Yet, this order is not unchallenged. The recent Chinese 'takeoff' (Huang, 2012) since late 1970s and remarkable development in leading industries shaping a path to exponential economic growth has increasingly gained relevance on an international stage, threatening USA's established liberal world order and unique position as leader in international politics. This has raised one pertinent question amongst academics and researchers, due to China's re-emergence as a superpower and significant advancements in AI and related technologies, will China use the inevitable fourth industrial revolution to overtake the United States as a superpower, disrupting the rules and hegemon it has formed, just as the US once did in a post-cold war era? What does this mean for the distribution of global power?

The current debates on US-China asserting world dominance are missing one essential element: Europe. In this article, I formulate an argument on why it is essential to include Europe in this conversation. Whilst it's true that the US will long remain to be a superpower as its "market power is still unparalleled and underpinned by the dollar's status as the unrivalled global reserve currency" (Routledge, 2015); China does represent an emerging threat in distribution of power - with the ability to challenge the US status as leading country in the next era of artificial intelligence and related technologies.

Artificial intelligence (thereafter AI) is the driving force of a new round industrial revolution that will cause significant changes in social efficiency, economic growth, and national security. The AI race is a multisectoral race affecting every industry, throughout this journal I present an analysis on the US's, China's, and Europe's, specifically France and Germany, AI advancements and the pivotal role this plays in shaping the future of international politics. Moreover, by dissecting EU-US-China tripartite relationship, I formulate arguments on why it is essential for the European Commission to articulate a clear, unified AI vision centered around developing, a strong ecosystem – ensuring AI doesn't become a source of indifference within Europe

Review of Literature

What is Artificial Intelligence?

Currently AI has been misperceived as extremely futuristic technology that is unobtainable. Due to the vague 'visionary' description of this concept, there are room for various interpretation and analogies from the most far-fetched fiction books to academics drawing parallels to their specific discipline. As these approaches developed alongside AI advancements, the perception of the general technology depicts a flawed image of what AI is and can be. What few understand is that AI is not new: it is mostly based on algorithms developed from pre-existing knowledge from the '60s and '70's.

In order to understand how AI effects, the balance of power and Europe's role, a definition is required; however, defining AI is no easy task. Artificial Intelligence was first coined in 1956 by McCarthy - often referred to as one of the 'founding fathers' of this technology. He defined it as the science and engineering of making intelligent machines, especially intelligent computer programs (McCarthy, 2007). However, as AI evolved, creeping into every sector, the approaches to defining this concept became ever so different. Fundamentally, it refers to a program whose ambitious objective is to understand and reproduce human cognition; creating cognitive processes comparable to those found in human beings (Meurier, 2018). The main reason why this concept has become so relevant in the 20th century is due to two vital innovations that are predominantly responsible for AI entering a new era, an era of: machine learning[1] and deep learning[2] (both of which are subsets of AI). Whilst this paper is focuses on the political implication of this technology it is worth noting that AI advancements have impacted almost every industry from health and transport to development of robots and blockchain due to drastic increases in computing power and the rapid digitalization of

[1] Machine learning uses algorithms to interpret vast amounts of data, learn from that data and make informed decision based the information gathered
[2] Deep learning is technically a subset of AI that layer's structures of algorithms to create an "artificial neural network" that can learn and make decisions independently.

Then, AI R&D provides the necessity framework to determine a nations potential in terms of innovation and capabilities. By further dissecting this section, I will be able to compare each state's potential, thus competitiveness on an international stage. Some of the sections I will be analyzing include: the general paper output and influence in AI related research, the number of AI patent, and the number of AI talent – for both firms and countries.

Finally, for a nation to fully benefit from its vision, hardware, and R&D it must first and foremost develop a strong AI ecosystem. Thereby, by understanding the difference in AI ecosystem of each region through primarily focusing on the funding and number of AI startups, a comparison can be made between China, the US and the EU in terms of their talent and foundations for AI.

