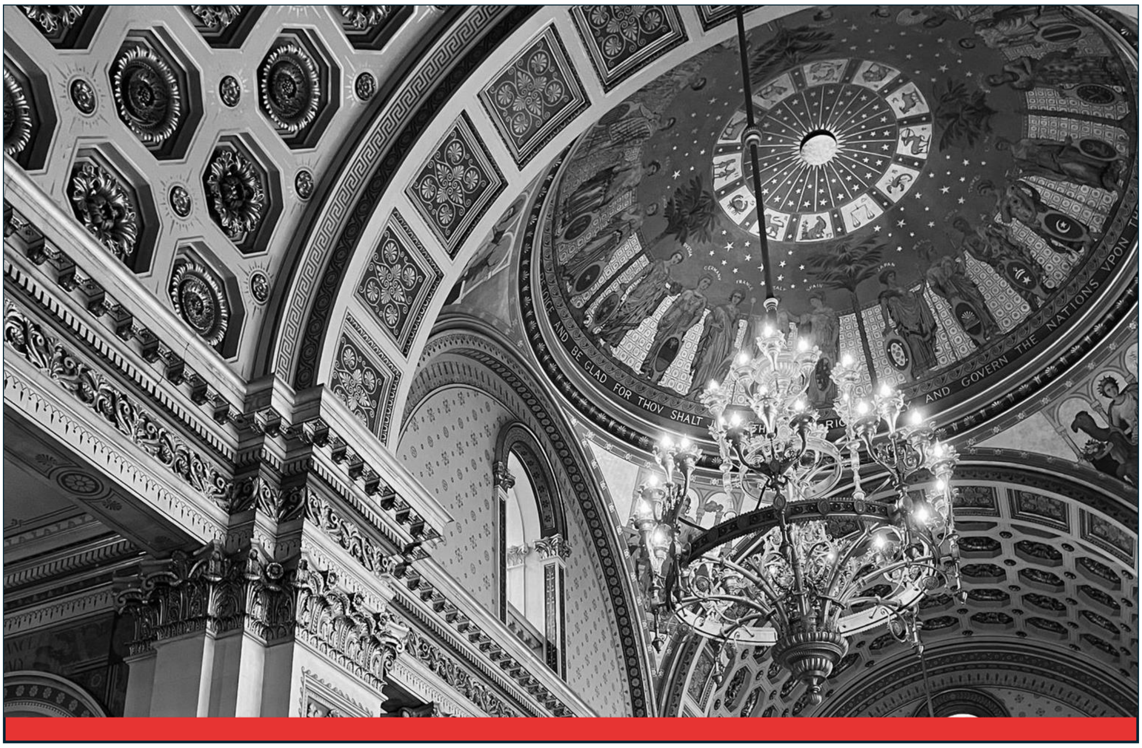

How can the FCDO utilise data science to maximise UK influence on strategic technologies through its global network of partnerships?

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Executive Summary

This report, along with the tool developed alongside it, explores how the Foreign, Commonwealth & Development Office (FCDO) can utilise data science to strengthen the United Kingdom's (UK) influence in strategic technologies through global partnerships.

Our core argument is that the UK's strategic advantage in technology cannot be understood through domestic capability alone. Instead, partnerships between states are paramount. Dominance in this field requires influence across multiple spheres, including international norm-setting, regulation, innovation and research and development (R&D), access to upstream components, and large-scale production capacity. This reflects the Integrated Review's "own, collaborate, access" framework in its approach to strategic technologies.

The UK faces increasing global competition in strategic technologies, driven by intensifying systemic rivalry between states and a deteriorating security environment. In this volatile and fast-moving landscape, the UK must adapt quickly while working with constrained resources, requiring a cost-effective approach that prioritises high-impact alliances in strategic areas, delivering the greatest return for taxpayers. Aligning with Foreign Secretary David Lammy's commitment to putting data science "at the core" of the FCDO, we therefore propose a three-stage framework for data-driven diplomacy: use data to assess, identify, and measure (AIM).

1. **Assess Global Trends and the UK's Position**: The FCDO can use data science to deepen its analysis of United States (US)-Chinese technology competition and assess the UK's current influence and partnerships.
2. **Identify Strategic Opportunities:** Data science can uncover underutilised relationships to strengthen UK influence, such as deepening partnerships with Greece, Switzerland, and Austria in quantum technology and leveraging the Baltic states for cybersecurity collaboration. Further

opportunities exist in the Global South, where Sierra Leone, Jamaica, Nepal, and Sri Lanka show increasing interest in strategic technologies.

3. **Measure Policy Impact**: Data science can track the effectiveness of FCDO programmes, ensuring priority is given to those with the greatest impact, while also providing insights to the Cabinet and Prime Minister. Tools can monitor policy initiatives, track access to upstream components in strategic technologies, and monitor the success of bilateral research collaborations, while discourse analysis can measure whether UK-led initiatives shape global priorities and influence international rhetoric.

The tool developed as a proof-of-concept alongside this report demonstrates how the assess, identify, and measure framework can be implemented for data-driven diplomacy. In line with FCDO and Ministry of Defence's (MoD) policies to better integrate open-source data, we use four open-source data sets: United Nations (UN) voting records and speeches, trade data in key upstream components, and research collaborations in quantum technology, Artificial Intelligence (AI), and engineering biology.

Our policy recommendations fall into two categories. First, next steps the FCDO should take considering our analysis. Second, how the FCDO, and wider civil service, can better utilise data science to aid in strategic decision making.

Policy Recommendations: Strategic Priorities for UK Influence

1. **Strategically Engage with the Global South** by fostering partnerships in Quantum Technology with Kenya, Namibia, Sierra Leone, and Belize. Boost Cybersecurity initiatives with Togo, Liberia, Gabon, Mauritius, Panama, and Jamaica. Engage in emerging technologies with South Asia: Sri Lanka, Nepal, Pakistan and Bangladesh. Champion the issue of energy security as an alternative to Chinese influence.

2. **Expand Indo-Pacific Engagement** by deepening current collaborations with Japan, South Korea, and Australia. However, better leverage the current UK-India Technology Security Initiative as a regional springboard for issues of technology transfer, capacity building and the digital divide.
3. **Leverage Underemployed European Allies** by strengthening semiconductor ties with the Netherlands and Czechia. Prioritising cybersecurity and capacity-building initiatives with Estonia, Sweden, Slovenia, Lithuania, Latvia, and Finland. Existing collaborations with Germany should be expanded, and quantum partnerships developed with Austria, Switzerland, and Greece.
4. **Deepen Transatlantic Ties** by expanding collaborations with other bridge nations such as Canada and France.
5. **Manage Chinese Relations** by diversifying research partnerships to reduce dependence on China, while monitoring offshoring of critical technology supply chains, particularly in Thailand, Malaysia, and Vietnam.

Policy Recommendations: Improving Data Science Implementation

1. This tool should be integrated into targeted diplomatic engagement, ensuring His Majesty's Ambassadors (HMAs) and Heads of Mission (HOM) use data-driven insights to inform strategy.
2. The FCDO should extend its use across government to align with a whole-of-government approach to strategic technology policy, sharing the tool with the Cabinet Office, Department for Business and Trade, MoD, UK Research and Innovation, Department for Science, Innovation and Technology (DSIT), and the Research and Innovation Network (RIN). This would support national security and foreign policy objectives, improve trade and economic relations, enhance defence and security planning, guide research collaborations, and optimise funding allocation.

3. The FCDO should build upon this proof-of-concept tool integrating further applications:
    a. Building on these tools by further disaggregating data to identify key research institutions for additional funding.
    b. Analyse how UN alliances shift based on voting topics.
    c. Apply our data pipeline to economically focused multilateral bodies like Association of Southeast Asian Nations (ASEAN), the African Union, the Organisation for Economic Cooperation and Development (OECD), and technology standards bodies such as International Organisation for Standardization (ISO), International Electrotechnical Commission (IEC), and Institute of Electrical and Electronics Engineers (IEEE).

By leveraging data science to assess global trends, identify strategic partnerships, and measure policy effectiveness, the UK can maintain its leadership in shaping the future of strategic technologies. A data-driven approach will ensure UK diplomacy remains proactive, forward-thinking, and influential.

Our Accompanying Data Science Tool

Our approach goes beyond answering how the FCDO can use data science to strengthen its influence in strategic technologies. It also provides a practical tool and data pipeline that enables the FCDO to apply this analysis directly. All our data visualisations are highly interactive. While we have included snapshots throughout the report, we strongly encourage readers to explore the tool online for the full experience. This project should be viewed as a combination of the report and the interactive tool—neither stands alone. Visit our website to explore the data in real time as you read: https://fcdo-dspp-capstone.github.io/fcdo_dspp_repo/.

List of Acronyms and Abbreviations

Abbreviation	Full Term
AI	Artificial Intelligence
AMP	Aid Management Platform
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
ASPI	Australian Strategic Policy Institute
AUKUS	Australia, United Kingdom, United States [alliance]
BERT	Bidirectional Encoder Representations from Transformers
CET	Critical and Emerging Technologies
Commonwealth	Commonwealth of Nations
CSET	Center for Security and Emerging Technology
DBT	Department for Business and Trade
DDaT	Digital, Data and Technology
DSIT	Department for Science, Innovation and Technology
EU	European Union
FCDO	Foreign, Commonwealth & Development Office
G7	Global 7
G20	Group of 20
GDP	Gross Domestic Product
GCRF	Global Challenges Research Fund
GPAI	Global Partnership on Artificial Intelligence
HOM	Heads of Mission
HMA	His Majesty's Ambassadors

IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
INDEX	Information and Data Exchange
IPPC	Integrated Pollution Prevention and Control
IR	International Relations
IR Refresh	2023 Integrated Review Refresh
ISO	International Organisation for Standardization
ITU	International Telecommunication Union
MoD	Ministry of Defence
NATO	North Atlantic Treaty Organization
NATO PA	NATO Parliamentary Assembly
NLP	Natural Language Processing
OECD	Organisation for Economic Cooperation and Development
OSINT	Open Source Intelligence
PCA	Principal Component Analysis
PLJ	Pulse Lab Jakarta
R&D	Research & Development
RIN	Research and Innovation Network
S&T	Science and Technology
SiDLab	[University of Geneva] Science Lab in Diplomacy
STN	UK Science and Technology Network
TPNW	Treaty on the Prohibition of Nuclear Weapons
UAE	United Arab Emirates

UN	United Nations
US	United States of America
USSR	Union of Soviet Socialist Republics
UK	United Kingdom
UKRI	UK Research and Innovation
WTO	World Trade Organisation

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1. Introduction

The UK government has identified five strategic technologies which are critical to national security, economic growth, and global competitiveness: AI, semiconductors, quantum technology, future telecommunications, and engineering biology (DSIT & Prime Minister's Office, 2024; Ministry of Defence, 2020). As these technologies shape the geopolitical and economic landscape, the government has decided to take a cross-government approach ensuring UK influence over their development, access, and regulation (FCDO & DSIT, 2023, p. 6).

The government's centrally developed "own-collaborate-access" framework for UK leadership in Science and Technology (S&T) is inherently international, requiring the UK to work with global partners (Cabinet Office, 2021, p. 21). As a result, the FCDO is critical to driving this government-wide policy. According to the framework, "owning" refers to UK development of these critical technologies, which will "invariably involve elements of both collaboration and access" with international partners (Cabinet Office, 2021, p. 21). "Collaboration" refers to the UK's role in identifying strategic partners for both international regulation and fostering collaborative innovation. Finally, "accessing" prioritises acquiring S&T innovations and S&T components from both established and novel partners. Thus, the FCDO is critical for shaping global technology standards, securing access to critical supply chains, and fostering international collaboration.

To advance these goals, the FCDO engages in three types of partnerships: multilateral, minilateral, and bilateral. Multilateral partnerships—such as the G7, G20, OECD, North Atlantic Treaty Organisation (NATO), Council of Europe, Commonwealth, and the UN—provide platforms for shaping international norms and regulations in critical technologies (Cabinet Office, 2021, 2023). The UK plays a leading role in advocating for open, democratic standards and countering authoritarian state-led approaches that seek to exert control over global technology governance (Ibid). Minilateral partnerships, such as AUKUS, allow for deeper cooperation between a smaller number of like-minded countries. For instance, through Pillar Two of AUKUS, the UK has enhanced trilateral S&T collaboration with Australia and the US (Ministry of Defence, 2024). Bilateral partnerships further strengthen the UK's access to key technologies, such as the UK-South Korea agreement on supply chain resilience the Japan-UK Digital Partnership (DSIT, 2023a).

1.1 Data Science Tool for FCDO Support

This report, and its data science tool, are designed to support the FCDO in managing its partnerships more effectively with data. They reflect umbrella policies for the FCDO and MoD to better use open-source data (Cabinet Office, 2023, p. 59). The tool aims to enhance the FCDO’s ability to navigate the complex network of partnerships across the regulatory, innovation, trade, and norm-setting spheres. Unlike existing data science tools developed by think tanks—often focused on strategic competition in critical technologies and reliant on static indices—our approach prioritises policy levers fundamental to the FCDO’s work: networks. We utilise network analysis and clustering techniques to visualise alliances, partnerships, and patterns of international influence. The data science tool and data pipeline are a proof of concept and are designed to be adaptive, scalable, and reusable.

Our tool examines UK influence on strategic technologies from four angles: regulatory, norm-setting, research collaboration, and trade. We incorporate four distinct data sources:

1. **UN Roll-Call Data**: This analysis examines UN voting patterns, selected as a test case. The framework developed for this analysis could also be applied to any confidential or proprietary roll-call data. For instance, voting records at the OECD, International Telecommunication (ITU), and the NATO Parliamentary Assembly (NATO PA).
2. **UN General Assembly Speeches**: This dataset allows us to assess national priorities by analysing how countries frame technology issues in diplomatic discourse. Unlike voting behaviour—often shaped by strategic pressures—speeches provide insights into countries’ long-term interests. Therefore, we

can identify countries that align with UK interests but are underutilised as strategic allies, particularly middle powers.

