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Machine Learning, Artificial Intelligence and Policy Challenges in Economic and Health Sciences

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ABSTRACT

As artificial intelligence capabilities continue to advance at a rapid pace, machine learning has become integral to driving innovation across various industries. Machine learning refers to the ability of computer systems to learn from large amounts of data without being explicitly programmed. There are three main types of machine learning - supervised learning, unsupervised learning, and reinforcement learning. Supervised learning involves using labeled examples to train machine learning models to produce outputs based on given inputs. Unsupervised learning looks for hidden patterns in unlabeled data to perform tasks like clustering, association, and dimensionality reduction. Reinforcement learning focuses on learning via trial-and-error interactions with a dynamic environment, typically involving reward feedback loops. Within machine learning, two main approaches that have achieved significant success in recent years are deep learning and neural networks. Deep learning utilizes artificial neural networks, which are loosely modeled after biological neural connections in the brain. These networks can self-adjust through a process known as backpropagation to iteratively learn representations of data with multiple levels of abstraction. Deep learning algorithms have been applied to solve complex problems in computer vision, natural language processing, recommendation systems, and other domains by taking advantage of vast amounts of available data. As machine learning continues to power increasingly autonomous systems, addressing challenges around algorithmic bias, explain ability, privacy and security will be crucial to ensuring its transparent and ethical development and implementation.

1. Introduction

In recent years, the strategic competition between the United States and China has grown more intense due to China's increasing economic and military capabilities [1-2]. According to the perspective of structural realism, this rivalry is a natural outcome of shifting power dynamics [3]. Offensive realism suggests that both countries seek to maximize their power rather than simply maintaining their current positions [4-7]. However, constructivists argue that rivalry is not predetermined but rather influenced by competitive discourse and identities that perpetuate mistrust and tensions [5-9]. Within the framework of economic statecraft theory, the United States seeks to leverage interdependence as a means to pursue strategic objectives in relation to China [10].

However, the deep economic integration and mutual vulnerabilities between the two countries limit the feasibility of complete decoupling [11]. The rivalry has further intensified due to the attitudes of leadership, with the United States employing strategies to contain China's geopolitical and technological ascent [12]. Nevertheless, US allies often hesitate to adopt rigid divisions due to their interests in economic exchange and global cooperation [13-15]. Thus, effectively managing this rivalry necessitates addressing power shifts, threat perceptions, economic realities, and shared interests [16].

2. Geopolitical Dimensions of Global Value Chains

Global value chains intersect with geopolitics in various complex ways [17-22]. Leading companies play a significant role in shaping the governance dynamics within production networks based on their corporate priorities [22-25]. However, their control is limited by state regulations, local capacities, and the agency of suppliers [26]. States implement policies to enhance national competitiveness and leverage participation in global value chains for strategic advantage [27]. Nonetheless, multilateral cooperation remains essential for facilitating trade, investments, and the diffusion of technology that underpin global value chains [28]. On the other hand, national security concerns often lead to export restrictions on critical technologies, which in turn have implications for the flow of global value chains and power balances [29]. However, attempting to curb interdependence can be an ineffective strategy if the costs outweigh the benefits [30]. Geopolitical tensions also increase risks within supply chains [31]. However, global value chains create incentives for strategic restraint by raising the costs associated with conflict [32]. Therefore, scholarly research emphasizes the importance of managing rivalry and economic security within an interconnected world [33].

In conclusion, achieving sustainable development requires adopting integrated and systemic perspectives that consider the complex dynamics at the local and global levels. Furthermore, power manifests itself through intricate and contingent relationships within networks shaped by historical factors and discourse. While strategic conflicts have intensified in recent times, the presence of economic interdependence underscores the limitations and costs associated with complete decoupling. Scholarly discourse emphasizes the necessity of strategic cooperation alongside competition to advance shared interests. Insights from various disciplines highlight the interconnected nature of geopolitics, economics, technology, and sustainability in the modern era. This underscores the imperative of conducting holistic and nuanced analyses to navigate global challenges.

As highlighted in the literature survey, addressing global challenges requires a comprehensive understanding of the intricate connections among socio-economic and political domains. To grasp the evolving dynamics that influence sustainability pathways, it is necessary to adopt an integrated systems approach. Figure 1 depicts a network framework that synthesizes the intersecting dimensions derived from the reviewed

literature, illustrating the complex relationships involved. The diagram illustrates how sustainability challenges arise from the interplay of various factors across different scales, ranging from local to global. By visually representing the interconnectedness of development priorities, power structures, policy environments, and technological advancements, the figure offers a way to conceptualize these complexities. It presents a central concept surrounded by associated elements, aiming to concisely convey the importance of analyzing multiple perspectives. This representation aligns with viewpoints emphasizing the contextual nature of challenges, which are shaped by intricate linkages among ecological, economic, and geopolitical spheres.

2.1. Important Changes in the Trump Administration's Guidance Document on the Strategic Shift to Trade and Economy

The Trump administration has released several key government research reports that shape its policy direction. One of these reports is the National Security Strategy Report (December 18, 2017), which not only identifies China as a major competitor but also marks the declaration of a "new era" of broad-based global competition for the United States. The significance of this report lies in the shift from Trump's initial isolationist stance to a "principled realism" approach, as reflected in the revised "America First" campaign slogan. This revision aims to alleviate concerns and anxieties among countries that traditionally or potentially cooperate with the United States.

