperity: OECD Recommendation and Companion Document, OECD Publishing, Paris, p. 24.

Many of the cybersecurity risks raised by digital technologies will apply to AI as well. Yet AI may amplify cybersecurity risks. For example, the expansion and interconnecting of the IoT in homes, cars, and factories, combined with constant collection of data that is analyzed by AI to improve IoT performance means that cyber attacks that misuse or compromise data through an IoT device can cause property damage or compromise personal safety.[64] At the same time, AI can help address cyber risks. According to one survey, 81 percent of U.S. federal government agencies use big data analytics for cybersecurity purposes.[65] This could include using AI to better predict attacks as well as to respond more effectively and in a timely manner.[66]

The opportunity and challenges of AI require governments to develop national cybersecurity strategies. For example, the United States government has outlined a wide-ranging cybersecurity strategy that recognizes securing cyberspace as an economic and national security imperative.[67] The NIST Framework for Improving Critical Infrastructure Cybersecurity provides a common organizing structure for business to guide cybersecurity activities and cybersecurity risk assessment and management.[68] The U.K., Japan, Australia, and China, to name a few, have also developed cybersecurity strategies.

International agenda

As noted, the interconnectedness of the internet, including the connections through devices, sensors, and the cloud means that a cybersecurity breach in one country can have global effects. Yet, addressing cybersecurity also presents economic and trade risks and opportunities. For instance, while getting cybersecurity right is key to ensuring trust in using AI, cybersecurity standards can create barriers to trade in AI. For instance, China is using cybersecurity as a justification to develop China-specific cyber standards. Vietnam requires services to be located domestically for cybersecurity reasons.[69]

Cybersecurity threats are also constantly evolving. This underscores that addressing cybersecurity risks from AI should be risk-based and avoid favoring a particular technology, instead leaving it up to firms to innovate the best solutions. Developing international cyber standards can help distinguish

64. Ashwin Pal, "The Internet of Things (IoT) – Threats and Countermeasures, CSO, https://www.cso.com.au/article/575407/internet-things-iot-threats-countermeasures/, last visited 19th April, 2019.
65. www.meritalk.com/study/navigating-the-cybersecurity-equation.
66. Geluvaraj B., Satwik P.M., Ashok Kumar T.A. (2019) The Future of Cybersecurity: Major Role of Artificial Intelligence, Machine Learning, and Deep Learning in Cyberspace. In: Smys S., Bestak R., Chen JZ., Kotuliak I. (eds) International Conference on Computer Networks and Communication Technologies. Lecture Notes on Data Engineering and Communications Technologies, vol 15. Springer, Singapore.
67. National Cyber Strategy of the United States of America, September 2018.
68. Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1, National institute of Standards and Technology, April 116, 2018 https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.04162018.pdf.
69. Vietnam Decree No. 27/2018/ND-CP amending and supplementing Decree No. 72/2013/ND-CP on Internet Services and Online Information.

between legitimate cybersecurity needs from those aimed at protecting domestic industry. For example, the American NIST framework references international standards where they exist.

Trade agreements should also be used to secure agreement on the need to develop non-discriminatory international standards and to use these to guide the development of domestic approaches to cybersecurity. The WTO Technical Barriers to Trade (TBT) Agreement and FTAs provide a set of rules aimed at minimizing unnecessary regulatory diversity and distinguishing protectionist standards from otherwise legitimate regulation. For instance, under the WTO TBT members must use international standards as basis for their technical regulation unless the standard would be inefficient or inappropriate.[70] Such international standards are to be developed in an open and consensual basis. In addition, mutual recognition of standards or conformity assessment should be non-discriminatory and open to participation.[71]

Trade agreements can also be used to encourage cooperation on cybersecurity. For instance, USMCA includes a commitment by the parties to endeavor to build the cybersecurity capabilities of their relevant national entities and to strengthen cooperation to help identify and respond to cybersecurity incidents.[72] The parties to USMCA also agree to use risk-based approaches to deal with cyber threats, reflecting that uncertainty as to future cyber threats requires a calibrated response.