3. **Trade Relations and Supply Chains**: This analysis examines UK trade relations, particularly strategic dependencies in supply chains. Given the increasing importance of offshoring, understanding how the UK's supply chains are evolving is critical.
4. **Research Collaboration Networks**: This analysis maps global research partnerships to evaluate the UK's position within the international research ecosystem. Tracking these trends in key technologies allows us to assess how UK research institutions are positioned globally.

1.2 Report Structure

This report will be structured as follows:

1. **Policy Problem**: Defining the current geopolitical challenges facing the FCDO and exploring potential strategies for addressing them.
2. **Conceptual Framework**: Providing a detailed description of our framework, emphasising how the FCDO can apply data science to enhance its technology diplomacy efforts.
3. **Literature Review**: Offering a brief review of the current state of FCDO technology diplomacy and examining how other organisations and think tanks are proposing the integration of data science to address similar challenges.
4. **Methodology**: Outlining the methodology behind each of our data science approaches.
5. **Analysis**: Presenting our initial analysis and the conclusions that can be drawn for improving technology diplomacy through this approach.
6. **Policy Recommendations**: Addressing both immediate actions for the FCDO and longer-term strategies for integrating data science more effectively into its decision-making process.

2. Policy Problem

2.1 Navigating Global Strategic Competition in S&T

The UK faces increasing global competition in strategic technologies, particularly in AI, quantum computing, semiconductors, and cybersecurity (Cabinet Office, 2022; DSIT, 2023a, 2023b; Office for Artificial Intelligence et al., 2021; Science Innovation and Technology Committee, 2025). This competition is driven by the intensification of systemic rivalry between states, a key factor in the deteriorating security environment (Cabinet Office, 2021, 2023). A growing convergence of authoritarian states, particularly China and Russia, is challenging the conditions for an open, stable, and peaceful international order (Cabinet Office, 2023, p. 8). These actors have demonstrated a clear intent to exploit science and technology for strategic advantage, engaging in below-threshold competition—a form of geopolitical rivalry that falls short of armed conflict but nevertheless undermines democratic norms (Cabinet Office, 2023, p. 9). In response, the UK government has recognised the need for a more dynamic approach to navigate this increasingly competitive and fluid environment. This includes reinforcing international institutions that are under threat and deepening strategic partnerships to ensure UK leadership in key technologies (Ibid).

Concurrently, geopolitical dynamics are shifting, with the rise of non-aligned powers complicating the UK's diplomatic and economic strategies (Cabinet Office, 2023). Strategic technologies do not exist solely within the domains of regulation and commercial competition—they are also deeply intertwined with supply chains, research ecosystems, and international innovation networks. This volatile and fast-moving landscape requires the UK to adapt quickly, yet the FCDO and other departments must do so within increasingly constrained resources, necessitating a cost-effective approach by focusing on high-impact alliances.

A critical element of this challenge is assessing the growing geopolitical blocs surrounding the US and China. The FCDO must be able to assess and anticipate geopolitical realignments, particularly identifying states that may be shifting towards positions that threaten UK interest in maintaining an open and rules-based international order.

2.2 The Need for a Data Driven Approach

For the UK to achieve dominance in strategic technologies they must leverage the full spectrum of statecraft tools: diplomacy, trade policy, security cooperation, R&D funding, and economic statecraft. While it is evident that the FCDO is committed to incorporating data science tools into its analysis – approximately 85% of the annual FCDO programme portfolio spending is managed through their own data science tool, the Aid Management Platform (AMP) — challenges remain (FCDO, 2024). Discussions with FCDO staff and external practitioners have revealed that data science tools are often siloed in their use by security clearance restrictions, thus limiting their potential.

The FCDO must adapt to keep pace with other foreign ministry peers. For example, the US Department of State has recognised the critical role of data analytics in modem diplomacy, by launching the first ever Enterprise Data Strategy in September 2021, hoping to transform the department into a data-centric organisation (Department of State United States of America, 2021). Work in the US has also used an evaluation approach for digital diplomacy using social network analysis to record "comment networks" in response to public diplomacy efforts (Sevin & Ingenhoff, 2018). The FCDO must also incorporate data-driven analysis to remain preeminent in diplomatic circles (Lammy, 2025).

As the FCDO faces the challenge of achieving more with constrained resources, a targeted, evidence-driven approach can offer significant cost savings and enable more effective policy decisions. Our work aligns with the government's Open-Source Intelligence (OSINT) hub, which seeks to "upgrade and better […] analyse publicly and commercially available information" (Cabinet Office, 2023, p. 59). Our tool can build on the work of the National Situational Centre and could be integrated into the new Information and Data Exchange (INDEX) service to coordinate efforts across government (Cabinet Office, 2023, p. 59).

Any whole-of-government approach requires that departments share insights: the benefit of using open-source data is it can be shared without complex security clearances, facilitating faster decision-making and coordination. Therefore, we advocate that the FCDO share this report and corresponding tool with DSIT, the MoD, the Cabinet Office, and the Department for Business and Trade (DBT). This interoperability between departments reflects Mission Three of the Roadmap for Digital and Data, which aims to “enable departments to share and use data safely and securely for better public services and decision-making” (Government Digital Service & Central Digital & Data Office, 2023).

3. Conceptual Framework

Our conceptual framework is built around the government’s central pillars of “Own, Collaborate, and Access” (Cabinet Office, 2023, p. 21). At the core of this framework is the acknowledgement that UK’s influence in S&T is not determined solely by domestic capabilities, instead its relative position regarding S&T should be understood by evaluating how the UK leverages its position through coordination with partners and allies. In other words, the UK’s strategic position in technology is shaped by its ability to:

1. Influence international regulation and norms to maintain a global rules-based technological order.
2. Shape international discourse on emerging technologies, positioning the UK as a leader in tech diplomacy and governance.
3. Leverage trade relationships to enhance technological capabilities and benefit from foreign innovations.

4. Collaborate with global research institutions and universities, not only to expand knowledge but also to reinforce the UK's standing as a hub for scientific excellence.

When determining which technologies to focus on in our proof-of-concept tool our aim was to focus on the five critical technologies identified in the UK's International Technology Strategy —AI, Quantum Technologies, Engineering Biology, Semiconductors, and Future Telecommunications (DSIT & Prime Minister's Office, 2024; FCDO & DSIT, 2023; Ministry of Defence, 2020). However, we have found in the data we have examined it has been much harder to capture information on future telecommunications. Therefore, we have prioritised the other four technologies. Moreover, although we have tried to provide in-depth analysis for each, due to limitations in some of our data sources, achieving this level of disaggregation was not always feasible, at which point we focused on general trends in emerging technologies and diplomatic relations. We have also broadened our analysis to include cyber-attacks and espionage, as the UK is a world cyber leader (Cabinet Office, 2022; IISS, 2021). Our approach is responsive to forum. For example, in the UN, we increase our scope to also focus on military technology topics (e.g., nuclear, chemical, and biological weapons) and energy security, which is vital to national capabilities in dual-use technologies. For trade data analysis, rather than focusing solely on end-use technologies, we concentrate on upstream components. Throughout this process, we have worked closely with the FCDO to refine the focus of our analysis, incorporating their feedback at each stage.

3.1 A Data-Driven Approach to Strategic Partnerships and Policy Innovation

Our framework harnesses open-source data, but our data pipeline can be harnessed easily to integrate confidential and proprietary data across the FCDO and wider government. This approach ensures that our analytical tools have applications beyond this study, serving as a platform for better data usage for security privileged data sets.

Our data science framework is built on three core tenets: Assess, Identify, and Measure (AIM). These are the three areas over which our data science tool can be used to improve strategic decision-making and resource deployment, as well as post hoc analysis of the effectiveness of policies.

1. **Assess:** Understanding emerging trends in international partnerships and technological advancements. Recognising shifts in global technology landscapes that present challenges or strategic openings for the UK.
2. **Identify:** This primarily means uncovering overlooked strategic opportunities by using data analytics to detect anomalies, deviations from historical trends, and untapped potential. Key applications include:
   a. Potential for early-warning systems to identify when governments are shifting their priorities through showing breaks with historical trends.
   b. Network mapping to uncover underutilise potential partners for UK collaboration in research, norm-setting, regulation, or trade.
3. **Measure:** Monitoring the impact of UK policy Initiatives. Possible use cases with our tool could be:
   a. Tracking changes in UK-Japan academic collaborations after the UK-Japan-Digital Partnership (DSIT, 2023a).
   b. Assessing whether the 2023 Bletchley AI Summit led to measurable changes in global AI governance discussions (DSIT, 2024).
   c. Evaluating export data to measure whether UK investments in strategic technologies are translating into increased global market share.

This approach is directly applicable within the FCDO; however, it also has many potential use-cases outside of the FCDO. For example, in the DBT, it could be used to monitor the UK’s competitiveness in key technological exports and identify which countries would be most beneficial for a trade agreement. Thus, meeting the Foreign Minster's aims for the FCDO "to work hand-in-glove with the Department for Business and Trade and the Office for Investment. To spot opportunities abroad and help overseas firms to grasp those opportunities from doing business with Britain" (Lammy, 2025. For DSIT, it could be used to identify which UK institutions were most involved in research collaborations, and then to monitor how increased funding to those institutions impacted the number of research collaborations.

4. Literature Review

Although this report continues to use reports and policy agendas from previous administrations, our FCDO counterparts have stressed that, core priorities remain unchanged. Moreover, our analysis aligns with the new administration's foreign policy vision of a "Britain reconnected" (Labour Party, 2024, p. 119). By emphasising the UK's partnerships across four key areas – norms setting, regulation, trade, and R&D – we offer a broader perspective than other data-science tools focused solely on comparative advantage. This aligns with the Foreign Minister's, David Lammy's, commitment to "reconnect with allies and forge new partnerships" (Labour Party, 2024, p. 120). Through data science, we can assess, identify, and measure the strength of Britain's network of partnerships, helping to shape strategic decision making, and evaluate the success of the administration's goal of a "strong and connected Britain" (Labour Party, 2024, p. 120).

To analyse how data science can be used to assess, identify, and measure UK influence over strategic technologies, it is essential to first examine the UK's existing multilateral, minilateral, and bilateral technology partnerships. The UK's multilateral strategy emphasises a "varied set of science and technology-based international partnerships" used to "shape international norms and standards, using our reach and influence in the multilateral system" (DSIT, 2023b; DSIT & Prime Minister's Office, 2024, p. 14). Particularly through institutions such as the G7, G20, OECD, NATO, and the Council of Europe, to "shape open, democratic norms, rules and standards"

(Cabinet Office, 2023, p. 28). The UK's role in norm-setting and regulation within these multilateral frameworks is evident in its involvement in the Global Partnership on Artificial Intelligence (GPAI), which it has leveraged to shape AI governance in alignment with UK values as well as in its collaboration with NATO on the AI Partnership for Defence (Cabinet Office, 2023; Office for Artificial Intelligence et al., 2021). Moreover, the current administration, have championed the UK-India Technology Security Initiative, signed in July of last year, which aims to "bring into sharper focus collaboration in critical and emerging technologies (CET) across priority sectors" (FCDO et al., 2024). This initiative builds on a series of bilateral agreements, such as the UK-US Technology Partnership from June 2021, which prioritised strategic cooperation on key issues through both innovation and trade. Similarly, the Japan-UK Digital Council, which convened for the third time this January, has focused on strengthening cooperation in semiconductor supply chain resilience and R&D (DSIT, 2025) These areas of bilateral engagement can be monitored using our data science tool; assessing whether academic collaboration has increased since these partnerships were established and whether they have improved UK access to semiconductors. Beyond established partners with whom the UK has long-standing historical ties, our tool offers another valuable approach: identifying potential strategic partners who remain underutilised, expanding opportunities for UK influence in critical and emerging technologies.

Our approach is built upon Robert Keohane's and Joseph Nye's international relations (IR) theory of "complex interdependence", which supports our focus on domestic power being rooted in international networks. We also use Keohane and Nye's framework to define "influence" in our analysis – establishing influence to be the same as power over other agents, ie. "control over outcomes" (Koehane & Nye, 2012, p. 10). This is why we have taken a holistic, networked approach to assessing UK influence, evaluating it as arising from multiple overlapping networks (over regulation, norms, trade, and innovation) which constrain both a state's "power to" develop strategic technologies and a state's "power over" others development of them

(Barnett & Duvall, 2005, pp. 41, 44). This perspective contrasts with traditional IR theories, particularly Realism, which tends to evaluate UK influence over strategic technologies primarily in terms of dominance over other nations, often measured through military or economic superiority. Although indexes such as Tortois and the Oxford AI Index adopt a broader view of influence in AI development—including regulation—they do not appear to incorporate the principle of complex interdependence in their conceptualisation (Hankins et al., 2023; Mostrous et al., 2024; Nettle et al., 2024; Tortois News, 2023). They primarily define each country only in relative comparison to others. Our approach offers a more holistic view of power and influence, better aligning with the FCDO's own focus on "own, collaborate, access" (Cabinet Office, 2023). This encompasses both "power to" and "power over" elements of influence whilst recognising that neither can be achieved by the UK in isolation.

To evaluate the value of our data science tool and analysis, we need to position it within the broader data science-driven decision-making framework of the FCDO and the wider British government. The FCDO is moving towards "data-driven diplomacy", as demonstrated by the establishment of FCDO Labs in 2017 (Whicher, 2022). In line with this, our project aims to support the FCDO's ambition to develop an organisation that "reflects the UK's position as a technology and data power; a world leader in the use of information, digital, and technology to deliver diplomatic and development outcomes" (Whicher, 2022).

More broadly, there is a growing international push for the use of data science in foreign ministries and diplomacy. Examples include the US Department of State, the United Arab Emirates's (UAE) platform for the UN "Big Data for Sustainable Development", and work by the Indonesian Ministry of Foreign Affairs and Pulse Lab Jakarta (PLJ) to categorise the content of diplomatic documents (Alfahim, 2022).Other initiatives include ETH Zurich and the University of Geneva's Lab for Science in Diplomacy (SiDLab), which focuses on "negotiation engineering" to address diplomatic challenges (Alfahim, 2022). The German Institute for International and Security Affairs has also highlighted various negotiation scenarios where AI analysis could be valuable, including the recent UN General Assembly Cybercrime Resolution cases (Alfahim, 2022).