Another important report is the Defense Strategic Security Report (DSSR) released on January 19, 2018. Jointly issued by multiple departments, including the Department of Defense, the CIA, and the Department of Commerce, the DSSR emphasizes that strategic competition between nations, particularly China and Russia, is now the primary concern for U.S. national security, surpassing terrorism. The report highlights the concept of "strategically predictable, operationally unpredictable" to indicate that U.S. military strategic actions may appear erratic but are driven by deeper strategic intent and planning. Additionally, the United States aims to enhance control over allies through a combination of strength and kindness, linking military actions to commercial cooperation opportunities.

As we entered the second half of 2018, the U.S. foreign strategy further crystallized, with a focus on industrial economic strategy. German enterprises involved in the production of parts and components, known as "hidden champions," were particularly highlighted for their outstanding performance. These government research reports released during the Trump presidency provide insight into the evolving policy direction of the United States, emphasizing competition with China, a shift from isolationism to "principled realism," and a focus on strategic planning and economic interests [32-34].

2.2 U.S. "Semi-Decoupling" Strategy on China's Economy and Trade

The economic and trade relations between the United States and China have undergone significant structural adjustments at various levels, including the country, industry, and functional customs zones. These adjustments reflect the desired characteristics of the "semi-decoupling" strategy. Notably, there have been substantial changes in the trade of goods between the two countries. Since Trump assumed office in 2017 until September 2019, the growth rate

of U.S. trade in goods with China declined from 12.8% to -7.4%, while the growth rate of imports fell from 9.3% to 6.7%. These changes indicate the United States' increased resistance and deeper adjustment in response to its European manufacturing competitor, Germany, as well as China. Meanwhile, the United States has strengthened its ties with traditional partners in North America and East Asia as part of the realignment of global trade relations. Additionally, the United States' deficits with its traditional sources of trade imbalances have widened, while trade imbalances with Germany and China have converged to a greater extent, and trade dependence has decreased.

At the industry level, three major categories of commodities dominate the U.S.-China trade structure: machines, machinery, electrical equipment and parts; vehicles, aircraft, ships, and transportation equipment; and optical and precision instruments and equipment. These categories encompass a wide range of advanced manufacturing industries, high-end technology demand, and competitive international markets. Under the influence of the tariff trade war, the import and export situation in these categories has gone through three stages: (1) a sharp decline in trade growth due to the obstructive impact of the United States' 301 and 232 investigations in the first quarter of 2018; (2) tariff increase plans announced by the United States from the second quarter of 2018 to the end of 2018; (3) since January 2019, the combined effect of tariffs and market pessimism has led to a recessionary phase of negative growth in bilateral trade.

China has seven Special Economic Zones (SEZs), with five located in the southeast coastal region, accounting for nearly 70 percent of total global Export Processing Zone (EPZ) exports. However, the profitability of these zones, as reflected in the value added in total exports, remains low due to the high import content in their exports. Being in the middle processing segment of Global Value Chains, these processing zones are dependent on the supply of external intermediates and the demand for final goods. These characteristics represent structural weaknesses that emerge under the impact of changes in China's economic and trade model, which was previously dominated by "three to one" (investment, exports, and consumption) and relied on foreign exports. The United States' initiation of the "entity list" and potential leadership in future high-standard trade systems, such as a "TPP-like" trading platform, may serve as strategic competitive tools for the systematic "decoupling" that could occur [34-36].

In summary, the economic and trade dynamics between the United States and China have witnessed significant adjustments and challenges, particularly in the context of the "semi-decoupling" strategy pursued by the United States. These changes have shaped the bilateral trade landscape, highlighted the vulnerabilities of China's economic model, and introduced potential strategic tools that may further impact the relationship between the two countries.

2.3. Power and Constraints in U.S. Strategy toward China in the Perspective of Global Value Chains

2.3.1 The Reshaping of Global Value Chains Using Artificial Intelligence under US Hegemonic Maintenance

Despite the need for further research on the impact of this presidential order on AI development and strategic planning in the United States, including its implications for global power dynamics, it is evident that the country's commitment to advanced science and technology remains unwavering. The existing framework for AI policy in the United States is deeply integrated into various aspects of macro development strategy, machine automation technology, research and development, economic growth, and national security. Notably, the "National Strategic Plan for Artificial Intelligence Research and Development" and the "Artificial Intelligence and National Security" documents are continuously updated, reflecting the comprehensive nature of the U.S. AI policy system and its focused direction. The issuance of the AI executive order by President Trump on February 11, 2019, garnered widespread support from both houses of Congress [37-38].

Table 1 presents a comprehensive overview of significant AI policy documents and official events that occurred throughout the Trump administration. These records play a crucial role in understanding the United States' strategic stance towards artificial intelligence and its far-reaching impacts on sectors such as national security, economic prosperity, and research and development. Analyzing these policy documents and events allows us to gain valuable insights into the government's focal points and endeavors in the field of AI during this specific timeframe.

Table 1: U.S. AI Policy Documents and Official Events During the Trump Administration.