Capacity building in other countries should also be part of an engagement strategy on AI. Such capacity building is in everyone's interest given the potential cross-border nature of cybersecurity threats. Progress here will enable other countries to better protect themselves and assist in addressing threats that target mutual interests.[73]

4. Protect the privacy of personal data

Domestic agenda

Strong privacy rules will be required for people to willingly allow their personal data to be used for AI learning. From this perspective, there is no inherent trade-off between developing AI and strong privacy rules. Yet, it is in the details that privacy rules can create burdensome compliance costs, particularly for small and medium enterprises, or privacy rules can be poorly adapted to the realities of how data is collected and used.

70. WTO TBT Agreement Article 2.4
71. WTO Agreement on Technical Barriers to Trade; United States-Mexico-Canada Agreement Technical Barriers to Trade Chapter.
72. USMCA Article 19.15.
73. National Cyber Strategy of the United States of America, September 2018.

The U.S. approach to privacy relies on sectoral privacy laws in areas such as health information,[74] information collected for insurance or employment,[75] and information provided to financial institutions.[76] In addition, the Federal Trade Commission (FTC) protects consumer privacy through enforcement of Section 5 of the FTC Act, which prohibits "unfair or deceptive acts or practices in or affecting commerce."[77] The NIST is also developing a voluntary Privacy Framework that would complement the NIST Cybersecurity Framework.[78]

Despite these privacy protections, in a 2017 Pew survey, two-thirds of American said that current laws are not good enough at protecting people's privacy. Various U.S. states have privacy laws and the 2018 California Consumer Privacy Act (CCPA) (which comes into effect on January 1, 2020) provides levels of protection similar to the EU General Data Protection Regulation (GDPR). In this context, a 2019 report by the U.S. Government Accountability Office (GAO) recommended developing federal privacy legislation.[79]

The EU GDPR is the other main privacy model and provides a comprehensive set of privacy rules, including with respect to cross-border data flows. From an AI perspective, the challenge is to have privacy rules that are effective and sensitive to how data is collected and used to develop AI systems.

International agenda

As countries and regions develop privacy rules, mechanisms will be needed to ensure interoperability of privacy systems. The U.S. allows cross-border transfers of personal data across borders, holding the U.S. entity transferring the data liable for any breach or treatment of the data inconsistent with its privacy policy. In contrast, under the GDPR, personal data can be transferred to a non-EU country that has adopted a privacy regime whose level of protection is "essentially equivalent" to that guaranteed within the EU.[80] Other GDPR options are for firms to transfer data in accordance with Binding Corporate Rules (BCRs) or Standard Contractual Clauses (SCCs). BCRs and SCCs are mechanisms, respectively, to authorize company-wide or transaction-specific data transfers. All these mechanisms are costly, particularly for small businesses. Moreover, a physical presence in the EU or representative is required in order to use BCRs or SCCs.

74. Health Insurance Portability and Accountability Act, Pub. L. No. 104-191, 110 Stat. 1936 (1996).
75. Fair Credit Reporting Act, Pub L. No. 91-508, 84 Stat. 1114 (1970).
76. Gramm-Leach-Bliley Act, Pub. L. No. 106-102, 113 Stat 1338 (1999).
77. 15 U.S.C S45(a)(1).
78. https://www.nist.gov/sites/default/files/documents/2019/02/27/outline_privacy_framework_2.27.19.pdf
79. GAO 2019. Internet Privacy. Report to the Chairman, Committee on Energy and Commerce, House of Representatives, GAO-19-52.
80. Schrems v. Data Prot. Comm'r [2014] I.E.H.C. 310, para 73.

So far, considerable effort has gone into developing global privacy principles and interoperability mechanisms including by the OECD and the Asia-Pacific Economic Cooperation (APEC) forum, with support from trade agreements such as CPTPP and USMCA. The following outlines elements of an emerging framework to support cross-border data flows for AI that also addresses underlying privacy concerns[81]:

1. Further develop global privacy principles, building on existing principles such as those in the OECD.[82]
2. Implement domestic privacy laws and regulations based on global privacy principles. The GDPR and U.S. approaches to privacy are consistent with OECD Privacy Principles, though the GDPR goes further in a number of areas. This underscores that global privacy principles can provide a common baseline but will not lead to identical privacy outcomes, requiring mechanisms to bridge the differences.
3. Build interoperability mechanisms that allow personal data to flow between countries with different privacy regimes. For example, the U.S.-EU Privacy Shield allows for data flows between the U.S. and EU, despite having different approaches to privacy. The Privacy Shield could be a building block for greater global interoperability.
4. A commitment by governments to the free flow of data, limiting data flow restrictions to those necessary to protect domestic privacy standards. This is consistent with the approach in USMCA and CPTPP.