The FCDO has access to public-access data-science tools developed by leading academics and think tanks. We carefully studied these tools to avoid creating a redundant application. Many existing tools focus primarily on AI and typically feature indices at their core (Mostrous et al., 2024; Nettle et al., 2024). Notable examples include the Lowy Institute’s Asia Power Index and Australia Strategic Policy Institute’s (ASPI) Tech Tracker on Quantum Communication (Gaida et al., 2023; Patton et al., 2024). The Lowy Institute's tool evaluates comprehensive measures of power and influence across the Asia-Pacific, but it emphasises comparative metrics rather than exploring network-based relationships (Patton et al., 2024). ASPI's Tech Tracker provides historical analyses of quantum technology performance through highlighting comparative technological capabilities and innovation trends among countries (Gaida et al., 2023). But it does not prioritise or connect strategic alliances or deeper network interactions. These methodologies predominantly measure comparative advantage, focusing on assessing national capabilities and specialisations. While valuable, these approaches fall short in assessing broader, complex relationship dynamics. Our approach is distinct, adopting a multi-network perspective that emphasises both direct and indirect relationships shaping strategic technology influence.

However, several of these existing tools significantly influenced our work, guiding our tool's direction and our conceptualisation of partnership networks. Our meeting with Robert Collett, alongside his website inspired us through his use of network charts to visualise cybersecurity networks (Robert Colett, 2023). Similarly, his clustering techniques, such as Principal Component Analysis (PCA) categorised countries based on their voting patterns on UN technology-related resolutions. Collett effectively maps intricate national relationships, prioritising visual clarity and interactivity, and argues that “visual representations of votes at the UN can assist cyber diplomacy practitioners, researchers, and stakeholders in communicating and interpreting voting behaviour” (Collett, 2024, p. 377). We adopted these visualisation principles into our own tools. Additionally, we drew insights from the Centre for Security and Emerging Technology’s (CSET) Science Map (Emerging Technology Observatory, 2024). These tools provided valuable methodologies for visualising technological capabilities, readiness, and strategic positioning. Integrating these inspirations, we developed an original approach tailored specifically to UK diplomatic needs. Our tool clearly evaluates strategic technology partnerships, aligning with the FCDO's overarching goal to enhance UK influence through interconnected diplomacy.

In conclusion, while our work builds upon conventional data science techniques such as network analysis, topic modelling, and clustering, its application within foreign policy—particularly in assessing the UK’s evolving strength in strategic technologies—yields a unique and previously unexplored product, at least among publicly available tools. By evaluating the UK’s position in strategic technology development through the lens of complex interdependence, which considers influence across multiple interlocking networks, we align our approach with the current administration’s emphasis on the UK’s broader network of interconnected partners.

5. Methodology

The conceptual framework and discussions with FCDO staff shaped our methodology at every stage. Our aim was to produce novel analysis focused on the connectivity between nations and technologies. We developed our tool, selected analytical techniques, and formulated recommendations with a clear understanding of how they would align with existing FCDO work and priorities—ensuring they remain both repeatable and scalable for various use cases across the department and wider government. To support future applications, we chose four open-source datasets, either recommended by the FCDO or that could be easily replaced with FCDO's confidential and proprietary data for deeper analysis. These were UN voting data, UN General Assembly speeches, Comtrade data on upstream components, and research collaboration citations.

5.1 United Nations Voting Data

5.1.1 Methodological Aims

We included UN voting data in our analysis to assess how countries align in terms of regulation, with the initial aim of focusing on UN votes related to technology. Our final method did not disaggregate for vote type, but successfully assessed relationships between countries based on their voting behaviour in the UN General Assembly. This provides a uniquely useful tool as the sheer volume of roll-call data makes it hard to interpret through reading alone. Our method prioritised the aim of showing the relative 'distance' in bilateral relationships in country pairs, detecting country blocs with distinct voting patterns, and showing changes over time.

We were able to implement this through reducing the dimensionality of our data: reducing a high-dimensional dataset (many columns of data) to one (a single value score) or two (X and Y coordinates). Several methods for dimensionality reduction exist, typically focused on preserving as much information as possible while reducing complexity for easier analysis. The most well-known techniques are Factor Analysis and PCA, both of which reduce a data frame with multiple columns to fewer columns with abstract numerical values.

5.1.2 Literature on Roll Call Analysis

The literature on roll call analysis mainly focuses on dimensionality reduction and clustering techniques to study voting behaviour of individuals and blocs in voting bodies. Although there is less literature on UN-specific voting data. In selecting our methodology, we considered the recommendations of Collett and Rieselbach who sought to simplify UN roll call data into one or two key scores, making it easier to visualise how countries compare and how closely they align with each other (Collett, 2024; Rieselbach, 1960).

Ultimately, we chose PCA over other techniques, based on subjective evaluation over plot clarity and existing academic research supporting PCA as a suitable method for analysing voting data with multiple voting blocs (Potthoff, 2018). To our knowledge, no other research has used all UN General Assembly votes or connected multiple consecutive years in roll call analysis.

5.1.3 Data Collection and Cleaning

The dataset used for our analysis is the United Nations General Assembly votes dataset, published by the UN Digital Library, which includes all votes from 1946 to 2024 (UN. Dag Hammarskjöld Library, 2024). It records each country's vote (Yes, No, Abstention, Not Present) for every document or proposition. Each row represents a country’s vote with unique identifiers for the year and proposition. All four vote options are treated as distinct when calculating a country’s positional values.

To track changing patterns over time, we run the PCA algorithm annually, using a rolling window of three years. For example, the positions for 2024 are based on the votes from 2022, 2023, and 2024. The visualisation also allows filtering by Gross Domestic Product (GDP) per capita and population size, using 2024 or the latest World Bank data (Worldbank, 2024). The values are transformed into percentiles (0 to 1) for better proportionality. For example, selecting the GDP per capita range of 50% to 100% includes the top 50% of countries by GDP per capita. These filters allow analysis of specific groups, such as wealthy or highly populated countries, or middle-income, middle-sized nations.

5.1.4 Visualisation and Distance Measures

Here are the PCA results for 2024, with no filtering applied and coloured by continent.

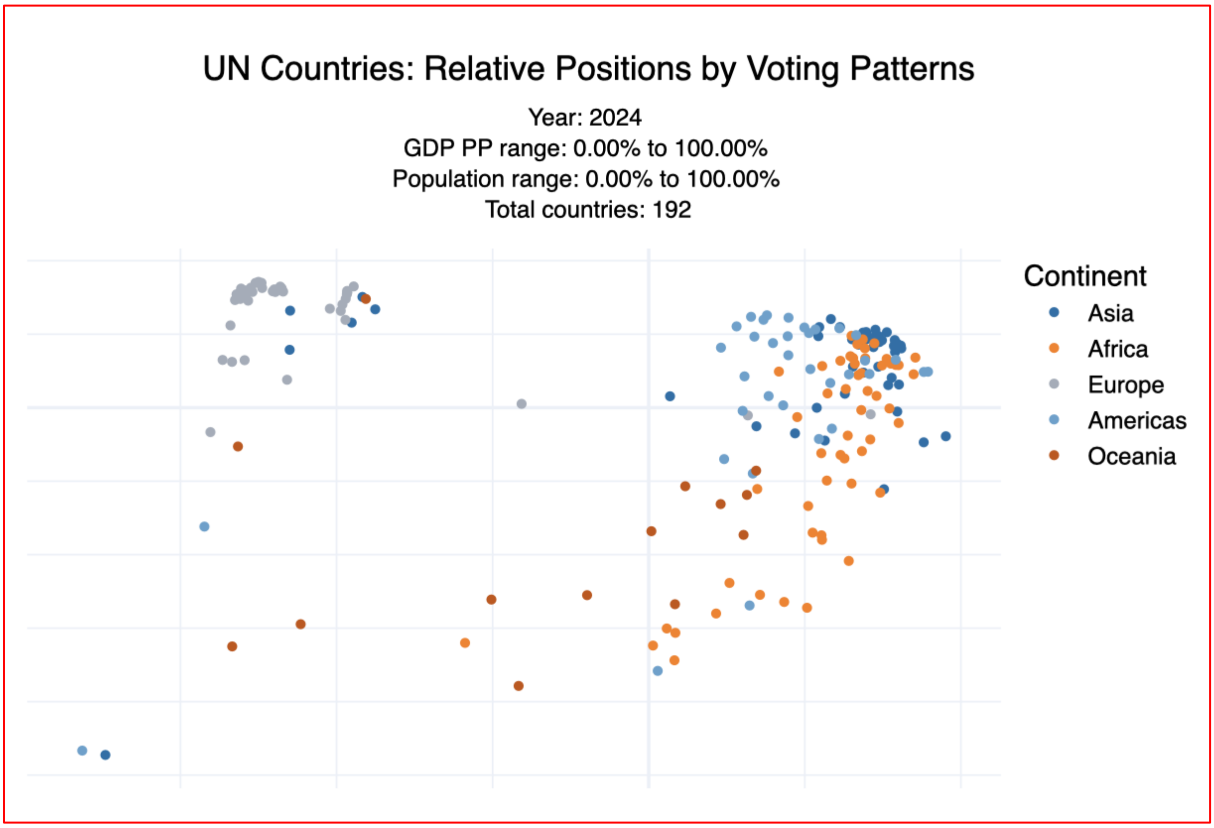

Figure 1: UN Votes in the General Assembly

Country coordinate positions are stored in the database as numbers for both the X and Y axes. Using these, we calculate two measures of relative distance: the mean pairwise distance between all country pairs from 1990 to 2024, and the average distance of each country from all others over the same period. These are displayed in two sortable tables.

Country Pairwise mean distance 1990 - 2024

United Kingdom

Country	Mean distance
Australia	16.65%
Austria	24.16%
Belgium	19.82%
Denmark	22.11%
Spain	23.07%
Finland	22.38%
France	8.04%
Greece	24.24%
Sweden	23.72%

Figure 2: Country Pairwise Table

5.2 Network Analysis

Network analysis was chosen for its ability to reveal relationships within interconnected data. Unlike methods focused on independent observations, network analysis uncovers patterns in relational data. It relies on nodes (entities) and edges (connections between them). In our UN discourse data, nodes represent both topics and countries, while in trade and citation data, they represent only countries. By visually and analytically mapping relationships, network analysis highlights key patterns, influential nodes, and interaction strengths, offering insights into global connectivity and collaboration.

5.2.1 Text Analysis of UN General Assembly Speeches

Our theory on the usefulness of textual data in assessing alignment between countries—and identifying potential collaborators for the UK within a network of partners—is based on Speech-Act Theory, developed by J.L. Austin and John Searle (Barrero, 2023). This theory argues that language is not just descriptive but performative, meaning that words themselves constitute actions. This concept is particularly relevant in fora like the United Nations, where states carefully choose their language to signal alliances, policy positions, and strategic intentions. By analysing linguistic similarity between nations, we can interpret it as an intentional act of alignment, suggesting shared priorities or diplomatic connections (Grzyb et al., 2024; Kim & LaFleur, 2020). Thus, we use speeches to assess how countries express support for specific issues and how their language reflects alliances with other nations.

The dataset used for our analysis was the United Nations General Debate Corpus (1956–2023), which compiles all addresses delivered by UN member states before each UN General Assembly session (Jankin et al., 2017). In these addresses, countries focus on “discussing the issues they consider most important in global politics, revealing their government’s positions, and seeking to persuade other states of their perspective” (Jankin et al., 2017). These speeches “provide invaluable information to scholars of international relations—comparable globally and across time” (Jankin et al., 2017). We restricted our sample to years after 1992 to avoid complications from the break-up of the Union of Soviet Socialist Republics (USSR) and the reunification of Germany. Additionally, the technology topics we were interested in only were discussed in the last thirty years.

Since these addresses are relatively short, they do not typically contain dedicated paragraphs on specific topics, resulting in brief discussions of each issue. To address this, we split the text into individual sentences for topic classification. This approach was chosen because segmenting the text at a higher level (e.g., paragraphs) would risk missing topic meanings, particularly given that sentences rarely contain references to multiple topics.

We used BERT (Bidirectional Encoder Representations from Transformers) for our topic classification. BERT is a natural language processing (NLP) model designed to process text in context rather than one word at a time (Grootendorst, 2024; Pham, 2023). For our implementation, we used the "all-MiniLM-L6-v2" model (Grootendorst, 2022). This is a smaller model which, whilst slightly less accurate than larger models, worked well for us because it offered a good balance between efficiency and performance. After manually reviewing randomised classification results, we were satisfied with the model’s performance.