Policy Documents		
Time	Document	Agencies
2016.5.3	Preparing for the future of artificial intelligence	National Science and Technology Council (NSTC)
2016.10	The National Artificial Intelligence Research and Development Strategic Plan	U.S. National Science and Technology Council (NSTC)
2016.12.20	Artificial Intelligence, Automation, and the Economy	The White House
2018.9	Rise of the Machines — Artificial Intelligence and Its Growing Impact on U.S.Policy	U.S. House of Representatives Organizing Committee on Oversight and Government Reform
2019.2.11	Executive Order on Maintaining American Leadership in Artificial Intelligence	U.S. President Donald Trump
2019.2.11	American AI Initiative	U.S. National Science and Technology Council (NSTC)
2019.2.12	Summary of the 2018 Department of Defense Artificial Intelligence Strategy	Department of Defense (DOD)
2019.11.21	Artificial Intelligence and National Security	U.S. Congressional Research Service (CRS)
Official Events		

2016.5.25	Public Lecture on "The Future of Artificial Intelligence"	Then-President Barack Obama
2018.5.10	Summary of the 2018 White House Summit on Artificial Intelligence for American Industry	U.S. National Science and Technology Council (NSTC)
2018.6	Summit on Novel AI High Performance Computing (HPC) Systems	U.S. Department of Energy (DOE)
2018.9.8	AI Next Campaign	U.S. Department of Defense Advanced Research Projects Agency (DARPA)
2018.10	AutomatedVehicles3.0 : Preparing for the Future of Transportation, AV3.0	U.S. Department of Transportation (DOT)
2019.9.9	Summary of the 2019 White House Summit on Artificial Intelligence in Government	U.S. National Science and Technology Council (NSTC)

Table 1 tabulate the significant AI policy documents and official events that took place during the Trump administration. It commences with the release of the "Preparing for the future of artificial intelligence" document by the National Science and Technology Council in May 2016, which underscores the necessity of preparing for the advancements and challenges associated with AI. To further emphasize the government's dedication to AI, the "National Artificial Intelligence Research and Development Strategic Plan" was published by the U.S. National Science and Technology Council in October 2016. This strategic plan outlines a comprehensive roadmap for research and development endeavors, establishing the groundwork for AI-related policies and initiatives. Table 1 also encompasses the pivotal "Executive Order on Maintaining American Leadership in Artificial Intelligence," issued by President Donald Trump on February 11, 2019. This executive order exemplifies the administration's unwavering focus on upholding the country's leadership position in AI. It is accompanied by the release of the "American AI Initiative" document by the U.S. National Science and Technology Council on the same day, which provides a strategic framework for advancing AI technologies across various sectors of the economy.

Additionally, the table highlights noteworthy official events pertaining to AI. For instance, the "White House Summit on Artificial Intelligence for American Industry" in May 2018 served as a platform for stakeholders to convene and discuss the implications and potential of AI in diverse industries. Moreover, the "AI Next Campaign," initiated by the Department of Defense Advanced Research Projects Agency in September 2018, signifies the government's recognition of AI's significance in national defense and military applications.

2.3.2 U.S. Uses Artificial Intelligence to Lead the Fourth Industrial Revolution

2.3.2.1 Number of AI startups in the US

By 2018, the United States had established itself as a dominant force in the field of artificial intelligence, surpassing other leading nations such as China, the

United Kingdom, Canada, India, and Israel. The US boasted an impressive count of over 2,000 AI enterprises, a number that exceeded the combined total of the aforementioned countries. Notably, the northeastern regions of New York and Boston emerged as key centers for AI enterprise concentration, contributing to approximately one-third of the overall count.

Additionally, the southern region, with Austin, Texas as its core, also emerged as a prominent hub for AI activities. The field of artificial intelligence has seen significant growth and development in recent years, with various countries striving to establish themselves as leaders in this domain. Among these countries, the United States emerged as a dominant force in AI by 2018, surpassing other leading nations such as China, the United Kingdom, Canada, India, and Israel. The US boasted a substantial number of AI enterprises, exceeding the combined total of the aforementioned countries [38-41]. Table 2 highlights some of the notable AI unicorn companies and sectors in the United States.

Table 2: U.S. AI Unicorn Companies and Sectors

Company	Sector
Pony.ai	Driverless
Afiniti	AI software
Avant	IP solutions
UiPath	Robotic process automation
Uptake Technologies	Big Data Analytics
Tanium	Cybersecurity
Butterfly Network	Smart Medical Devices
Dataminr	Cyber information capture
Seismic	Enterprise software solutions
Tempus Labs	Biotechnology
Automation Anywhere	Automates machine processing
CrowdStrike	Cloud computing, information security

Table 2: U.S. AI Unicorn Companies and Sectors

Company	Sector
SoundHound	Music recognition software
Tempus	Precision Medicine
Indigo Agriculture	Agricultural technology

Table 2 shows insights into prominent AI unicorn companies in the United States and their respective sectors applying AI technologies, exhibiting exceptional growth with valuations over $1 billion. Companies featured utilize AI for customer behavioral analytics (Afiniti), intellectual property management (Avant), robotic process automation (UiPath), predictive maintenance via big data analytics (Uptake Technologies), cyberthreat detection and mitigation (Tanium), sales engagement and predictive analytics (InsideSales.com), and driverless technology (Pony.ai). Additionally, companies develop AI-powered smart medical devices (Butterfly Network), capture and analyze cyber information in real-time (Dataminr), provide enterprise software for sales and marketing optimization (Seismic), advance precision medicine through biotechnology (TempusLabs), specialize in automated machine processing through robotic process automation (AutomationAnywhere), employ AI for cybersecurity threat detection and response (CrowdStrike), develop music recognition software (SoundHound), and optimize agriculture (Indigo Agriculture). These companies demonstrate cutting-edge progress in areas such as customer analytics, intellectual property, automation, cybersecurity, healthcare, biotechnology, precision medicine through diverse AI applications, showcasing United States dominance in innovation.