Through a cross-country qualitative case study method, I will use these four categories to examine advancements in AI across the US, China, and Europe, specifically France and Germany. This report draws upon specialized databases to understand the current state of the AI industry notably in AI output (journals, patents, and talent), AI specialists and policy documents. The data collected draws upon various reliable sources from both previous academic research conducted and databases.

Comparing AI dreams

Understanding China's AI Dream

In 2017, China's president Xi Jinping outlined his vision for China becoming a global science and innovation leader by 2050. The government has been paving the way for years and the country's knowledge-intensive high-tech sectors has been developing at a rapid pace.

In the 19th Party Congress in October 2017, China's General Secretary of the Chinese Communist Party Xi Jinping outlined his vision for China's advancements and his aspiration for China to be "a leading nation in terms of national power and global impact by 2050" (Roberts et al., 2021) notably regarding "propelling China into a leading position in terms of economic and technological strength" (Jinping, 2017). Development in AI has become fundamental for realizing this goal. A clear turning point in China's AI views that led to such important initiatives to developing this technology was in March 2016 with the victory of Google DeepMind's AlphaGo (a computer program) on Lee Sedol, winner of 19 world titles, 4-1 (Li & Ruiyang, 2016). The victory of the computer algorithm played a vital role regarding China's views on AI and acted as a sort of 'sputnik moment' for China and "the event paved the way for a new flow of funds into the discipline" commented the two professors who consulted with the government on their AI strategy (Mozur, 2017). In July 2017, The State Council of China released the 'New Generation Artificial Intelligence Development Plan' that officially outlined 3 strategic objectives, making China's growth in the AI sector a "national priority". These objectives are: (1) by 2020, China will have actualized important progress in the spheres of AI and AI related technology – with aspirations to make China the world's primary AI innovation center cultivating leading AI 'backbone enterprises' with an AI core industry scale exceeding RMB 150 billion, and of related industries exceeding RMB 1 trillion; further developing its AI ecosystem as well as developing AI ethical norms. (2) By 2025, China aspires to develop "major breakthroughs in basic theories for AI" as well as have official legal frameworks established for AI laws. (3) By 2030, China dreams of becoming the major hub for AI innovation and development with the AI core industry exceeding RMB 1 trillion and related industries exceeding RMB 10 trillion (Graham Webster et al., 2017). Whilst this plan does represent an important milestone for China, it is only a small part of its overall AI strategy, merely acting as a continuation of previous government initiatives like the '14th Five-Year Plan' or the 'Made in China 2025 Industrial Plan'. As well as, in the past, academics and researchers have assumed that China's approaches to AI were defined by its "coherent top-down geopolitically driven national strategy, reflecting Chinese leaders' global ambitions" (Zeng, 2021). With China being a re-emerging global superpower it is home to 23% of AI companies (Lam et al., 2019) - like Tencent, Alibaba, and Baidu - the central government does play an important

guiding role in AI advancements however is not the sole contributor. As scholars like Jinghan Zeng argue, instead of a top-down approach, China's government dictates the overarching goals and is simply designed to help bureaucratic agencies, private companies, academic labs, and subnational governments to achieve their own interests, thus also allowing businesses to adopt, through its flexibility, a bottom-up approach (Zeng, 2021).