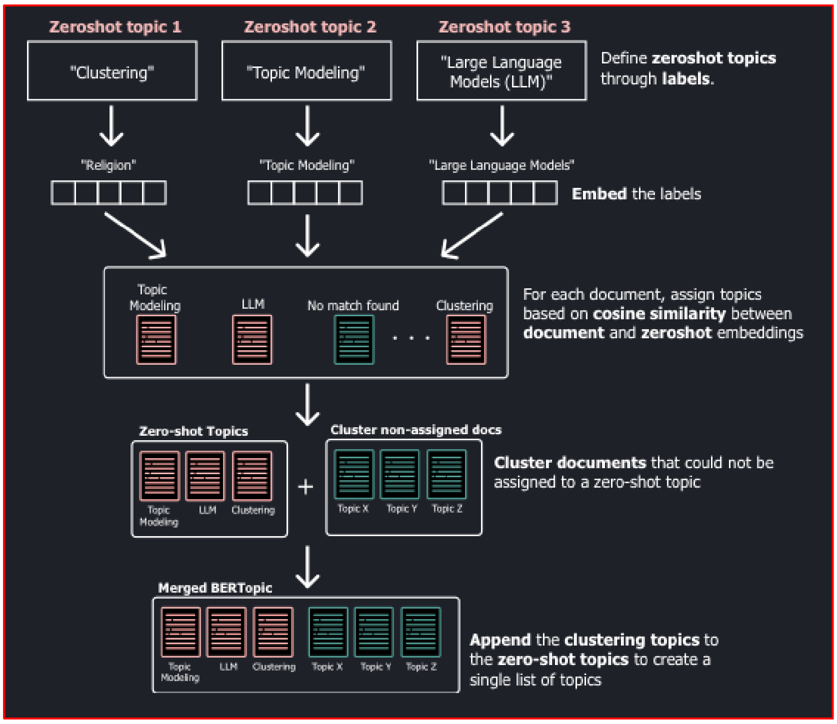

Figure 3: Zero Shot Classification Methodology (Grootendorst, 2024)

Our initial approach to topic classification was fully unsupervised: we allowed BERT to automatically identify topics from the dataset. However, this resulted in overfitting, generating over 9,000 different topics, many of which were too granular to be meaningful. Despite this, the unsupervised results provided valuable insights, influencing our decision to expand the number of strategic technologies analysed, incorporating military technologies, cyber topics, and capacity-building discussions. We then decided, to reduce overfitting and make the classification process more replicable for the FCDO across different datasets, to adopt a zero-shot classification approach. Zero-shot classification allows us to define topics and then to compare document embeddings with topic embeddings using cosine similarity (more on cosine similarity below). If a document's similarity exceeded a pre-defined threshold (0.5 in our case), it was assigned to that topic, we verified the threshold through empirical testing. All documents that did not match the predefined topics, were processed through the regular BERTopic pipeline. This method not only enabled us to identify predefined topics but also allowed for the discovery of new topics in documents that did not fit into our predefined categories. This classification pipeline is illustrated in the above diagram (Grootendorst, 2024). Below is the list of zero-shot topics used in our analysis:

Military Technology	**Dual-Use and grey-zone Technology**	**Civilian Technology and Capacity Building**
• Nuclear Weapons • Biological Warfare • Chemical Weapons	• Artificial Intelligence • Quantum Technology • Supply Chains • Data Security • Biological Engineering • General Emerging Technology • Atomic Energy • Energy Security • Cyber Attacks and Offensive Cyber • Cyber Espionage	• Climate Change and Renewable Energy • Health Technology • Technology in Education • Electric Cars • Digital Divide • Technology Capacity Building • Technology Transfer

Figure 4: Zero-Shot Topics

Our FCDO counterparts stressed the importance of assessing how key countries' discussions on strategic technologies have evolved and identifying regional shifts—particularly whether countries aligned with the US, China, the UK, or the EU. Ideally, we would analyse each strategic technology individually, but data sparsity made this unfeasible. To address this, we grouped technologies into broader categories aligned with the FCDO's interests. Initially, we defined six categories—military, dual-use, civilian, capacity building, and grey-zone technologies—but later merged grey-zone and dual-use and removed civilian and capacity-building due to continued sparsity.

We measured the cosine similarity of each country's discussions over time relative to the UK, China, the US, and Germany (as a proxy for the EU). Statements from 2021 formed the base embeddings, though the rolling average included 2019–2023 data. We chose 2021 as it coincided with consolidation of key strategic frameworks by both the UK and US, and the FCDO agreed this was a useful baseline year. Running the analysis across multiple base years, we consistently found that US speeches had greater cosine similarity with most other countries' speeches than Chinese speeches, this robustness reinforced confidence in this result. This study calculates cosine similarity between document embeddings for each country over a rolling five-year period, with the centre year plotted on the x-axis. To compute embeddings, we retrained a BERT model after aggregating all statements within each five-year window. Cosine similarity measures the angle between textual embedding vectors but has limitations—document A can be equally like both documents B and C, even if B and C differ significantly. Therefore, results should not assume that equidistant documents are necessarily alike.

We also used network analysis, where nodes represent either countries or zero-shot topics (predefined topics selected for analysis). Edges (the lines between nodes) are weighted by the number of times a country has discussed a topic since 1992. For clarity, we excluded "Climate Change and Renewable Energy" and "Nuclear Weapons," as their high connectivity obscures the identification of UK strategic allies.

5.2.2 Centrality-Based Analysis

The next section of our paper will utilise centrality-based analysis for trade data and research co-citation data. Centrality-based analysis is a key approach in network analysis, widely used to identify the most influential countries in a network and measuring connectivity for intermediary countries. Key centrality metrics include:

1. **Degree Centrality:** Measures a country's direct connections, highlighting active and influential participants. In research networks, countries with high degree centrality, like the US, act as major collaboration and trade hubs.
2. **Betweenness Centrality:** Captures how often a country sits between others on the shortest path, identifying bridges between otherwise disconnected clusters. Countries with high betweenness centrality may not have the most connections but play crucial roles in linking regions.

These metrics allow the FCDO to identify high-volume partners to strengthening existing ties, recognise strategic bridges to influence indirect relationships and monitor evolving patterns of collaboration. For both of our visualisations showing degree centrality, we used NetworkX in Plotly (Hagberg et al., 2008).

5.2.3 Global Trade Network

Our approach to assessing global trade dynamics and maximising UK influence in strategic technologies is rooted in network analysis. This enables the FCDO to identify key trade partners, leverage economic relationships, and strengthen supply chain resilience. International trade is inherently interconnected with countries forming complex trade networks and relationships based on the imports and exports of goods and services. By applying graph theory and network visualisation, we can quantify these trade relationships, assess the UK's positioning, and identify influential trade hubs where diplomatic and economic efforts could be most impactful.

The key concept here is that trade networks indicate structural interconnectedness among countries. Therefore, rather than viewing trade bilaterally, this approach treats it as a network system, revealing hidden dependencies, emerging alliances, and vulnerabilities in supply chains, aligning with the FCDO's "own-collaborate-access" framework (Cabinet Office, 2021). Through this, we aim to identify which countries are major facilitators, strategic partners, or potential competitors and provide insights into where the UK can strengthen partnerships or diversify dependencies. This methodology is informed by recent academic work on global trade networks in critical technology sectors, such as the semiconductor supply chain (Zhang & Zhu, 2023).

To assess how the UK can maximise its influence, we analysed trade flow data through the UN Comtrade database (International Trade Centre, 2004). Data from the years, 2010, 2020, 2023 and 2024 was selected to provide a balanced historical and contemporary perspective on the global trade patterns. These years also allowed us to examine long-term trends, disruptions, and evolving trade policies so that we could consider a strategic approach to our decision-making for the FCDO.

We focused on four key products that related to the FCDO's strategic technologies due to their critical role in emerging global technology supply chains (DSIT, 2023a; DSIT & Prime Minister's Office, 2024; Haramboure et al., 2023):

1. **Semiconductor Silicon Wafers:** The foundation of microchip manufacturing.
2. **Semiconductor Equipment:** Machinery required for chip production.
3. **Electronic Integrated Circuits:** Core components of modern computing and communication devices.
4. **Electronic Computers and Components:** Finished products and supporting parts for computational infrastructure.

The datasets contain trade values for each country pair, reported separately for imports and exports, which allows for a detailed analysis of trade flows.

To analyse the global trade network, we modelled countries as nodes and trade flows as edges, weighted by total trade value (imports and exports). This network-based approach enables the FCDO to identify strategic trade partners, chokepoints, and facilitators within emerging technology supply chains. We applied network filtering to assess different levels of trade concentration:

1. Full Network: Includes all reported trade flows.
2. Top 20 (imports and exports): Focuses on the 20 highest-trading nations.
3. Top 10 (imports and exports): Highlights the most dominant trade relationships.

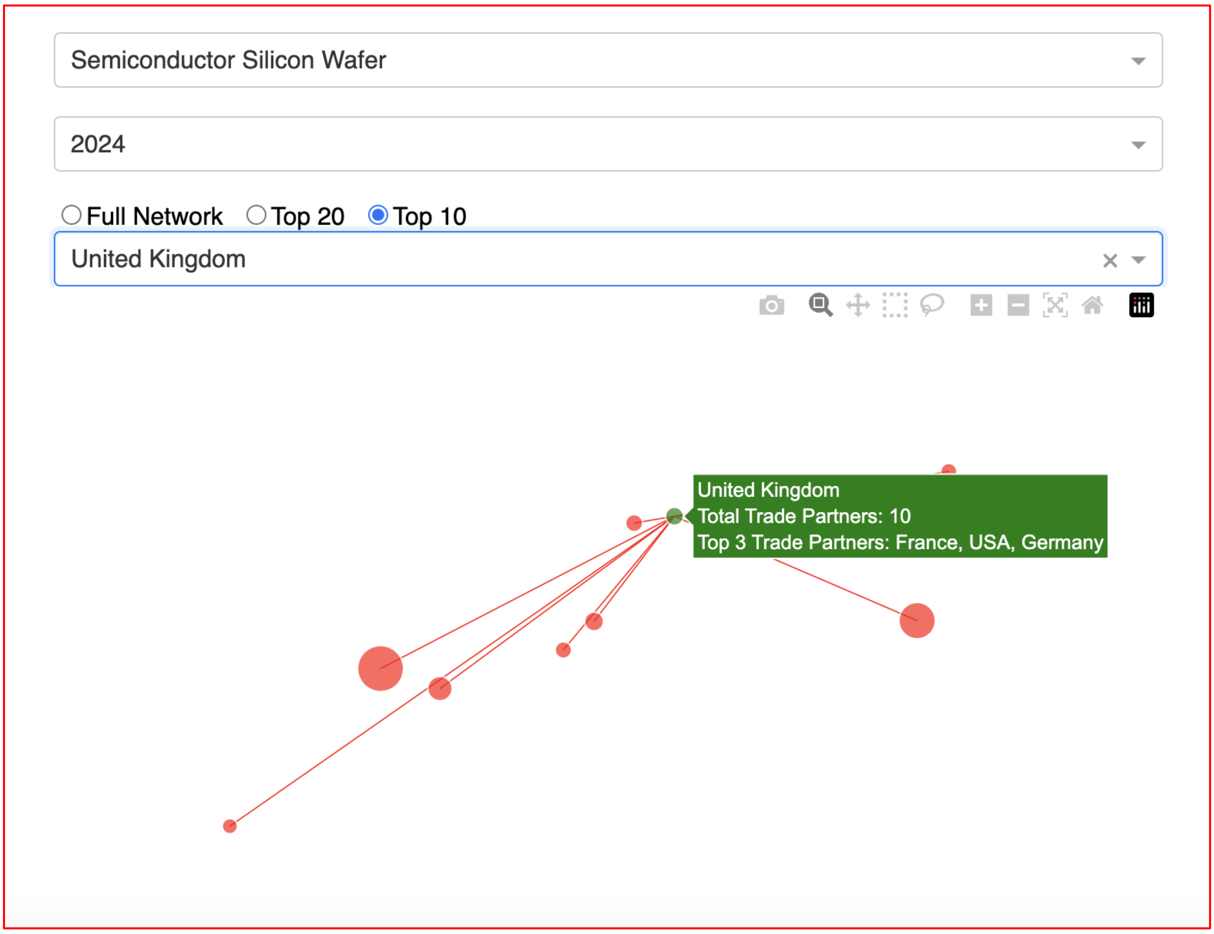

Figure 5: Network Analysis of Global Trade

We implemented a spring layout algorithm, visually mapping trade dependencies and clusters. This interactive tool allows policymakers to explore trade alliances, track shifting dynamics, and pinpoint areas where the UK can enhance its influence in trade supply chains.

To identify the most influential trade partners, we applied network analysis to assess each country's position in the trade network, helping the FCDO strengthen partnerships, diversify dependencies, and mitigate supply chain risks. We analysed degree centrality (a country's direct trade connections) to gauge integration and influence. Weighted trade rankings identified the top 10 importers and exporters per technology category, highlighting trade flow dominance. Trade flow directionality distinguished net exporters from net importers, revealing supply chain control and reliance. These insights enable a strategic approach to trade, helping the UK foster key partnerships, anticipate disruptions, and strengthen its role in semiconductor and technology markets.

5.2.4 Network Analysis of Co-Authorship Technology Research

This methodology uses OpenAlex bibliometric data to map international research collaboration in AI, Quantum Technology, and Engineering Biology—three of the five critical technologies identified by the UK government (FCDO & DSIT, 2023). These sectors are key to the UK's influence in global technology governance. By analysing co-authorship networks, we identify how nations collaborate through academic partnerships, providing a proxy for the strength, structure, and evolution of international ties. Co-authorship ties, based on institutional affiliations, reveal research alliances often overlooked by traditional metrics. Network analysis highlights both established and emerging clusters of collaboration, helping the FCDO identify strategic partners in the evolving global technology landscape.

OpenAlex was chosen as the primary data source for its comprehensive, openly accessible bibliometric records, providing structured metadata on scholarly works, authors, institutions, citations, and topic classifications. This makes it well-suited for tracking emerging global partnerships in strategic technologies. A Python pipeline collected up to 10,000 randomly sampled scholarly works per topic (AI, Quantum Technology, Engineering Biology) using OpenAlex's API (Priem et al., 2022). Each work included metadata on authors, institutions, country codes, and publication year. Records were filtered by predefined concept IDs for each technology area and limited to 2000–2005. Given the dataset's size, a random sample was used to demonstrate proof of concept and represent real-world relationships. Scaling to the full dataset is feasible with greater computing power.

A country-level co-authorship network was created to map global research partnerships in strategic technologies. Each country is a node, with edges representing co-authored research between institutions. For visualisation, we used a force-directed layout algorithm positioned highly connected nodes centrally and less connected nodes on the periphery, making spatial arrangement meaningful. Node sizes reflect degree centrality, and filtering by year or country allows users to explore historical and emerging research collaborations.