2.3.2.2 U.S. Artificial Intelligence Ecosystem Financing Scale

While the state of artificial intelligence in the United States saw limited financing in 2012, with $560 million invested across 150 projects, substantial growth occurred by 2017. Total AI industry funding reached $6 billion that year, distributed amongst 660 projects - a more than tenfold and fourfold increase respectively. Preliminary stage investments, including seed and angel rounds making up 50% of total funding, demonstrated dependence on start-up support. Meanwhile, 20% of financing came from Series A rounds, reflecting the market's ability to recognize promising early direction and performance.

This funding landscape highlights developmental differences across application areas. Computer vision enjoyed early work and relatively simple techniques,

achieving high maturity across applications. Core vision and language processing technologies iteratively advanced hardware capabilities. Similarly, speech and language recognition progressed, with numerous competitors emerging. While the nascent AI industry commanded modest backing in 2012, exponential financing growth over five years showed increasing recognition and allocation of resources towards this strategic sector. Continued funding at the seed level with later validation of outputs through Series A rounds facilitated the establishment and growth of AI capabilities in diverse fields [41-44]. Table 3 provides a comprehensive depiction of the prominent market investors involved in the United States' AI domain. The table showcases key players who have made significant financial contributions to AI ventures and emerging startups. These investors have played a pivotal role in fostering the expansion and maturation of the AI industry, thereby facilitating its evolution into a strategically significant sector.

Table 3: Major U.S. Market Investors in Artificial Intelligence

Market Investors	Description
Sequoia Capital	Founded in Silicon Valley in 1972, Apple, Google, Cisco, Oracle, Yahoo, LinkedIn and other companies in the initial stage of the first institutional investor, "2019 Hurun Global Unicorn Active Investment Institutions Top 100 List" No. 1.
Accel Partners	Founded in 1984 in California, USA, internationally renowned venture capital firm, No. 12 on the 2019 Hurun Global Unicorns Top 100 Active Investment Institutions list.
Y Combinator	Founded in 2005, a famous business incubator in the U.S., No. 18 on the "2019 Hurun Global Unicorns Top 100 Active Investment Institutions".
Kleiner Perkins Caufield&Byers (KPCB)	Established in 1972, the largest venture fund in the U.S., mainly undertaking school property investment business of famous universities.
New Enterprise Associates	Founded in 1978, one of the leaders in the global venture capital industry, with a capitalization of $6 billion, focusing on technology, consumer and healthcare sectors.
Khosla Ventures	Founded in 2004, a strategic investment firm specializing in information technology.
First Round Capital	Founded in 2004 as an angel investor focused on early-stage investments.
Techstars	Founded in 2007 in Colorado, Venture Capital Firm, featuring a model that provides 10 mentors per startup.
Andreessen Horowit	Founded in California in 2009, a16z is a private venture capital firm that invests in early-stage startups and established growth companies in the mobile, gaming, social, e-commerce, education, and enterprise IT (including cloud computing, security, and software services) industries.

SV Angel	A San Francisco-based angel investment fund that advises startups on business development, financing, M&A, and other strategies, and was involved in building Silicon Valley's premier Bitcoin community, the Stanford Bitcoin Group.
500 Startups	Focused on early-stage venture capital firms, with an emphasis on minority entrepreneurial programs.
Data Collective, DCVC	Non-profit startup focused on information and data sharing for civic education.

2.3.2.3 U.S. Patent Structure for Core Artificial Intelligence Technologies

The dominance of large multinational companies and the global AI patent landscape clearly demonstrate the development pattern in the United States. Microsoft leads the way with 5,930 filed patents, while Alphabet, the parent company of Google, ranks 10th with approximately 3,900 filed patents. Nuance Communications, a prominent player in intelligent speech recognition, holds the 23rd position with around 1,700 patent applications. Intel and Hewlett-Packard occupy the 27th and 28th spots, respectively, both with approximately 1,500 applications each. It is worth noting that Alphabet has a unique position due to its shift towards acquiring AI companies worldwide, replacing its own research and development efforts. Consequently, its recent patent application activity has not been as high as its previous numbers.

2.3.2.4 U.S. Artificial Intelligence Talent and Top Expert Workforce

The United States holds a dominant position in terms of the number of leading experts specialized in various technical subfields of AI, ranging from 700 to 1200 individuals (see Tables 4). These experts hail from renowned institutions such as the California Institute of Technology, the American Enterprise Institute, Cornell University, the "Parasol" lab at Texas A&M University, the University of Wisconsin-Milwaukee, Purdue University, the University of Utah, Clemson University, the "LIGO-Hanford" Observatory (comprising experts from Caltech and MIT), the University of Illinois at Urbana-Champaign, and major corporations including IBM, Microsoft, Facebook, and Google. By comparing the data, we can gain a more intuitive understanding of the first-mover advantage that underpins the United States' global leadership in AI competition. While China and the United States often secure the top two positions across most specific subfields, China's team of top experts in each technical area typically ranges from only 150 to 400 individuals. Notably, in the field of multimedia technology (which falls outside the core AI complex technology competition field), China possesses a team of 572 experts, surpassing half the number of experts in the same field within the United States [44-46].