Understanding the US's AI Dream

In February 2019, the Trump Administration signed Executive Order (EO) 13859, Maintaining American Leadership in Artificial Intelligence, announcing a nationwide plan for developing AI. This launched the American AI Initiative, identifying USA's long-term vision for AI development under five major strategies (Kratsios & Parker, 2020) that were later codified into laws as part of the National AI Initiative Act of 2020. The EO aims to "ensure that technical standards (…) reflect Federal priorities for innovation, public trust, and public confidence in systems that use AI technologies (…) and develop international standards to promote and protect those priorities". These AI strategies as per the EO include (1) driving technological breakthroughs, (2) developing appropriate technical standards, (3) training the current and future generation of American workers, (4) foster public trust and confidence, and (5) promote an international environment supporting American AI research and innovation (Trump, 2019). In support of this initiative, the Select Committee released an updated version of the 2016 National AI R&D Strategic Plan; accounting for new research and innovations, it outlined eight clear strategic priorities to guide federally funded AI research. According to the 2020 Budget for a 'Better America', it provides USD 688 million for the National Institute of Standards and Technology (NITDR) to "conduct cutting-edge research, including quantum computing, artificial intelligence, and microelectronics" (Kratsios, 2019). Later, the NITDR also released a Supplement Report to the President's FY2020 Budget showing a breakdown of the first agency-by-agency budget allocation for non-defense AI R&D, equating to nearly USD 1 billion for the year (White House, 2020). The document also provides an important baseline that outlines key programs and the administration's strategic priorities, making AI - along with quantum information sciences and strategic computing - the second highest R&D priority behind national security. In addition to USD 1 billion pledged by the US government, starting from 2019 fiscal year, the Defense Advanced Research Projects Agency (DARPA) plans to add an additional USD 2 billion over the next 5 years in "new existing programs called the 'AI Next' campaign". This campaign aims to bring about a 'third wave' of AI technologies where "systems are capable of acquiring new knowledge through generative contextual and explanatory models" (DARPA, 2019). Whilst the US government does play a role in the development of AI, it has over the years adopted a bottom-up approach with private companies leading the growth of AI. It is important to consider, government spending represents a small portion of total investments, with the tech giants like Nvidia, Alphabet and Amazon paving the road for AI investments. As a report from CSET argues, major AI companies are often categorized together as general AI leaders, however, focus on very different subfields within AI with "considerable differentiation in the areas of research they prioritize in". Essentially, positioning the US government as a 'gap filler' in research that is underinvested by the private sector (Gelles et al., 2021).

Understanding the EU's AI Dream

In 2018, the European Council formulated a Declaration of Cooperation on AI, signed by 25 European member states (including the UK). Whilst some of these countries, mainly the west, already have announced their own AI initiatives it is essential for the EU to formulate a coordinated approach to increase its competitiveness with major powers like the US and China as well as to ensure that 'European values' are upheld. This coordinated approach aimed to (1) ensure Europe is competitive in the AI landscape, (2) guarantee all countries adapt in this digital transformation, and (3) develop new technologies in accordance with its values. Moreover, in February 2020, the European Commission published a White Paper on AI which proposes policy options on how to achieve the "twin objective of promoting the uptake of AI and of addressing the risks associated with certain uses of this new technology". In cooperation with both

national and private sector, the EU's holistic approach aims "to increase investment and reach a total of at least EUR 20 billion" (European Commission, 2020). The EU is also actively promoting research and innovation whilst safeguarding ethical aspects of the progress achieved regulated by the EC-appointed High-Level Expert Group on AI (European Commission, 2019). As argued by scholars like Fabien Merz, the EU has created an 'umbrella approach' where it aims to maintain global competitiveness in AI and create the conditions to closing the gap between the US and China whilst simultaneously developing corresponding regulatory and ethical guidelines. France and Germany are arguably two of the most advanced countries in AI within the EU however have two distinct strategies.

Understanding Germany's AI Dream

In November 2018, the Federal Government of Germany launched like France an AI Strategy, that presented the progress made, goals for the future and policy initiatives to be done in Germany. The strategy is revolved around three main goals: (1) increasing and consolidating Germany's future competitiveness by making Germany and Europe a leading center in AI, (2) guaranteeing a responsible development and deployment of AI which serves the good of society, and (3) integrating AI in society in ethical, legal, cultural, and institutional terms in the context of a broad societal dialogue and active political measures. The FY2019 Budget has allocated a total of EUR 500 million to 'beef up' the AI strategy for 2019 and pledged by 2025 to provide around EUR 3 billion for the implementation of the strategy (Federal Republic of Germany, 2020). Of the EUR 500 million budgeted in 2019, EUR 190 million was invested in research and education in AI. As well as some of the key projects it announced were to create at least 100 additional professorships for AI to ensure its presence in higher education system as well as establish a 'teach-and-learn AI' platform dedicated to developing the necessary skills to understand, thus, operate AI. Moreover, in response to the AI talent shortage, the Federal Government also launched large scale qualification initiatives revolved around 'upskilling' and 'reskilling' workers across any industry to make them more future ready (Federal Ministry of Education and Research et al., 2018). Moreover, Germany announced numerous partnerships both locally and nationally, like the Franco-German research and development network to ensure cooperation in AI research and innovation. Similarly, to France, the report also focuses on "integrating AI in society in ethical, legal, cultural and institutional terms" through developing joint guidelines with businesses and AI dedicated platforms.