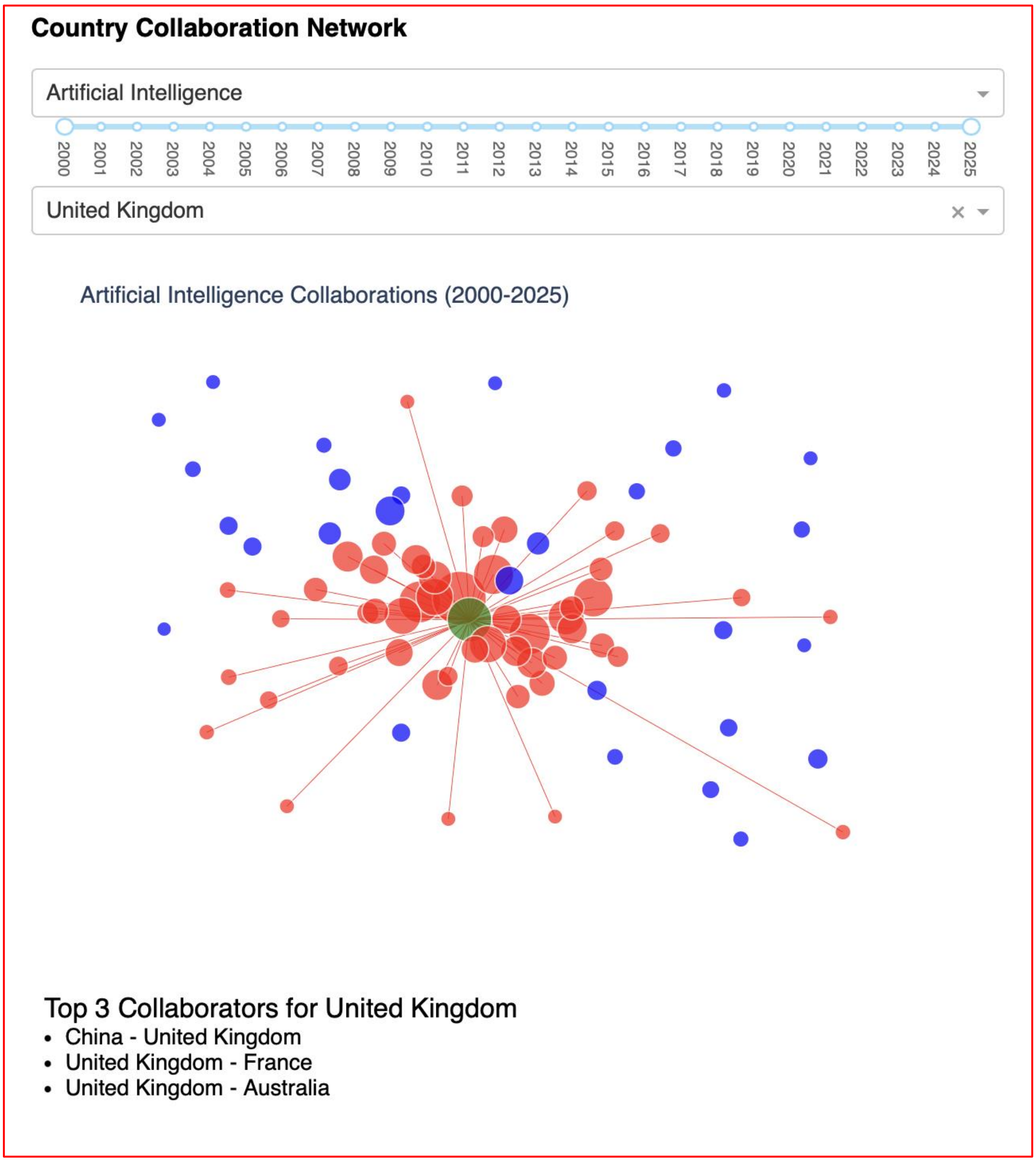

Figure 6: Country Collaboration Network Analysis

6. Analysis

Although our policy recommendations and conclusions will be integrated, the following analysis is divided into four key areas of the UK's network of relationships: multilateral regulation and standard-setting, international norm-setting and signalling, supply chains and trade, and research collaborations and citations. This analysis follows the three tenets behind our use of data science to better assessing the UK's influence over strategic technologies: assessing, identifying, and measuring. Our time-focused analysis will primarily concentrate on the assessing pillar — examining global and UK-specific trends. For instance, do we observe a growing alignment with China among non-aligned countries in the UN? The identify pillar focuses on strategic relationships that the UK is currently underutilising. Finally, we will explore how the tool can be used to measure influence and assess the impact of individual FCDO bilateral and minilateral strategic relationships.

Each section will conclude with an overview and policy recommendations specific to that data source, divided into two categories: strategic decision-making and improvements in integrating the data-science component of the tool. This structure ensures readers can clearly trace how each analytical method informs policy recommendations. Ultimately, these individual recommendations will be consolidated into a holistic approach in our final conclusions, demonstrating how our four-point framework, when integrated, is greater than the sum of its parts.

6.1: Analysis of Multilateral Voting: Mapping United Nations Voting Patterns

The first section of our analysis examines how UN voting records reveal alliances, partnerships, and geopolitical blocs within the General Assembly. While the conclusions may not be groundbreaking, the methodology is innovative. The findings largely align with expectations, confirming that countries vote in predictable patterns. However, the key value of this approach lies in its data-driven methodology: capturing positional distributions based solely on aggregated voting records, rather than relying on qualitative political or economic interpretations.

This analysis is particularly valuable when paired with our study of UN technology rhetoric, as it reveals a clear divergence between traditional voting patterns and discourse on technology issues, highlighting shifting geopolitical dynamics. Our initial objective was to fully disaggregate technology-related votes; however, limitations in topic modelling meant that a reliable classification mechanism would require manual labelling or, at a minimum, a pre-labelled dataset which could be used to train a classification model. While this process is feasible for an organisation like the FCDO within a few weeks, it was beyond the scope of a part-time research team of four. Nevertheless, our base code would be easy to update to show this disaggregation, if we had a labelled dataset of different voting documents to train a classification model. This capability offers significant potential not only for the International Technology Department but also for other divisions within the FCDO seeking to analyse UN voting patterns in greater depth.

6.1.1 UN Voting Structures Before 1990

Although our final data science tool focuses on post-1990 trends, our initial analysis examined the full dataset from 1946 to 2024, identifying distinct patterns that evolved over time. The early voting structures, from 1946 to 1960, reflect an emerging division between the US and Soviet blocs, though this alignment was not yet firmly established. From 1960 onwards, the Cold War period became more pronounced, marked by strong US-USSR polarisation and a clear division within Europe. The USSR and Eastern Bloc countries formed one cluster, while the Western European bloc—primarily led by the UK and France—coalesced separately. Interestingly, while the US remained aligned with the UK, it occupied its own distinct space alongside Israel, a pattern that persists today.

This Cold War structure persisted until around 1990, when a post-Cold War realignment began. Over the following decade, Europe consolidated into a single bloc, positioned equidistantly between the US-Israel alignment and the Global South, though not necessarily acting as a bridge between them. By 2005, this post-Cold War structure had stabilised, and it has remained largely unchanged since.

Given that this tool is designed for contemporary policymaking rather than historical research, our focus is on post-Soviet actors and emerging trends. While this dataset holds value for historians, the FCDO's primary interest lies in assessing current and future geopolitical shifts.

6.1.2 UN Voting Patterns Post-1990

For the sake of brevity, our analysis focuses on the voting structure as of 2024, though, as previously noted, the core patterns have remained stable since 2005. The interactive year selector in our tool enables the FCDO to track incremental shifts in voting behaviour year by year, allowing for a detailed examination of how specific historical events have influenced alliances. Whilst such an in-depth exploration is beyond the scope of this report, the tool provides a foundation for further analysis.

The voting distribution follows both geographical and geopolitical lines. European countries tend to cluster together, while Asia, Africa, and Latin America—forming what can broadly be termed the Global South—align as a separate bloc. The US and Israel stand as notable outliers, forming a third distinct position. These three groups create a triangular structure, with the US-Israel bloc at one vertex, Europe and its allies at another, and the Global South at the third. Within the Global South, larger middle powers such as China, India, Saudi Arabia, South Africa, Egypt, Argentina, and Brazil play a significant role in shaping voting trends.

The most analytically interesting countries in this dataset are those that deviate from these broad blocs. Two main characteristics define these outliers: either their historical and political relationships pull them towards alignment with countries outside their geographic region, or they are small, economically weaker states with more fluid voting patterns. One expected exception to the standard regional clusters is a subset of non-European states that maintain strong ties to Europe. These include Turkey, Japan, South Korea, and New Zealand, which consistently align with Europe despite their geographical distance. Conversely, within Europe, only Russia and Belarus remain positioned within the Global South cluster. Turkey's alignment with Europe may reflect its longstanding aspirations for EU membership. If Turkey were to join the EU, it would be valuable to examine whether its voting behaviour would shift accordingly. Another group of outliers consists of smaller, poorer nations, particularly in Africa, the Caribbean, and Oceania, which lean towards the US but without passing through the European bloc. Certain countries also occupy intermediate positions, such as Serbia, which sits between Europe and the Global South, and Armenia, which remains closer to the latter.

One particularly relevant observation for the FCDO is the presence of an Anglo bridge between the US and Europe, formed by the UK, Australia, and Canada. This suggests that UK's traditional positioning of itself as having a distinct role as the transatlantic bridge is correct. However, the UK's closer alignment with the US than the rest of Europe places it a slightly weaker positioning in terms of building alliances with the Global South—where Europe, in fact, holds a closer position. This pattern of Europe aligning more closely with the Global South than either the US or the UK is also reflected in technology discourse. Since the UK's voting patterns are even more distant from the Global South than those of Europe, it may be in the UK's strategic interest to strengthen its connections those countries bridging the European and Global South Blocs, particularly through partnerships with France, Turkey, and South Korea.

Finally, this also highlights that the UK's strongest diplomatic positioning comes from its close alignment with Canada and Australia and its function as a gatekeeper between the US and Europe. This is already leveraged through initiatives such as the AUKUS technology partnership, and the UK-US bilateral technology relationship (Quantum Statement and AI Strategy). However, no equivalent partnership exists with Canada, which presents a potential opportunity for the UK to enhance its geopolitical influence.

The next section returns to the UN, but shifts focus exclusively to technology discourse. Unlike voting patterns, we might expect discourse to allow countries to break free from their traditional blocs more frequently, revealing clearer insights into individual national positions, and allowing us to identify which countries the UK should target for more strategic relationships.

Summary of Multilateral Voting Patterns

1. Since 2005, three main clusters have formed: Europe, the Global South, and the US/Israel.
2. The UK bridges the US and Europe, with close allies including Australia, Canada, and France.

3. The UK is not a bridge to the Global South; Europe holds stronger ties. To improve connections with the Global South the UK must start in Europe.
4. Turkey, Japan, South Korea, and New Zealand vote similarly to the EU.

Policy Recommendations for FCDO decision making

1. The UK is in a privileged position to help articulate and strengthen relations between Europe and the US. Canada, Australia, and France are similar, and the UK should build these relationships.
2. Priority non-European partners for building closer relations should include South Korea, Japan, Turkey, and New Zealand.
3. Engaging with the Global South should be approached in coordination with other European allies.

Policy Recommendations on Data Science Implementation

1. **Topic-Specific Voting Analysis:** Filtering by topic can be improved via manual labelling of topics, 5,415 topics could be labelled manually within a few weeks.
2. **Detailed Historical and Group Analysis**
   Examining individual countries and group movements over time reveals context, while linking voting shifts to historical events deepens insight.
3. **Applying the Method to Other Institutions**
   This analytical approach can be applied to any voting body, such as the UK Parliament, international organisations like the OECD, WTO, and ITU, as well as technology standards bodies like the IEEE, IETF, and ISO.

6.2 Analysis of International Norm-Setting and Signalling: United Nations General Debate Speeches

The second section of our analysis shifts from examining UN voting patterns to focusing on discourse, specifically country statements made at the start of the General Assembly. Within our assess, identify, and measure framework, tracking how topics evolve over time could serve as a valuable measuring tool for the FCDO to assess UK influence. Our analysis highlights that the UK charts its own course in technology discourse, exhibiting a low similarity score compared to other nations. This is largely due to the UK addressing a broader range of topics, with a stronger emphasis on dual-use and civilian technologies than other UN members, including leading technology powers like the US and China, whose discourse remains largely focused on military applications such as nuclear and chemical weapons.

Whilst the dataset contained fewer references to technology than anticipated—particularly regarding capacity building and the digital divide which are areas of particular interest to the FCDO—the methodology itself has proven effective in capturing patterns of convergence and divergence among nations and shifts in global trends. This suggests that applying the same data pipeline to other international bodies, where dual-use and civilian technologies are likely to receive greater attention, could be a highly effective way for the FCDO to leverage data science in shaping UK influence on strategic technologies.

6.2.1 Time Trends

Our analysis shows that the topics raised in General Assembly speeches are driven more by global events than by national agendas. Nuclear weapons dominate UN technology discussions by a significant margin, followed by climate change and renewable energy, and then chemical weapons.

Our dataset, beginning in 1992 (when Russia could be consistently tracked after the USSR's dissolution), shows that while nuclear weapons have always been the most discussed technology issue, their prominence peaked in the 1990s, reaching around 300 mentions per year in 1996 and 1998 before falling to an average of 150 per year in the 2000s. However, key geopolitical events caused sharp spikes. In 2009, Barack Obama's Prague speech advocating a nuclear-free world, alongside North Korean missile tests, likely drove a surge in mentions. Similarly, North Korea's multiple nuclear tests and ICBM launches in 2017 prompted intensified UN discussions and the adoption of the Treaty on the Prohibition of Nuclear Weapons (TPNW). This suggests the US, backed by key allies, has been a major driver of nuclear debates at the UN.