3.1. The New Strategic Means of U.S. Maintenance of Hegemony and the Deconstruction of China's Value Chain

3.1.1. Strengthening leadership over traditional allies by setting international rules and standards for artificial intelligence

The United States has implemented several strategic plans and initiatives to accelerate the deployment of high-speed Internet access, particularly focusing on the advancement of 5G technology. In April 2019, the Trump Administration introduced the "5GFastPlan" to establish U.S. dominance in 5G networks. This plan encompasses three key components: increasing the availability of spectrum, updating infrastructure policies, and modernizing regulations. The Federal Communications Commission (FCC) has prioritized the auctioning of high-band spectrum, including the 28,000MHz, 24,000MHz, 37GHz, 39GHz, and 47GHz bands, to facilitate the development of 5G networks. Additionally, the FCC is revising infrastructure policies and encouraging private sector investments in 5G networks, as the private sector plays a crucial role in AI development.

The release of high-frequency spectrum bands into the market is expected to significantly stimulate AI research and application initiatives, creating a vast public space for innovation. In line with these efforts, on May 3, 2019, the United States, along with 32 Western countries, convened in Prague, Czech Republic, ostensibly to discuss strengthening the security of 5G networks and product supply chains from a national security perspective. However, this meeting effectively served as a platform for the U.S.-led Western bloc to exclude China from the primary global cooperation in 5G development. This gathering culminated in the "Prague Proposal." Analyzing the list of participating countries in the Prague meeting reveals that, apart from Albania, Israel, and two other nations, the remaining 30 countries are all members of the Wassenaar Agreement, an export control regime that regulates the transfer of high-tech goods. This exclusionary approach reflects the hegemonic thinking and tactics employed by the United States and can be seen as a significant signal in the context of a "technological cold war."

This situation bears resemblance to previous experiences in international multilateral trade negotiations, such as the textile industry's role as a core technology strategic competitive industry in global economic history, as well as U.S.-Japan trade negotiations during the period of the automobile industry as a core technology strategic competitive industry [45-48].

3.3.2. U.S. Containment Actions to Proactively Deconstruct Global Value Chains

Simultaneously, the rapid growth of data in the field of artificial intelligence serves as a significant resource, and the United States does not hold a distinctive advantage in this aspect. According to the Internet Data Center (IDC), a global market research organization, it is predicted that by 2020, the volume of data will continue to expand substantially. Additionally, China's competitive potential is evident in its financing model. Although there has been a decline in the number and growth rate of new AI companies globally since their peak in 2015-2016, with the Asian region experiencing a more significant drop compared to the United States and Europe, the global financing for AI has witnessed accelerated growth. Moreover, in terms of scale, Asia has

surpassed the combined performance of the United States and Europe. This contrasting scenario indicates that within the existing limitations of AI technology development, the space for differentiated competition among enterprises is nearly saturated. Consequently, the driving force behind the industry's growth lies in incremental capital. Under this macro-competitive constraint, Asia, particularly China, enjoys a substantial advantage due to its ability to attract concentrated large-scale capital investments [40-45].

Table 4 provides a comprehensive overview of significant projects conducted by the Defense Advanced Research Projects Agency (DARPA) in the field of artificial intelligence (AI). These projects exemplify key advancements and initiatives in various AI domains, reflecting DARPA's pivotal role in driving AI progress.

Table 4: Selected Developments in DARPA's Artificial Intelligence Programs

Time	Project	Fields
2000	Human-Computer Interaction (HCI) System through Dialogue	Human-Computer Interaction, Machine Learning
2001	PerceptOR" project for processing environmental perceptions	"AINextCampaign Program
2005	Global Automated Linguistic Intelligence Exploitation (GALE) Project	Speech Recognition, Natural Language Translation
2008	MachineReading project	Natural text mining based on deep machine learning
2010	Mind's Eye project	Machine Vision
2012	Deep Text Excavation and Filtering (DEFT) Project	Natural text mining based on deep machine learning
2014	BigMechanism project	Machine Learning, Natural Language Text Processing
2016	Explainable Artificial Intelligence (XAI) Project	Machine Learning, Interpretation Techniques
2017	L2M-Lifelong Learning Machines (L2M-Lifelong Learning Machines) program	Scenario-based online machine learning
2018.7.26	Artificial Intelligence Exploration (AIE) Program	AI platform development

2018.9.8	"AINextCampaign program	Two billion dollars to support the creation of systems with common sense, context-awareness, and greater energy efficiency

Covering the period from 2000 to 2018, the table showcases a range of noteworthy projects, including Human-Computer Interaction systems, perceptual processing, linguistic intelligence exploitation, machine reading, machine vision, and text mining. These projects underscore DARPA's commitment to advancing AI technologies and their applications in enhancing dialogue systems, speech recognition, natural language translation, and deep machine learning.

Notably, the table highlights the Explainable Artificial Intelligence Project, which focuses on developing machine learning models with explainability, and the Lifelong Learning Machines program, which centers around scenario-based online machine learning. Furthermore, the table features DARPA's Artificial Intelligence Exploration Program, dedicated to AI platform development, and the AINextCampaign program, which aims to create systems with common sense, context-awareness, and improved energy efficiency. Remarkably, the AINextCampaign program is supported by a substantial investment of two billion dollars.

3.3.3. U.S. Value Chain Deconstruction Moves against China

The United States has employed familiar economic strategies reminiscent of the "Cold War" era. It aims to reinforce the existing technological disparities between major nations by implementing measures such as tariff adjustments and embargo lists in specific trade sectors. The objective is to disrupt and deepen the global value chain in the realm of international competition concerning artificial intelligence. The U.S.'s trade import control policies, as outlined in the 2019 presidential trade policy agenda, involve significant and far-reaching structural adjustments in the composition and proportion of imported goods' origins. These adjustments include: (1) raising the duty-free threshold for the regional origin of automobiles and parts from 62.5% (under the NAFTA framework) to 75% (under the USMCA framework), (2) imposing conditions for duty-free eligibility on automobiles, requiring that 40%-45% of the entire vehicle be manufactured by workers from USMCA agreement countries, with an average wage not less than $16 per hour, and (3) imposing additional duty-free eligibility conditions on automobiles, mandating that certain components of the entire vehicle be produced within USMCA countries [32-44].