Understanding France's AI Dream

The report written by mathematician and member of parliament Cedric Villani in 2018 subtitled 'Towards a French and European Strategy' announced France's AI ambition to "playing a leading role at [a] global level and compete with non-European giants [in AI]", heavily relying on research and innovation (Meurier et al., n.d.). The Mission Villani report essentially addresses seven main objectives, which are to: (1) develop an aggressive data policy, (2) target the 'four strategic' sectors (healthcare, environment, transport, and defense), (3) boost the potential of French research, (4) plan for the impact of AI on labor, (5) make AI more environmentally friendly, (6) open up AI black boxes[3], and (7) ensure that AI supports inclusivity and diversity. According to the European Commission the French government will dedicate EUR 1.5 billion to the development of AI by the end of 2022, including EUR 700 million for research. Some of the key issues that France's faces regarding AI development is the 'endemic' brain drain of researchers towards the major industrial players "GAFAM and other unicorns" due to its weak AI ecosystem which then results in significant knock-on effects regarding competitiveness for AI talent. Thus, one of the main focuses of the French AI strategy highlighted by Emmanuel Macron, the French president, is "to improve the AI education training and ecosystem to develop and attract the best AI talent" (European Commission, 2021). In coordination with

[3] In machine learning, AI black boxes are systems whose inputs and operations are not visible by the user or creator and are created directly by the algorithm from the data to calculate predictions. Models are creating where even those who design them are unable to understand how variables are being combined to make predictions.

leading research entities and universities, the National Research Institute for Computer Science and Automatism (INRIA) oversees the main strategies proposed. One of the two flagship projects suggested by Villani is the establishment of interdisciplinary institution on AI (known as 3AI) across France, which essentially creates a network designed to strengthen the AI sector and enhance research and innovation amongst institutions involved in AI research. As well another of Villani's flagship projects is the creation of an Ethics Advisory Committee for Digital Technologies and AI to oversee AI developments. Essentially these two initiatives will 'encourage' AI development that is environmental and ethical; through collaborations and immediate access to cutting-edge AI research for France and partnered countries (Villani, 2018). By promoting collaborative research agreements between renowned research institutions notably with the trilateral French-Japanese-German research projects on AI in partnerships with: the French National Research Agency (ANR), the German Research Foundation (DFG), and the Japan Science and Technology Agency (JST); will as outlined by the European Commission create a network that will allow "for an efficient sharing of knowledge associated with AI across various stakeholders and increases their motivation to participate in cutting-edge AI research" (European Commission, 2021). France has also created a National Commission for Information Technology and Liberties (CNIL) which developed a Digital Republic Bill that outlined characteristics that must be "at the heart of the French AI model: including respect for privacy, protection of personal data, transparency, accountability of actors and contribution to collective wellbeing" (Lemaire & Mandon, 2017).