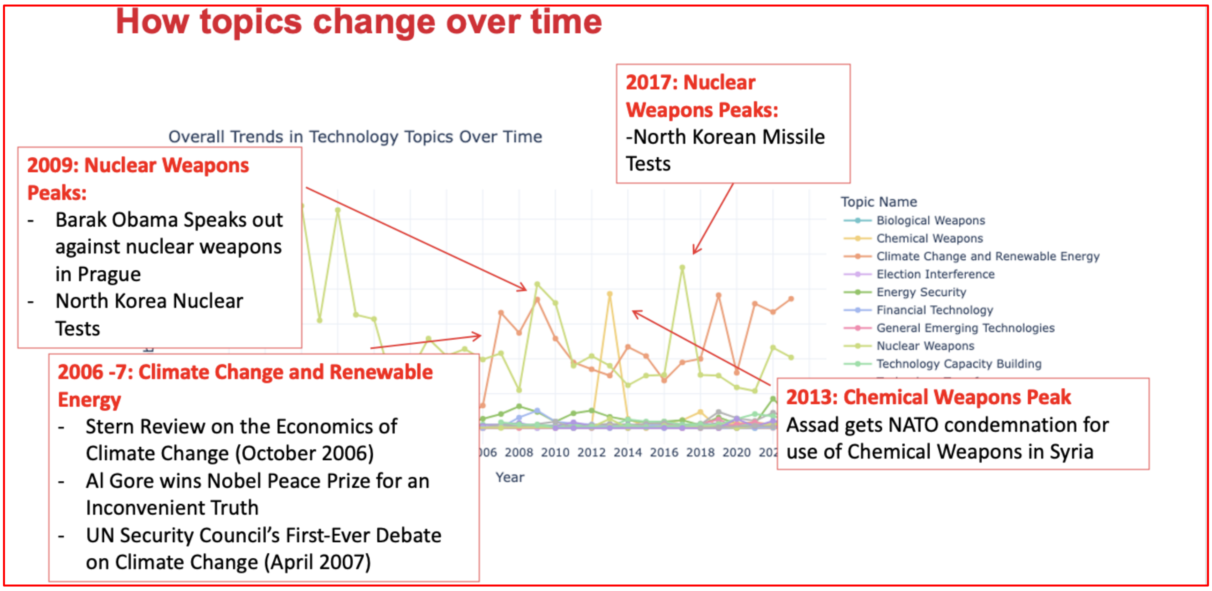

Figure 7: Overall Trends in Technology Topics

Other topic spikes also reflect global events. Climate change and renewable energy saw a sharp rise in UN discourse between 2006 and 2007, with mentions doubling from 30 to 66 in just one year, coinciding with the release of the Integrated Pollution Prevention and Control (IPPC) report and Al Gore's Nobel Peace Prize win. This suggests that discussions in other multilateral fora can influence UN agendas. Similarly, the spike in chemical weapons discussions in 2013 appears directly linked to reports of their use by Bashar al-Assad in Syria. Further analysis reveals this issue is highly polarised, with discussions led predominantly by US military allies, reinforcing US influence over UN debates, particularly regarding military interventions.

Energy security discussions also align closely with global crises. The 2008 Global Financial Crisis and the Oil Price Shock, which saw oil prices soar to $147 per barrel due to supply constraints and speculative trading, heightened concerns about affordability and supply stability. The Russia-Ukraine gas disputes (2006–2009) likely reinforced this focus. A renewed spike in 2012 coincided with US and EU sanctions on Iran's oil exports and fears of Middle Eastern instability post-Arab Spring. More recently, the 2022 Russia-Ukraine war and the resulting energy crisis have reignited concerns. China's engagement on energy security is also notable. While many discussions are event-driven, China consistently raises the issue, aligning with its broader strategic priorities.

6.2.2 National Patterns of Topic Engagement

The UK stands out at the UN for the breadth of technology topics it engages with, reinforcing its ambition to be a "Science and Technology Superpower"—at least under the previous administration (DSIT & Prime Minister's Office, 2024). Whilst most countries dedicate around half of their technology discussions to nuclear issues, for the UK, this figure is just a quarter. Instead, it covers a far wider range, including AI, cyberattacks, supply chains, electric vehicles, and emerging technologies. This broad focus explains the UK's low similarity scores with other nations. Unlike the US, China, and much of the world, it does not concentrate heavily on nuclear weapons, chemical weapons, or energy security, making its discourse appear distinct. In contrast, the US remains fixated on military technologies, particularly nuclear and chemical weapons, with some focus on cybersecurity, while China's alignment with other countries is largely driven by shared concerns over energy security.

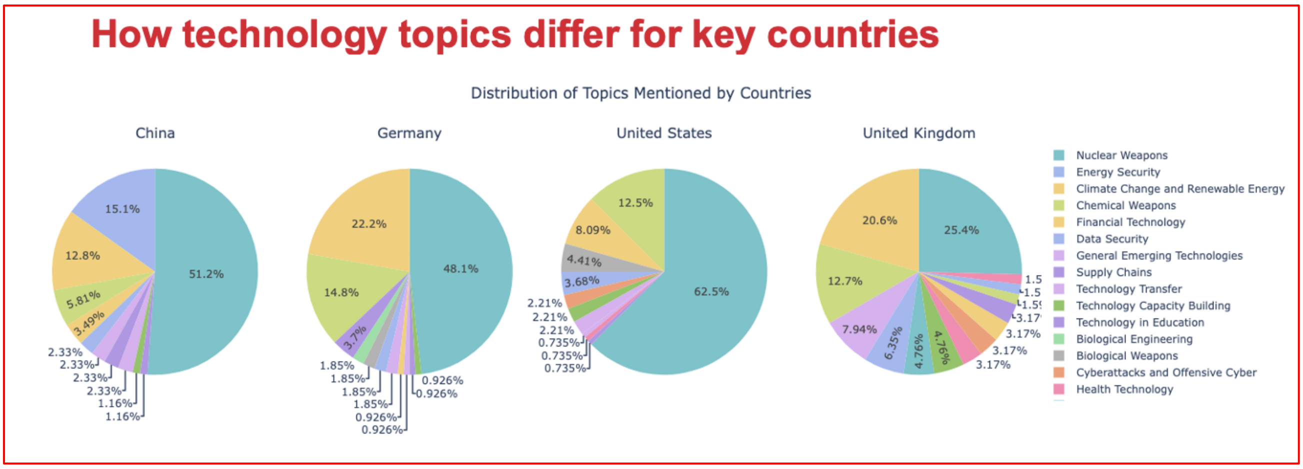

Figure 8: How Technology Topics Differ for Key Countries

6.2.3 Country Convergence and Divergence

As part of the assessing pillar of our data science framework, we tracked how countries converge or diverge over time, particularly in the context of US-China technology competition. Using similarity scores, we assessed whether the UK or China plays a greater role in shaping technology norms at the UN. These scores are based on cosine similarity, which measures the angle between numerical text embeddings generated using BERT. As this is not a perfectly linear measure, it is best understood through comparison with well-known texts.

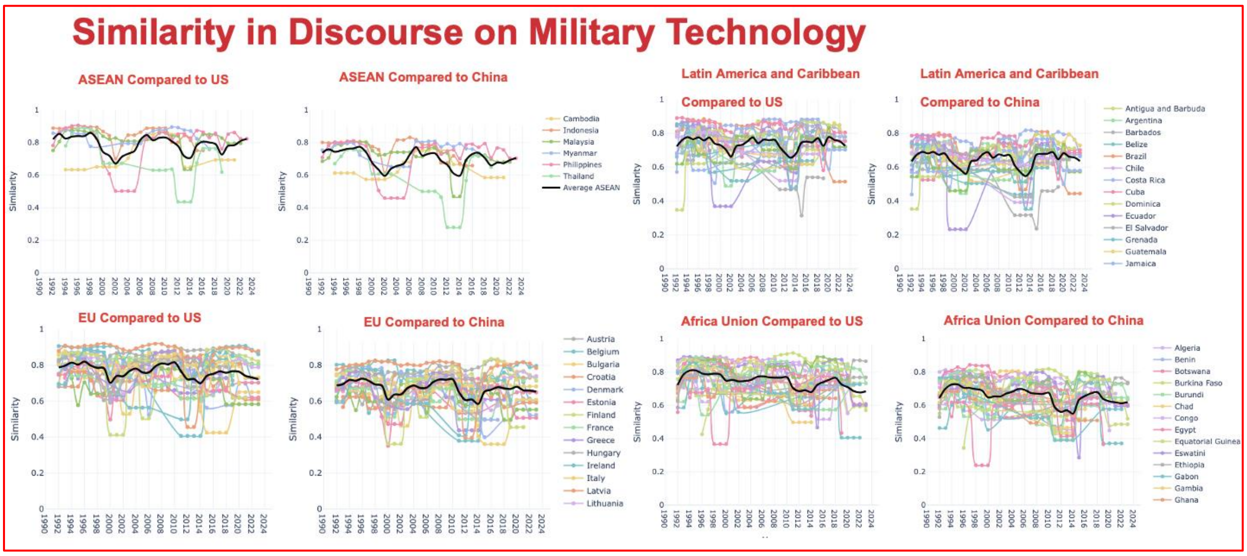

Figure 9: Similarity in Discourse on Military Technology

Our findings show that global statements on military technology align far more closely with the US than with China. Most regions have an average similarity score of 0.8 with US discourse—comparable to the similarity between *Henry IV Part 1* and *Henry IV Part 2*. By contrast, similarity with China is lower, around 0.7, akin to *Henry IV Part 1* and *Hamlet*. For dual-use technologies, most countries remain more aligned with the US than with China, with similarity scores around 0.5—closer to the difference between *Henry IV Part 1* and *A Midsummer Night's Dream* (Micheal Clark, 2018). Notably, there is greater variation in how different nations align with dual-use discourse compared to military discourse.

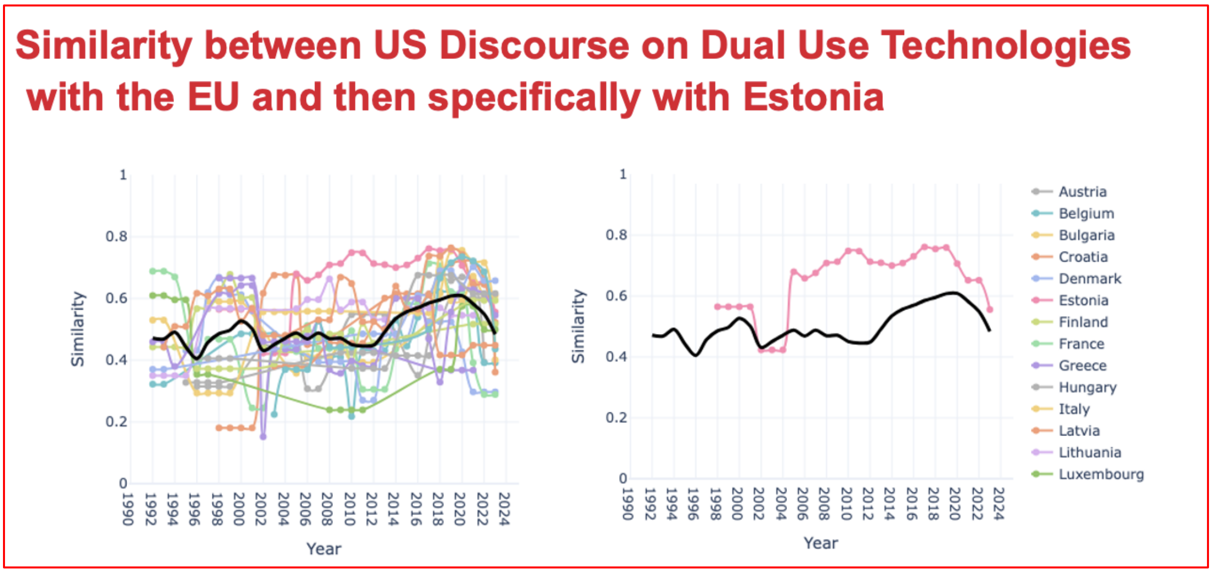

Figure 10: Similarity on Dual Use Technologies

Beyond tracking global trends, this tool also helps identify potential strategic allies. For example, Estonia shows remarkable alignment with US positions, validating this method. The following statements illustrate their close stance on cyber threats. In 2021, the US stated: *"We are hardening our critical infrastructure against cyberattacks, disrupting ransomware networks and working to establish clear rules of the road for all nations as they relate to cyberspace" (Jankin et al., 2017)* . This closely echoes Estonia's 2018 statement: *"we want to offer our perspective to ensure that human beings remain safe in this new world where cyber-related threats are combined with conventional ones" (Jankin et al., 2017).* Whilst cosine similarity does not establish causality, it effectively reveals patterns of alignment, offering valuable insights for diplomatic strategy.

6.1.4 Network Analysis

One of the most valuable aspects of our analysis is network analysis, which helps identify potential strategic allies in emerging technologies. Initially, we expected countries to discuss the same technologies in different ways, but our findings revealed that the key difference lies in which topics they prioritise rather than how they discuss them. This allowed us to build a network using topic mentions, broadening our scope to include capacity building, technology transfer, and civilian technologies. Aggregating data over time mitigated the challenge of limited individual data points, providing a clearer picture of global engagement.