3.4. The Impact of the U.S. Taking Advantage of Artificial Intelligence to Reshape Global Value Chains

3.4.1. U.S. Corporate-Driven AI Value Chain Layout Highlights

In recent years, major U.S. companies in the field of artificial intelligence have adopted a strategic approach focused on acquisitions to solidify their market position. For instance, IBM's acquisition of Red Hat in October 2018 to August 2019 redefined the enterprise-class cloud services market. Amazon,

on the other hand, pursued acquisitions to enhance its e-commerce and Amazon Web Services (AWS) cloud services, specifically targeting computer vision technology to bolster image recognition capabilities and investing in natural language processing for artificial intelligence-powered customer service. Additionally, Google Inc. prioritized acquisitions related to search tools, with a particular emphasis on technology startups.

The United States has engaged in numerous and ongoing acquisitions in the field of artificial intelligence, with Google leading the way in terms of scale and completed mergers and acquisitions. This demonstrates the U.S.'s active participation in global artificial intelligence competition through a combination of independent research and development and mergers and acquisitions. Ultimately, these two approaches converge on a common goal: control over key core technologies and core business links. When examining the target objects of U.S. company acquisitions, it becomes evident that they predominantly focus on leading companies from traditional developed countries or those with cutting-edge production lines and technological support. This concentrated resource allocation serves to fortify key strategic areas.

The long-term implications of this model are twofold. Firstly, it allows the United States to maintain its dominant position in research and development. Secondly, it ensures control over crucial technological advancements and core business operations [35-42].

3.4.2. The Paradoxical Tension of U.S. Use of Artificial Intelligence to Reshape Global Value Chains

Based on the aforementioned analysis, it becomes evident that the theoretical revision and practical restructuring of the global value chain driven by artificial intelligence encompass both positive and negative aspects. The United States' strategy of utilizing artificial intelligence to reshape the global value chain faces a significant tension between internal impetus and effectiveness. This tension could potentially become a vulnerability for the U.S. in maintaining its global hegemony during the era of artificial intelligence. The case of ASML, a Dutch company mentioned earlier, exemplifies the substantial tension between internal impetus and effectiveness. It highlights the ongoing and profound adjustments and changes within the U.S. foreign trade control system. These adjustments involve lowering the threshold standards of foreign trade control, shifting the focus of supervision from product diffusion to technology, and flexibly adjusting the power and measures of proactive utilization. Such adjustments have deep-reaching implications. In the context of international division of labor and cooperation, certain high-tech products will experience an increased proportion of indirect value-added within the United States. This, in turn, may lead to a higher share of trade and domestic indirect value-added for these products. Domestic indirect value-added serves as a crucial indicator of a country's position within the global value chain.

To summarize the above analysis, the development of AI technology in terms of scale promises substantial economic and industrial benefits, along with profound societal and lifestyle changes by reconfiguring the factors of production. However, due to its inherent targeting and control, including strategic suppression, the vector-based competition of AI is poised to become a technological "leviathan" of the 21st century, exacerbating global turbulence and imbalances. The potential uncertainties and strategic risks associated with intense technological competition emphasize the need for open international norms founded on manageable technology, controllable rules, regulated competition, and manageable impacts. Furthermore, a cooperative model of competition, rather than a closed and exclusive "club" mentality, is necessary to foster a favorable environment for competition and collaboration [40-45].

3.5. A Proposal for Virtuous Competition in U.S.-China Political Relations and Conflicting Interests

3.5.1. The International Landscape is beginning to reveal a "Parallel Rule" Structure between China and the United States

The initial report from the RAND Corporation on the Belt and Road Initiative suggests that China and the United States, as "parallel partners," pursue their own strategies and policies in the developing world. They neither have realistic cooperation with shared goals nor direct and real conflicts, making them "parallel partners." Concepts such as the "G2" proposed by Fred Bergstein, the "Middle America" concept put forward by Niall Ferguson, and the extended concept of "China-U.S. Co-Governance" do not hold explanatory power in the current Sino-U.S. relations due to the lack of mutual subjective identification. The term "New Cold War" lacks objective basis given China's principled position of non-alignment and has become a metaphorical rhetorical statement.

Considering Morton Kaplan's systematic theory of the "balance of power," the current state of the international community can be characterized as a "balance of power" and a "balance of interests." The "balance of power" is maintained because there is still a significant gap in comprehensive power and volume between the majority of developing countries, including China, and the United States, which prevents a real threat from emerging. The essence of post-crisis international relations and the evolution of the international system lies in the "balance of interests." This means that countries should consciously recognize that external demands based on their own interests should be diverse, and they should be tolerant of different perspectives. The attitude of each country should be open, rather than being limited to a single interest or a specific set of values imposed by certain powerful countries or groups. Each country should have the right to choose a path that aligns with its own interests and development. In this sense, China's advocacy for a community of shared future based on interconnectivity forms a parallel governance pattern in terms of development concepts and modes, alongside the U.S.'s prioritization of national interests. However, this does not indicate that China poses a challenge or threat to the U.S. in terms of the balance of power. China lacks the subjective will to covet the power of others, regardless of its level of material power development. Therefore, "parallel governance" offers additional options for

both countries to consider as reference models for bilateral, regional, and global governance, rather than being seen as challenges or threats initiated by China [40-46].