Takeaway

With the UK also trying to assert itself as the AI leader of Europe, France is not the only contestant. Before analyzing these two countries in a global context it is important to note that while the German government pledge to provide around EUR 3 billion for the implementing their AI strategy by 2025, it only allocated EUR 40-50 million to AI (Stix, 2020). Thus, Germany's relatively weaker AI initiative due to its limited resources could create an opportunity for France, rather than a threat; encouraging partnerships and research collaborations that would be mutually beneficial. In addition, even though AI is still in its infancy stage, France – like its European neighbors – have already fallen behind the US and China in numerous categories (later explored). Due to EU's 'umbrella approach' investments done by individual countries like France and Germany remain insignificant compared to its rivals. Even if France doubled its AI budget from EUR 1.5 billion to EUR 3 billion it is still no match for the colossal USD 68 billion investment by the US and USD 70 billion by China. Unlike the ecosystem developed in the US with a bottom-up approach where its tech giants shape the ecosystem through their own interests and company values and China's top-down approach where the government shapes the ecosystem through a single framework , countries like France and Germany are trying to create conditions encouraging ethical and sustainable ecosystem through 'multistakeholder collaboration' argues a report by Access Partnership (Williams, 2018). France's position as a potential AI leader could be strengthened by its soft-power agenda, reducing all the concerns and fears about AI integration.

Whilst the US needs to secure its position it remains AI leader. The US has traditionally led the world in developing and applying AI technologies with the development of its tech giants dominating the digital world. However, its position is increasingly threated due to its weak government initiatives as other governments are aggressively developing new initiatives, all aiming at being world leader in AI. The US industry is led by its tech giants, and the US is seen as a 'gap filler' however this approach may not be sufficient in the long run to outcompete its biggest competitors like China. Considering that AI technology is still in its nascent stage, the USA has the best-established ecosystem, thus able to attract the most top AI talent and develop the greatest number of startups and investments, however other nations like France, Germany and China are rapidly developing their own ecosystems.

The US, China, and EU have all expressed their desires to be leaders in this shift to the fourth industrial revolution powered by AI. After understanding these countries' goals in AI, this paper now examines their implementation.

Hardware

What do I mean by hardware in AI?

Advancement in AI hardware (also referred to as AI chips or AI semiconductors) is imperative to reach the title of leading country in AI. As major corporations and governments are looking to develop AI technology into their systems, semiconductors manufacturers have started to design hardware specifically tailored to support and develop AI. When defining AI hardware there are four main chips involved that can be used in training and developing AI technology, which essentially can then be divided into two categories. (1) Chips originally designed for other computing purposes but that can also be adapted for developing AI technology (e.g. CPU and GPU) and (2) chips that are specifically designed to accelerate AI especially in the fields of artificial neural networks, machine vision and machine learning (e.g. ASIC and FPGA) (AnySilicon, 2019). Both FPGAs and ASICs consume much less energy and allow for greater flexibility in their design, leading to greater speed and lower costs.

Given the broad usage of chips, the best way to analyze a countries AI development in the context of AI hardware is through comparing: (1) the global market share of semiconductor production, (2) the highest performing supercomputers, (3) the development of customizable chips and (4) AI chips investment.

Table 1. Top 15 Semiconductor Sales Leaders (IC Insights)

2020 Rank	Company	Headquarters
1	Intel	U.S.
2	Samsung	South Korea
3	TSMC	Taiwan
4	SK Hynix	South Korea
5	Micron	U.S.
6	Qualcomm	U.S.
7	Broadcom Inc	U.S.
8	Nvidia	U.S.
9	TI	U.S.
10	Infineon	Germany
11	MediaTek	Taiwan
12	Kioxia	Japan
13	Apple	U.S.
14	ST	Switzerland
15	AMD	U.S.