5. Increase access to government data

Domestic agenda

Governments can increase the availability of data by expanding access to publicly held datasets. As the OECD has observed, open government data can become the "platform that fuels the development of useful applications and solutions."[83] The U.S. federal government has made progress here in developing data as a strategic asset, including the development of a Federal Data Strategy, which aims to provide a consistent approach to federal data stewardship, use, and access.[84] Sharing data sets across government agencies and with state and local governments as well as with researchers and the private sector requires a consistent, transparent, and standardized governance framework. This includes common data standards and procedures for data management and release.

81. See A. Mattoo and J. P. Meltzer (2018), 'Data Flows and Privacy: The Conflict and Its Resolution', 21(4) *Journal of International Economic Law*.
82. 2013 OECD Privacy Guidelines on the Protection of Privacy and Transborder Flows of Personal Data, https://www.oecd.org/sti/ieconomy/oecd_privacy_framework.pdf.
83. OECD (2018), Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact, OECD Digital Government Studies, OECD Publishing, Paris.
84. https://strategy.data.gov.

International agenda

Many governments approach the open data opportunity from the perspective of increasing government transparency. This is important, but governments should also see data as a source of broader social and economic opportunity.[85] To operationalize will require building governance frameworks that can manage the privacy and security risks from access to government data.

There are various initiatives underway that support and guide governments as they increase the availability of government data. These include the International Open Data Charter adopted by a range of governments, including Australia, the U.K., Canada, Argentina, France, and South Korea, which includes the principles that government data should be open by default. The G-20 Anti-corruption Open Data Principles underscore the importance of open data for improving government transparency and reducing corruption. The OECD has identified a common framework to ensure policy impact from open data.[86] ISO has also developed principles on the governance of data.[87]

The USMCA includes some commitments to open data, including to make such data available in machine-readable form and to working together to find ways to increase access to government data. Such commitments are an important first step. Future trade agreements could expand on these commitments, such as by referring to open data principles and governance frameworks as a basis for governments' approach to open data.

6. Develop a balanced intellectual property framework

Domestic agenda

The development of AI raises IP issues. For example, training data for AI will often need to be copied and edited for use. Depending on how the data is collected, this could involve thousands of instances of unauthorized copying of protected works. In the U.S., it may be that relying on "transformative" or "non-expressive" fair use exception to copyright protection will provide legal cover for such use of data.[88] Fair use provides a flexible principles-based set of copyright exceptions.[89] These exceptions have supported a range of new digital business models in the U.S.[90]

85. OECD (2018), Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact, OECD Digital Government Studies, OECD Publishing, Paris.
86. Ubaldi, B. (2013), "Open Government Data: Towards Empirical Analysis of Open Government Data Initiatives", *OECD Working Papers on Public Governance*, No. 22, OECD Publishing, Paris.
87. Information technology-Governance of IT-Governance of data-Part1: Application of ISO/IEC 38500 to the governance of data, ISO Standard 38505-1: 2017.
88. Authors Guild v. Google Inc., 804 F.3d 202 (2nd Cir. 2015).
89. https://fairuse.stanford.edu/overview/fair-use/what-is-fair-use/.
90. See Perfect 10 Inc. v. Amazon. Com, Inc., 508 F. 3d 1146 (9th Cir. 2007), allowing fair use to excuse an image search engine's unauthorized reproductions of copyrights photographs; and Capitol Records, LLC v. ReDIGIT Inc., 934 F.Supp.2d (S.D.N.Y. 2013) which found that fair use does not excuse a second hand marketplace for digital sound recordings from liability for infringement.

International agenda

Fair use exceptions or similar copyright flexibilities do not exist in many other countries. For instance, the EU uses a specific list of exceptions to copyright law that does not include text and data mining and would not seem to include AI. Australia adopts a similar approach as the EU.[91] From an international trade perspective, this means that legal copying of data to develop AI in the U.S. might be deemed illegal in other countries, creating a barrier to the deployment of AI in these countries.