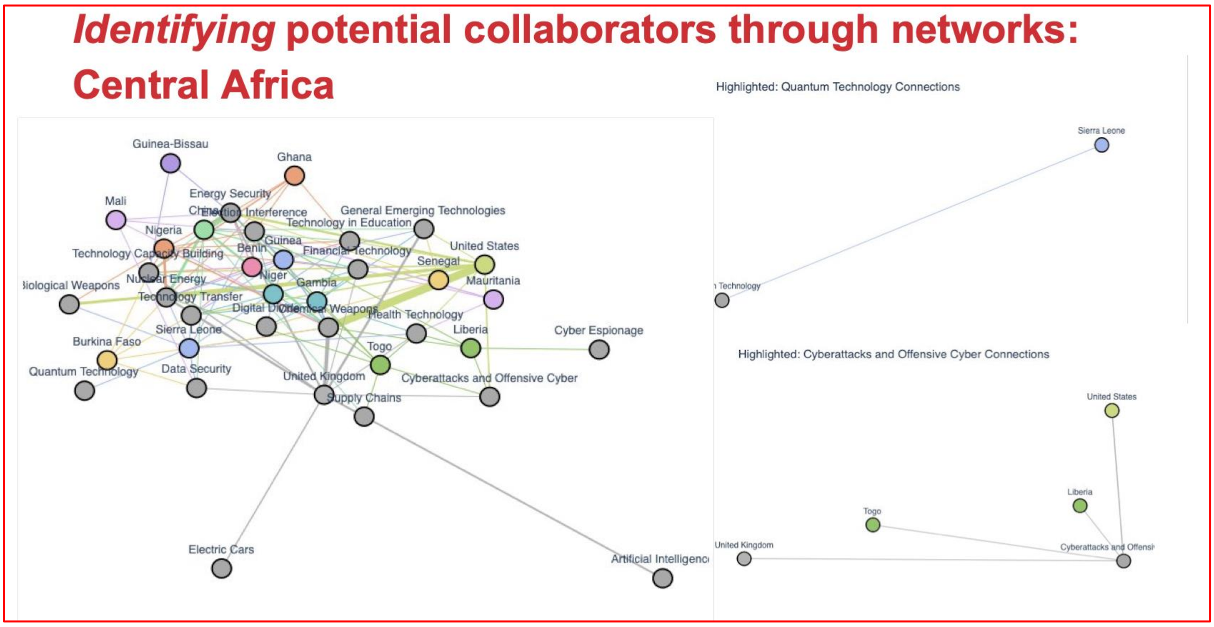

Figure 11: Network Analysis

Our analysis confirms that the UK discusses a wider range of emerging technologies at the UN than most other countries. However, there are clear opportunities to strengthen partnerships with underutilised but like-minded nations. The Baltic and Nordic states—particularly Estonia, Latvia, Lithuania, Sweden, and Finland—consistently engage on emerging technologies, cyber threats, data security, and capacity building, making them natural UK partners. Singapore also stands out as a key player in technology leadership, yet the UK is not fully leveraging this relationship. In Asia-Pacific, Malaysia and the Philippines engage actively on emerging technology topics and could be valuable allies. In Africa, Sierra Leone, Gambia, Guinea, and Uganda show strong interest in multiple strategic technology topics, presenting opportunities for tech-driven collaboration. The Gulf states (Qatar, UAE, Saudi Arabia, Oman) also make mention of capacity building, general emerging technologies – making them possible regional partners to leverage in this area.

Cybersecurity—particularly offensive cyber and cyberattacks—is an area where the UK could take a leadership role. Estonia, home to NATO's Cyber Centre in Tallinn, discusses offensive cyber more than any other country in the UN. A closer partnership with Estonia would allow the UK to shape Europe's cyber agenda. Other European nations—including Austria, Latvia, Lithuania, Slovakia, Hungary, Bulgaria, Romania, and Spain—also focus on cyber threats, reinforcing the potential for a European coalition. Meanwhile, cyber concerns in African and Caribbean nations such as Togo, Liberia, Gabon, Mauritius, Panama, and Jamaica highlight a growing global challenge, opening new avenues for engagement.

Technology transfer and capacity building are widely discussed but remain underexplored by the UK, despite being priorities for major global players such as China, the US, France, and India. The Baltic states—Estonia, Latvia, and Lithuania—stand out as key actors in these discussions. Across Africa, interest is particularly strong in West African nations like Benin, Guinea, Gambia, Burkina Faso, and Nigeria, as well as East and Southern African countries such as Malawi, Mozambique, Angola, and Namibia. In Latin America, Chile, Argentina, and Ecuador emerge as key players, with Belize and Panama also engaged. India leads global discussions on technology transfer and capacity building, presenting an opportunity for deeper UK engagement through its UK-India Technology Security Initiative (FCDO et al., 2024).

The digital divide is less frequently mentioned but remains a critical issue in specific regions. Once again, Estonia leads in Europe, with Latvia and Finland also active. In Asia, Singapore, the Philippines, and Thailand highlight concerns over the digital divide, offering potential for regional cooperation. In Latin America, Ecuador and Jamaica stand out, with Jamaica presenting a Commonwealth-based partnership opportunity for the UK. Malawi's engagement suggests it could serve as a regional tech hub in Africa. Meanwhile Bangladesh, Pakistan, and Nepal focus on the digital divide and capacity building, reflecting persistent regional challenges around connectivity and inclusion. By leveraging these insights, the UK can build more targeted alliances, ensuring its strategic influence in key technology discussions worldwide.

Overall Trends in UN Speeches Data

1. US rhetoric on technology aligns more closely with global discourse than China's. The UK, however, is significantly less similar—largely due to breadth of technology topics it engages with.
2. In Asia pacific, Singapore, Malaysia and the Philippines engage actively on emerging technology topics and could be valuable allies. In Africa, Sierra Leone, Gambia, Guinea, and Uganda show strong interest in multiple strategic technology topics, presenting opportunities for tech-driven collaboration.
3. Over cybersecurity, Estonia, Austria, Latvia, Lithuania, Slovakia, Hungary, Bulgaria, Romania, and Spain all show concern in Europe. While, Togo, Liberia, Gabon, Mauritius, Panama, and Jamaica highlight growing global cyber concerns in areas not traditionally considered tech hubs.
4. Technology transfer, capacity building and the digital divide is a large issue in the global south with currently India as its biggest champion, this is a strategic opportunity for the UK to leverage its relationship with India to connect more with Benin, Guinea, Gambia, Burkina Faso, Nigeria, Malawi,

Mozambique, Angola, Namibia, Chile, Argentina, Ecuador, Belize, Panama, Bangladesh, and Nepal.

Policy Recommendations for FCDO decision making

1. The UK and Germany share strong concerns over emerging technologies, but Austria, Estonia, Latvia, Lithuania, Sweden, and Finland are underutilised allies—especially in cybersecurity and AI. The UK should deepen ties with Austria in particular, as it leads Europe in discussions of quantum technology and Estonia as it leads in cyber.
2. Quantum technology does not have much airtime within the UN, and the UK does not make mention of it. However, Austria, Switzerland, and Greece are European players with existing quantum research initiatives. Kenya, Namibia, Sierra Leone, and Belize suggest growing quantum technology interest in Africa and Central America.
3. The UK is missing key cybersecurity partnership opportunities. Nations like Togo, Liberia, Gabon, Mauritius, Panama, and Jamaica offer untapped potential for collaboration, particularly in countering offensive cyber strategies and global cyber norm-setting.
4. Energy security is the top technology issue aligning countries with China. To counter Beijing's influence, the UK must make discussions of energy security a central pillar of its communication strategy.
5. Reports and norm-setting outside of the UN can have a huge impact on the discussions within the UN. The UK should therefore focus its attention not just on multilateral fora like the UN.

Policy Recommendations for Data Science Implementation

1. Track wider patterns in non-technology topics within the UN. This can be done with minimal modifications to the existing code, as broader issue labelling is already part of the analysis framework outside of zero-shot classification.
2. Improve similarity plotting by integrating data from economic forums and standards-setting bodies (e.g., ASEAN, African Union, OECD, ITU) for future telecommunications policy analysis. This would better align with the international technology department's priorities and strengthen results by increasing data points on dual-use and civilian technologies.
3. Measure the Bletchley Park AI Summit's influence by tracking spikes in AI-related discussions following the event. This would provide a quantitative assessment of the summit's global policy impact and inform future diplomatic engagements in AI governance.
4. Develop similarity scores for speeches to track rhetorical shifts in key nations, enabling the FCDO to prioritise high-impact statements.

6.3: Analysis of Supply Chains and Trade: United Nations Comtrade Data

This section shifts focus from norm-setting and regulation to examining the UK's access to critical upstream technologies, particularly in the supply chain of semiconductors and chips. The global trade network reveals distinct regional concentrations of influences, with a few dominant economies controlling the imports and exports of critical and emerging technologies. This analysis aims to highlight how global players are advancing in strategic technology development. It also aims to identify key trade relationships and explore how the UK can strengthen its position within the supply chain of critical and emerging technology sectors.

This network analysis serves three purposes within our assess, identify, and measure (AIM) framework:

1. **Assess**: Assessing how global trade flows in critical technologies have evolved.
2. **Identify:** Identifying strategic trade partners that the UK is not fully leveraging.
3. **Measure:** Measuring whether existing trade relationships effectively strengthen supply chain resilience.

The network visualisation utilises the United Nations Comtrade Database to effectively portray the trade relations among top importing and exporting countries. It aims to highlight the strategic interdependencies within a highly specialised and geopolitically sensitive market.

6.3.1 Time Trends

For this analysis, we focus on semiconductor silicon, semiconductor equipment, electronic integrated circuits, and electronic computers and components. These products form the hardware backbone of the three strategic technologies: AI, Engineering Biology, and Quantum Technology. We need to note that our conclusions are limited by the fact that Taiwanese and Chinese exports are aggregated.

Examining the trade patterns from 2010 to 2024 for these product categories reveals notable changes and new trends in the worldwide technology supply chains:

1. Semiconductor Silicon Wafers: In 2010, Germany and Japan dominated exports, but by 2023 China/Taiwan surged into poll position overtaking traditional exporters in this sector. However, by 2024, geopolitical shifts saw Japan and the US regaining export leadership. The UK's emerging role in this sector highlights a potential strategic position.
2. Semiconductor Equipment: Historically, this sector has been led by Japan and the US in 2010 while China/Taiwan became the top exporter by 2020. However, due to strategic recalibrations and global supply chain shifts, by 2024, the US, Japan and the Netherlands emerged prominently on the top. Over the years, the UK significantly increased its position in this sector which indicates a growing capability to compete in the supply chain environment.
3. Electronic Integrated Circuits: China/Taiwan has consistently dominated exports since 2010 to 2023, yet a market shift occurred by 2024, with Malaysia becoming the leading exporter followed by the US and Thailand. The UK's export in this sector grew modestly which implies a potential for increased strategic engagement.
4. Electronic Computers and Components: Initially driven by China/Taiwan, trade flows have shifted from 2024, with the US asserting dominance, and the UK establishing itself in second position globally. The decline of China's export brings into light the ongoing global efforts to diversify production hubs.

6.3.2 Shifting Influences and Strategic Implications

The analysis of the global trade patterns reveals significant shifts in critical and emerging technology sectors which are crucial for shaping and maximising the UK's strategic influence on technology supply chains.

The data highlights a clear movement away from China/Taiwan - a dominant trade player in key sectors such as semiconductor equipment, integrated circuits, and electronic computers. This shift clearly reflects the heightened geopolitical tensions between the US and China, strategic reshoring due to global supply chain disruptions during the pandemic and strategic diversification of trade hubs. These new production hubs are emerging in Southeast Asia, specifically Malaysia, Thailand, and Vietnam and within Europe, including the Netherland and Czechia. This is driven largely due to geopolitical tensions pushing global tech industries and manufacturers to strategically relocate to mitigate risks and strengthen supply chain robustness and aligning with boarder manufacturing trends (Gopinath et al., 2024).

Summary of Global Trade

1. Global supply chain in critical and emerging technology sectors such as semiconductor equipment, integrated circuits, and electronic computers and components are diversifying away from China/Taiwan's historic dominance.
2. The new production hubs are emerging in Southeast Asian countries (Malaysia, Thailand, and Vietnam) and European nations (Netherlands and Czechia).
3. Despite these shifts, the UK exports and imports remain stable, but this highlights the need for strategic expansion by leveraging global partnerships and creating proactive trade policies.

Policy Recommendations for FCDO decision making

1. Strengthen diplomatic relations through targeted trade agreements with emerging technology hubs specifically ones not used for Chinese offshoring, ie. Czechia and Netherlands.

2. New production hubs should be carefully investigated before deepening trade relations to protect the UK from even more unstable supply chains due to Chinese offshoring, for example in Malaysia, Thailand, and Vietnam.

Policy Recommendations Data Science Implementation

1. The FCDO should leverage internal proprietary trade-data sources to disaggregate China and Taiwan implementing our data pipeline.

6.4 Analysis of Research Collaborations and Co-authorship and Citations: Open Alex Data

The final section of our analysis examines research co-authorship in three key strategic technology areas using data from Open Alex. Within our assess, identify, *and* measure framework, this work serves three purposes: assessing how trends in global technology have shifted, identifying strategic research partners that the UK is not currently collaborating with, and monitoring whether existing research collaborations are effectively increasing co-authorship numbers. For this analysis, we have focused on three strategic technologies: AI, Engineering Biology, and Quantum Technology. Over the past three decades, international co-authorship patterns have changed radically. Initially dominated by Western countries, the global landscape experienced substantial diversification post-2005, notably involving China and broader Indo-Pacific partnerships.

6.4.1 Time Trends

Between 2000 and 2004, international research in strategic technologies primarily involved the US, UK, Germany, Japan, and Austria. It reflected historical alliances and traditional research hubs. During this period, collaborations were largely Western-centric or connected to established Asian technology centres.

From 2005, a notable shift occurred as China quickly became a significant international research player, significantly influencing AI and Engineering Biology. By 2014, China's collaboration networks expanded considerably, incorporating partnerships with Australia, Canada, Hong Kong, and the UK. Simultaneously, European nations such as Switzerland and Germany maintained strong roles, particularly in Quantum Technology.

Between 2020 and 2025, research collaboration network further diversified. Countries including the Netherlands, South Korea, Italy, and Switzerland increased their strategic importance. The smaller research countries highlight a shift towards a more decentralised global research landscape. This provides opportunity for UK collaboration with these nations, which has already begun with AUKUS and cooperation with South Korea on semiconductors, but this could be further expanded to cooperation on other strategic technologies.

6.4.2 Strategic Alignment with the FCDO's Goals

These shifts align with the strategic goals of the FCDO. Initiatives such as the UK Science and Technology Network (STN) and the Global Challenges Research Fund (GCRF) aim to strengthen global research ties and support international challenges, aligning with the growing inclusivity seen in co-authorship patterns (UKRI, 2024).