(1) The Global Market Share of Semiconductor Production

Many experts believe that chips specifically designed for AI will eventually outperform the multipurpose chips like GPUs. Thus, providing a competitive advantage for the US tech giants like Google, Alphabet, and Apple who are already manufacturing their own AI chips. In terms of general chip-making the U.S. semiconductor industry is the leading manufacturer in the world capturing 47% of global semiconductor revenue in 2019, generating USD 41 billion, making it the fifth largest export for the US (International Trade Administration). Whilst the US companies have nearly 50% of the global market share, over 80% of their sales don't take place in the country. According to Research

and Markets the "global AI Chip Market was valued at USD 9.29 billion in 2019 and is estimated to garner USD 253.30 billion by 2030". Developing AI chips is essential for China's and EU's ambition to release independence from American chip-making producers. It is currently reliant on imported chips, due to their "high initial costs and long creation cycle, processor, and chip development [which] may be the most difficult component of China's AI plan" (Wübbeke et al., 2016). According to research firm IC Insights, of the USD 143 billion in chips sold in China in 2020, only USD 22.7 billion worth were produced in China, and only USD 8.3 billion of that was produced by Chinese-headquartered companies (36.5%), accounting for only 5.9% of the total market. As per its forecasts, if China-based internal circuit manufacturing rises to USD 43.2 billion in 2025 it would still only represent 7.5% of the total market forecast in 2025 of USD 557.9 billion. Even with significant increases in Chinese-based production of chips, it would still likely represent only 10% of the global internal circuit market, far from its goal to being world leader in AI development (IC Insights, 2021).

(2) Highest performing supercomputers

One of the best ways to analyze a countries strength in producing chips is looking at supercomputers, because they are extremely fast, high performance systems that require powerful chips to process the mass amounts of data and massive calculations (Intel). The best benchmark to rank performance of supercomputers is perhaps best done by the TOP500 project which ranks and details the most powerful computer systems in the world. The performance of supercomputers is expressed using floating-point operations per second, also referred to as FLOPS (University Information Technology Services, 2020). China is the leader in this ranking with 219 supercomputers, more than the US with 116 and combined EU with 92. The US position in the development of the world's fastest supercomputers not only shows China's commitment to leading the race for the next forth industrial revolution but also demonstrates China's AI capabilities, as chips remain the backbone for creating an AI ecosystem.

Despite China's growth in supercomputers, Intel continues to dominate the TOP500 ranking where the US companies chip appears 95.6% of all systems, clearly showing Chinese and European reliance on American chipmakers (TOP500, 2019). Whilst USA remains essential to the production of chipmaking, it is losing global leadership in supercomputer. In 2010, 282 of the TOP500 performing supercomputers in the world were American, now there is only 116. There are also now nine Europe-based supercomputers in the top 25, and the fastest one is Germany-based 'JUWELS'. This shows, that whilst the US is still the leading manufacturer of semiconductor hardware chips, it is slowly losing its position as the most technologically advanced nation in AI technologies.

(3) The number of firms developing customizable chips

There are two categories of AI chips as previously mentioned, while the first category of 'traditional' chips is currently dominated by US companies; experts are hopeful that the category of 'new' chips will take over the chip market, thus leaving China and other countries in a competitive position.

In the first category of AI hardware producers of GPUs and CPUs are all mainly produced by US companies Nvidia, AMD and Intel. Amongst the top 10 American companies 4 specialize in GPU chip making; in contrast to the top 10 Chinese companies where non are specialized in either (Ding, 2018). According to the Foreign Policy journal, "the only serious Chinese rival to these advanced U.S. chips is the HiSilicon Kirin 9000, designed by Huawei's own in-house 'fabless' chip-design subsidiary" (Babones, 2020). However, amidst sanctions due to US-China trade war the business has greatly suffered as a large sum of its parts were acquired from American manufacturers.

To comprehend why firms are shifting to a GPU system incorporating CPU we must look back to Nvidia's first GPU chip GeForce 256 in 1999; originally designed to increase the processing power of complex computer games. As this technology evolved, in 2010 during the Google Cat photo challenge Nvidia, with 48 GPUs, achieved the same performance as 16,000CPUs – creating a new movement for GPUs (NVIDIA, 2021).

As per the Centre for International Governance Innovation, Intel was the biggest vendor in GPU market with 69% in Q4 2020, followed by AMD (17%) and Nvidia (15%). However, GPUs are not the only hardware platform that can train and execute neural networks. The main argument behind manufacturing hardware in the second category