Trade agreements have been hesitant in addressing the scope for copyright flexibilities. The inclusion in the CPTPP of a recognition by the parties of the need to achieve "an appropriate balance in its copyright and related rights systems" is a step towards developing similar copyright exceptions.[92] However, the USMCA does not restate the need for such a balanced approach to copyright protection. Going forward, trade agreements should continue to pursue the need for balance in IP rules.

7. Develop AI ethical principles

Domestic agenda

As noted, a sustainable environment for AI development will require establishing trust in AI.[93] A key element will be ensuring that AI processes and outcomes are ethical. In fact, the need to develop ethical AI has been recognized by the U.S., the EU, and other governments.[94] For instance, part of the EU AI strategy includes the notion of "building trust in human-centric AI."[95] This has included development of ethical guidelines by a High-Level Expert Group on Artificial Intelligence.[96]

Any attempt to establish ethical principles for AI must encompass how AI systems operate and what values they reflect and safeguard. This includes compliance with the law as well as ethical principles, which the EU sees as including respect for human dignity, freedom, democracy, and respect for human rights.[97] Part of AI ethics also involves transparency and an ability to explain how AI systems achieve results. This includes avoiding so-called algorithmic bias where AI produces

91. Joshua P. Meltzer, "Digital Australia: An Economic and Trade Agenda", Brookings Working Paper 118, May 2018
92. Comprehensive and Progressive Agreement for Trans-Pacific Partnership, Art 18.66.
93. OECD 2018. "Going Digital in a Multilateral World", Meeting of the OECD Council at Ministerial level, Paris 30-31 May 2018, p.33.
94. The National Artificial Intelligence Research and Development Strategic Plan, October 2016; Artificial Intelligence for Europe COM(2018) 237 final.
95. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Region, "Building Trust in Human-Central Artificial Intelligence", COM(2019) 168 Final.
96. https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines#Top.
97. Building Trust in Human-Centric Artificial Intelligence, COM(2019) 168 final, p. 2.

discriminatory or biased outcomes because the training data itself includes such biases or develops bias as the algorithm evolves.[98]

International agenda

While ethical guidelines seem necessary, there is the risk that they only reflect local standards and norms, with discriminatory impacts on access to data and use of AI. In fact, the EU is explicit that its ethical approach to AI is about building trust and building a competitive advantage for its companies.[99] This underscores the importance of international cooperation in developing AI ethics frameworks to avoid unnecessary barriers to AI diffusion globally. The OECD is in the process of developing AI principles which could help provide a baseline. The G-20 could also take up this challenge. Even with a common framework, countries might depart in some ways. Moreover, there will be the question of how to assess whether AI systems were built ethically or produce ethical outcomes. This raises trade issues such as in which country testing takes place and to what standards. These process issues could be discussed in trade negotiations at the WTO and in FTAs.

Summary

AI is emerging as a pivotal technology that will transform how economies grow, businesses trade, and people work. Attuned to the significance of AI, governments are rolling out an array of AI frameworks, including agendas and policies aimed at building domestic AI capabilities. AI development will also require regulatory oversight as well as efforts to prepare people for developing and working alongside AI and policies to mitigate AI's potential economic and social downsides. This matters because some jobs will inevitably be lost due to AI-driven automation and the potentially significant social effects of AI, if not carefully managed, could lead to a backlash and regulation that stifles innovation and the diffusion of AI globally, an outcome that will most likely be born disproportionately by developing countries.

At the same time, international coordination on AI regulation, including the development of shared norms and standards in areas such as privacy, cybersecurity, open data and AI ethics are needed to avoid the proliferation of unnecessary regulatory heterogeneity that raises the cost of AI diffusion

98. John Villasenor, "Artificial Intelligence and Bias: Four Key Challenges", www.brookings.edu/blog/techtank/2019/01/03/artificial-intelligence-and-bias-four-key-challenges/.
99. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Region, "Building Trust in Human-Central Artificial Intelligence", COM(2019) 168 Final.

globally, including trade in AI-embedded products. Among other things, this will require working with organizations such as the OECD; coordinating with international standard-setting bodies, and; including AI disciplines in trade agreements.

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