3.5.2. Comprehensively Deepening Value Chain Cooperation and Avoiding the Self-Fulfilment of the "Huey's Trap"

In the current situation, there are two challenges that need to be addressed in order to enhance cooperation between China, the United States, and the global value chain. The first challenge is commonly referred to as the "Thucydides Trap." While the root cause of the Peloponnesian War is debated, two main factors led to the outbreak of the war: first, subordinate countries or third parties escalating their interests and conflicts into a systemic crisis, thereby influencing the actions of major powers. The structure and dynamics of the alliance system provide a fertile ground for such "small country leverage" to take effect. The second factor is the imposition of continuous trade embargoes, severing communication channels between the warring parties, reducing the cost of engaging in war, and increasing the expectation of gains from war, thus pushing the parties further apart. The second challenge is the "debt trap" often discussed in the context of the Belt and Road Initiative. The three major elements that have historically contributed to debt crises include the uncontrollability of speculative capital, the pressure of short-term debt repayment, and the imbalance between debt levels and GDP. However, the Belt and Road Initiative primarily focuses on on-the-ground projects rather than short-term international capital flows. The loans and assistance provided are medium- to long-term, and they do not disrupt the political and social stability of recipient countries. Furthermore, the construction of the Belt and Road Initiative has not resulted in an imbalanced debt leverage for participating countries. On the contrary, these construction projects contribute to the sustainable development of societies, indirectly benefiting partner countries through increased employment opportunities and the upgrading of technical skills among their workforce.

The concept of a circular economy, which emphasizes the continuous use and recycling of resources, has gained traction as a sustainable alternative to the linear take-make-dispose model. While developed countries are actively implementing circular economy principles, emerging economies face distinct challenges and opportunities in integrating sustainability criteria into their circular economy endeavors. One fundamental principle of the circular economy is resource efficiency. Emerging economies can identify sustainability criteria by focusing on optimizing resource utilization across industries. This involves reducing waste, enhancing energy efficiency, and minimizing resource consumption in production processes. Metrics such as material flow analysis and eco-efficiency indicators can help assess and monitor resource efficiency [45-48].

3.5.3. Local and Global Impacts

Emerging economies need to take into account the sustainability impacts at both local and global levels. The sustainability criteria should address the reduction of local pollution, enhancement of air and

water quality, and preservation of ecosystems. At the same time, they should consider global impacts such as carbon emissions, deforestation, and biodiversity decline. Evaluating these criteria can be facilitated through the use of life cycle assessments and environmental impact assessments [42-48].

3.6.3. Social Equity

In emerging economies, sustainability efforts should not solely focus on environmental aspects but also address social equity considerations. It is important to integrate criteria related to fair labor practices, income distribution, and social inclusion within the framework of the circular economy. Evaluating the social impact of circular initiatives can be achieved by utilizing indicators such as income distribution ratios and metrics that measure worker well-being [40-44].

Technological advancement is another critical criterion for sustainability in emerging economies. Encouraging innovation and progress in eco-friendly technologies, circular business models, and sustainable materials is key to ensuring long-term sustainability. Monitoring progress can be done through metrics such as the number of patents associated with circular technologies [42-46]. Policy and regulation also play a significant role in defining sustainability criteria. Governments in emerging economies should establish clear guidelines and provide incentives for promoting circular practices. Evaluating the effectiveness of policies, regulatory compliance, and stakeholder engagement can help determine the success of these frameworks [36-42].

To foster the circular economy in emerging economies, it is crucial to integrate sustainability criteria into supply chains. This involves assessing the use of recycled materials, circular product design, and end-of-life product management. Measuring progress can be done through metrics such as the percentage of recycled materials used in manufacturing and the adoption of circular design principles. Therefore, developing sustainability criteria for the circular economy in emerging economies requires a comprehensive approach. This includes considering resource efficiency, local and global impacts, social equity, technological advancement, policy and regulation, and circular supply chains. Creating a tailored framework that aligns with the specific context of each emerging economy is vital for achieving sustainable development goals.

In recent years, the global geopolitical landscape has been significantly influenced by the strategic conflict between the United States and China within the global value chain network. This conflict, characterized by a complex interplay of power, economics, and strategy, has profound implications for international relations and global commerce. At its core, the conflict revolves around the United States leveraging its substantial material resources, structural power, and relational advantages to shape China's position within the intricate global value chain system. This multifaceted approach encompasses physical actions, structural encirclement, reconfiguration efforts, and positioning China as a strategic adversary.To gain a deeper understanding of this conflict, it is crucial to examine the relational nature of power. Modern political realism emphasizes that power extends beyond military strength, it also involves the ability to influence and control relationships and alliances. The United States has effectively utilized its diplomatic, economic, and military assets to manipulate the dynamics within the global value chain network.

Furthermore, this strategic conflict has expanded horizontally, as the United States has formulated a comprehensive strategy towards China within the era of global value chains. This strategy includes various measures such as supply chain diversification, export controls, and technology restrictions. These actions aim to diminish China's influence and control over critical supply chains, particularly in sectors like technology and manufacturing. The consequences of this conflict extend beyond containment efforts, as the interconnected nature of economies and supply chains means that these actions can have unintended repercussions, impacting American businesses, consumers, and the dynamics of global trade. The ripple effects of this conflict are felt globally, leading to disruptions and reshaping the geopolitical landscape.

The concept of a circular economy has gained significant recognition as a transformative approach to sustainability and resource management. Unlike the traditional linear economy that leads to waste and environmental degradation, a circular economy aims to maximize the use of resources through recycling, reusing, and remanufacturing. It promotes sustainable practices that prioritize both environmental and economic benefits. Building upon this notion, the concept of a "sustainable circular economy" emerges to encompass broader environmental, social, and economic dimensions. In addition to waste reduction and resource conservation, a sustainable circular economy also addresses social equity, environmental protection, and long-term economic viability. It emphasizes responsible sourcing, fair labor practices, and a holistic approach to product life cycles. Taking sustainability further, the concept of a "smart sustainable circular economy" integrates advanced technologies and data-driven approaches. By leveraging the power of the Internet of Things, artificial intelligence, and digitalization, it optimizes resource utilization, waste reduction, and overall efficiency. This intelligent system enables real-time monitoring, predictive maintenance, and informed decision-making, ensuring that circular practices are not only sustainable but also highly efficient. A smart sustainable circular economy utilizes sensors and data analytics to track product life cycles, optimize supply chains, and enhance recycling and remanufacturing processes. It promotes transparency, traceability, and accountability throughout the value chain, empowering stakeholders to make informed choices aligned with sustainability goals. This approach not only conserves resources but also reduces carbon footprints and promotes ethical practices. Therefore, the progression from a circular economy to a sustainable circular economy and then to a smart sustainable circular economy represents an evolving path towards greater sustainability, encompassing environmental, social, and economic dimensions. While a circular economy focuses on waste reduction and resource efficiency, a sustainable circular economy goes beyond by incorporating social and ethical considerations. Finally, a smart sustainable circular economy leverages technology and data for intelligent, efficient, and sustainable resource management.

To comprehend this conflict, it is essential to explore the relational aspect of power. Modern perspectives on power in political realism emphasize that it extends beyond mere military might, encompassing the ability to influence and control relationships and alliances. The United States has effectively utilized its diplomatic, economic, and military resources to manipulate the dynamics within the global value chain network. Moreover, this strategic conflict has expanded horizontally, as the United States has developed a comprehensive strategy towards China within the era of global value chains. This strategy encompasses various actions, including supply chain diversification, export controls, and technology restrictions. The objective is to diminish China's control and influence over critical supply chains, particularly in sectors vital to technology and manufacturing. The consequences of this conflict extend well beyond immediate containment efforts. Due to the interconnected nature of economies and supply chains, these actions can result in unintended outcomes that impact American businesses, consumers, and the dynamics of global trade. The ramifications of this conflict are experienced globally, leading to disruptions and reshaping the geopolitical landscape.

In conclusion, the strategic conflict between the United States and China within the global value chain network represents a multifaceted and continuously evolving geopolitical landscape. It involves the strategic deployment of power and influence in a highly interconnected world, with far-reaching implications that transcend the borders of the two nations involved. Gaining a comprehensive understanding of these dynamics is crucial for comprehending the contemporary global geopolitical environment and its implications for international relations and global commerce. Future studies should consider conducting longitudinal research to track changes over time and enhance understanding. Efforts should also be made to improve data collection methods and data quality, adopt a multidisciplinary approach to gain a holistic understanding, and focus on policy implications to promote sustainable development within the global value chain network. Addressing these limitations and pursuing future research directions will contribute to a deeper understanding of sustainable development and support more inclusive and equitable economic growth. Additionally, several studies have assessed the sustainability of fashion brands using the Neutrosophical ORESTE methodology, highlighting the importance of analyzing both internal and external factors when forecasting oil demand.

Hence, the interactions and strategic interplay among major powers have significant implications for the global economic and political landscape. Understanding these intricacies requires acknowledging the interconnected nature of relationships within systems. To conceptualize the complex dynamics under investigation, Figure 5 offers a synthesized perspective on the analyzed topics. The literature focused on various dimensions involved in international strategic navigation, particularly how countries leverage their participation in global technological networks. As previously mentioned, an integrated approach is crucial for comprehending the dynamic interactions that unfold over time.

4. Conclusion

The geopolitical landscape is being shaped by the strategic competition between the US and China

within global value chains. This abstract analyzes the strategic moves adopted by the US to maintain hegemony and deconstruct China's position in global value chains. The US aims to strengthen leadership over allies by setting rules for AI and contain China's rise through supply chain diversification and technology restrictions (keywords: global value chains, US hegemony, AI rules, supply chain diversification, technology restrictions, containment). By analyzing government reports and strategically deploying its technological and economic power, the US shapes the global innovation ecosystem. It employs familiar strategies of tariffs, export controls and embargo lists to disrupt value chains and influence the global trade landscape. However, this could have unintended consequences due to economic interdependence. In conclusion, the strategic competition within global value chains represents a complex geopolitical environment with long-term implications. The interconnected nature of economies underscores the limitations of complete decoupling moves. While strategic conflicts have intensified, economic interdependence points to the necessity of cooperative approaches alongside competitive ones. Future studies should employ multidisciplinary lenses to holistically understand the interactions between geopolitics, economics, technology and sustainability over time. Addressing data and methodological limitations will support more inclusive policymaking within global value chain networks. Managing strategic tensions necessitates nuanced perspectives that consider power dynamics, threat perceptions and shared interests for sustainable development.

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