The UK remains a global research powerhouse, leverage its scientific and technology strength to build both traditional and new partnerships. China's rise in key technologies—especially in AI, Quantum Technology, and Engineering Biology—offers opportunities but also poses diplomatic challenges. The UK needs balanced engagement strategies. Strong ties persist in Europe, notably with Germany, France, Switzerland, and Austria. However, the UK is also expanding collaborations in the Indo-Pacific, including Australia, Japan, and South Korea. Smaller nations are increasingly active in Quantum Technology and Engineering Biology and this growth presents new opportunities for the UK to enhance its scientific leadership and diplomatic influence.

In conclusion, the evolving trends in co-authorship demonstrate the UK's important role in global scientific diplomacy. The UK’s strategic alignment with international objectives ensures its continued relevance in the global research landscape. To maintain leadership, the UK should focus on strengthening international research networks, balancing collaborations with China, expanding partnerships with non-European nations, and reinforcing ties with key European research powers.

Summary of Co-authorship Network Analysis Patterns
1. AI research transitioned from Western-centric dominance toward inclusive global participation, with China significantly enhancing its role alongside the UK, US, Japan, and South Korea. 2. Engineering Biology has expanded beyond Europe to more global collaboration, prominently featuring the US, UK, China, and Indo-Pacific nations, notably South Korea. 3. Quantum Technology remains significantly European-driven, with Germany, France, Switzerland, and Austria as key UK partners. However, growing collaborations with Australia and Japan reflect strategic diversification into Indo-Pacific regions. 4. Germany consistently emerges as the UK's most dependable European collaborator, underscoring the importance of sustained European ties post-Brexit.

Policy Recommendations for Strengthening the UK's Scientific Diplomacy
1. **Strengthen diplomatic ties through diverse research collaborations** with currently underutilized countries like Switzerland, Austria and France. 2. **Expand funding for international scientific partnerships**: Increase investment in collaborative research, particularly in critical areas such as AI, Quantum and Engineering Biology. 3. **Develop targeted programs for collaboration with smaller, emerging nations**: Design initiatives that support partnerships between UK scientists

and researchers from smaller, emerging countries, helping to build a more inclusive and globally interconnected research network.

Policy Recommendations for Data Science Implementation

1. The FCDO should leverage greater computing power to utilise our same data science pipeline, but without having to randomly sample the data, instead using the full dataset available on Open Alex.

7. Conclusions and Policy Recommendations

In this report, we examine how the FCDO can use data science to maximise UK influence on strategic technologies through its global network of partnerships. At the heart of this project is a key contention: national strategic advantage cannot be measured solely through domestic capabilities. The UK’s strength in strategic technologies depends both on its own research and innovation and on how effectively it collaborates with global partners. Failing to recognise the importance of these partnerships’ risks hampering the UK's role in influencing critical technologies.

Our analysis and the tool we have developed demonstrate how data science can enhance strategic decision-making within the FCDO. This is particularly evident when applied through the assess, identify, and measure framework we propose for data driven diplomacy. First, assessing global trends and the UK’s position allows for more informed policy decisions. One of the central trends the FCDO has identified as a priority for greater assessment is how the dynamics of US-China technological competition shifts the global balance of power. Our analysis demonstrates that while there is increasing global alignment with Chinese priorities in the UN, this appears to be driven more by China moving toward others rather than a deliberate shift towards China. Alignment with the US remains strong, reinforcing existing geopolitical structures. Similarly, while China is emerging as a major R&D superpower, the recent expansion of R&D collaboration across a broader range of partners than ever before suggests that China's rise presents both challenges and opportunities for UK strategic partnerships.

In terms of assessing how the UK interacts with the rest of the world, our analysis illustrates how the UK charts an independent course in both voting and discourse at the UN, acting as a transatlantic bridge with distinct global positioning. Strengthening relationships with Europe, the US, Canada, and key Indo-Pacific allies is crucial to maintaining this role. While the UK has already taken steps in this direction through initiatives like AUKUS and growing partnerships with Japan and South Korea, further collaboration with Canada, France, and Turkey remains underexplored.

Beyond assessing existing trends, data science also helps to identify previously overlooked opportunities. Our research has uncovered potential partnerships that are not currently being sufficiently leveraged. Greece, Switzerland, and Austria show strong potential for collaboration in quantum technology, while the Baltic states present opportunities in cybersecurity, emerging technologies, and data security. Some of these ties are already being reinforced through NATO and initiatives such as the Cyber Centre in Tallinn, but deeper engagement could strengthen these partnerships further. We have also identified opportunities in regions not traditionally viewed as technology hubs but where interest in strategic technologies is growing. Countries such as Sierra Leone, Jamaica, Nepal, and Sri Lanka could become important allies, providing the UK with opportunities to establish diplomatic ties in new regions. This targeted approach allows the FCDO to direct its outreach toward countries that are already committed to technological development, rather than adopting a scattergun approach.

The measuring capabilities of data science are of crucial importance to the FCDO, offering a powerful way to track progress towards key policy aims. This ensures accountability to both the public and government departments while ensuring allocation of resources towards the most impactful initiatives. In trade, data science enables the FCDO and the DBT to track access to upstream components of strategic technologies and monitor UK exports in these sectors. This provides insight into the success of domestic technological development and highlights trade barriers such as supply chain constraints. Similarly, tracking research collaborations over time—such as UK-South Korea partnerships in semiconductors—helps assess the effectiveness of these initiatives. Data-driven analysis can quantify the impact of these collaborations, strengthening the case for further investment in similar partnerships. Discourse analysis also serves as a valuable monitoring tool, not only for evaluating whether UK-led initiatives are influencing global priorities but also for tracking changes in rhetoric. This helps assess how other nations perceive UK efforts and whether global discussions around strategic technologies are shifting in response.

From these insights, we offer a series of policy recommendations. These fall into two main areas- regional engagement as well as improving the use of data science tools within the FCDO and across the wider civil service. By leveraging data science to assess global trends, identify strategic opportunities, and measure policy impact, the UK can strengthen its influence in strategic technologies. A data-driven approach to decision-making will ensure the UK remains proactive in its technological diplomacy. Through this, the FCDO can play a central role in positioning the UK as a global leader in shaping the future of strategic technologies.

8. Policy Recommendations

8.1 Policy Recommendations for the FCDO Strategic Decision Making

1. **Deepen the Transatlantic Relationship and Leverage the UK as a Transatlantic Bridge**: The UK should leverage its role as a transatlantic bridge, especially with the US and Australia through AUKUS, whilst deepening its relationships with other ‘bridge’ countries like Canada and France. There are also opportunities to forge new partnerships with countries like Chile, Belize, Panama, and Jamaica, which show interest in strategic technologies.
2. **Cautiously Expand Indo-Pacific Relations**: The UK should continue strengthening its collaboration with Japan, South Korea, and Australia, leaders in research and semiconductor exports, with aligned interests in technology development. The UK should emphasise capacity building, technology transfer, and the digital divide in its partnership with India would align the UK with Global South priorities. Additionally, the FCDO and DBT should investigate the growing tech exports from Malaysia, Thailand, and Vietnam to prevent overreliance on potential Chinese offshoring.
3. **Better Leverage European Allies**: There is also significant untapped potential in semiconductor partnerships with the Netherlands and Czechia. Developing new bilateral research collaborations with Austria, Switzerland, and Greece in quantum technology, as well as with the Baltic states—Estonia, Slovakia, Sweden, Latvia, Finland, and Lithuania—in cybersecurity, AI, and capacity building, would further strengthen the UK's role in European technology development.
4. **Strategically Focus on Non-Aligned and Global South Potential Partners and co-opt Chinese talking points**: The UK should prioritise diplomatic and technological engagement with the Global South, leveraging partnerships with countries who have a pre-expressed interest and commitment to strategic

technologies. Kenya, Namibia, Sierra Leone, and Belize have shown interest in quantum technology, while Togo, Liberia, Gabon, Mauritius, Panama, and Jamaica are increasingly focused on cybersecurity. Similarly, Gambia, Guinea, and Uganda have expressed broader concerns about emerging technologies. By fostering research partnerships, facilitating student exchanges, and providing targeted capacity-building initiatives, the UK can strengthen alliances with these nations. In the Indian subcontinent Sri Lanka appears a technology leader while Nepal, Pakistan and Bangladesh have demonstrated interest in emerging technologies, especially in technology transfer and capacity building. The UK should position itself as a champion of energy security offering an alternative to Chinese influence.

5. **Address the China Question**: Whilst completely halting research collaboration with China could limit the UK's capabilities, the rapid emergence of new players in the research field presents an opportunity**.** By diversifying and strengthening research partnerships globally, the UK can foster a thriving and resilient research landscape.

8.2 Policy Recommendations for Improved Data Science implementation within the FCDO and wider UK Government

8.2.1 Optimising the Use of Our Existing Tool

1. **The FCDO should implement the tool with targeted diplomatic engagement**: Her Majesty's Ambassadors (HMAs) and Heads of Mission (HOMs) can ensure diplomatic outreach is data-informed and targeted. The tool can provide both micro-level insights and broader trends.
    a. Measuring Policy Effectiveness: The tool can be applied to track the impact of government initiatives and guide funding decisions.

b. The FCDO should extend the use of this tool to other departments, as open-source data can be shared without security concerns. This will help align with a whole-of-government approach to strategic technology policy.
    1. Cabinet Office – Ensuring alignment with national security and foreign policy priorities.
    2. Department for Business and Trade (DBT) – Supporting informed decisions on trade partnerships and economic relations.
    3. Ministry of Defence (MoD) – Enhancing defence strategy and security planning.
    4. UK Research and Innovation (UKRI) – Guiding research collaborations based on geopolitical trends.
    5. Department for Science, Innovation, and Technology (DSIT) – Facilitating targeted partnerships in technology and innovation.
    6. Research and Innovation Network (RIN) – Analysing global research collaborations, identify emerging technology trends and optimise funding allocation.

8.2.2 Using Our Existing Tool in New Ways

1. **Refining UN Speech Analysis with Vote Segregation**: UN voting topics could be labelled via supervised learning or manual tagging. Allowing the FCDO to disaggregate voting patterns on different topics within the UN. We began implementing this process but noted it could not be achieved by BERTopic alone; instead, a pre-labelled training set is necessary. This is feasible within a few weeks (although not for our project, as it was too resource intense for a part-time team of four).
2. **Expanding the Use of UN Speech Analysis:** The FCDO should integrate the 2024 speeches as soon as they are published in the Harvard Dataverse. It would highlight whether the Bletchley AI summit caused an increase in AI discussion

within the UN. Moreover, this tool has value to departments outside of the International Technology Department, as our zero-shot method gave all topics labels, even those not related to technology, this can be used by other departments within the FCDO.

3. **Further Expanding Trade-Data Analysis:** The current analysis focuses on three upstream components, but the UNComtrade database contains hundreds of additional components. This data could be expanded to meet specific needs. Potential applications include the MoD assessing supply chains for defence-related components.
4. **Expanding the Use of OpenAlex Research Data:** Our current analysis focuses on engineering biology, quantum technology, and artificial intelligence, but this could easily be expanded to other technology areas with minimal changes to the existing data pipeline. We have already gathered institution-level research data, though it was not included in the initial analysis due to our focus on national insights. By incorporating this information on research institutions, the UK government could develop a more granular approach to institutional funding and support, enabling them to:
    a. Identify which UK institutions collaborate most with international partners. Pinpoint which foreign institutions are cooperating most with the UK and encourage student exchanges with these institutions.
    b. Use these insights to guide funding and research grants. For example, this data could inform decisions on which universities should be targeted for government-funded projects, such as the Isambard supercomputer project in Bristol, prioritising those with the strongest global collaborations.

8.2.3 Leveraging New Data to Enhance the Existing Tool

1. **Integrating Additional Voting and Discourse Data to improve insights:** The UN's focus on peace and security means that civilian and dual use technology is underrepresented. Integrating voting records and speeches from other global

fora —such as ASEAN, the African Union, and the OECD—would provide a more comprehensive picture of international technology discussions. The FCDO is also particularly interested in technology standards bodies, such as the International Organisation for Standardization (ISO), the International Electrotechnical Commission (IEC), and the Institute of Electrical and Electronics Engineers (IEEE), but we were unable to access this proprietary data. With little effort these data sources could be integrated into the presented tool.

2. **Addressing Data Limitations in Trade Analysis:** The UN Comtrade data does not distinguish between Taiwan and China. However, the UK likely has access to additional trade datasets that make this distinction. Integrating such data into the existing pipeline would enable more precise trade analysis, particularly in assessing UK-China-Taiwan trade relations. Taiwan's role in the semiconductor industry makes this of high priority.

8.2.4 Applying Similar Data Science approaches to New Tools

1. **Improving the Efficiency of Reviewing External Documents and Other Governments' Speeches within the FCDO:** The similarity score method used in discourse analysis could help policy analysts prioritise document reviews. By assigning a similarity score to each speech based on previous discourse, it would be easier to identify significant shifts in rhetoric. This would allow analysts to focus on noteworthy deviations, rather than reviewing all documents indiscriminately.
2. **Expanding Network Analysis for Political Alignment:** A network analysis, based on the similarity between political leaders' statements (including social media, speeches, and foreign ministry releases), could track political alignment. Scraping platforms like X could offer real-time insights into global diplomatic shifts. Although this approach was not pursued due to funding limitations, it remains a feasible and cost-effective project that could significantly enhance diplomatic intelligence. A similar method has already been applied in the US (Sevin & Ingenhoff, 2018).

3. **Enhancing Machine Learning Models for Policy Analysis:** The current UN data and speech analysis rely on unsupervised models like BERTopic, with some fine-tuning. These models could be further enhanced using a supervised learning approach, especially with pre-labelled datasets. This would be particularly valuable for labelling roll call vote data and refining policy insights.

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10. Appendix

10.1 Terms of Reference

The following Terms of Reference outline the initial scope of our project. As the project progressed, the FCDO refined their focus, shifting from understanding how to use the tool to how we could extract meaningful insights from it. In response, we adjusted our report to align with this new emphasis: reducing explanatory content and instead demonstrating how we applied the tool to generate insights.

Terms of reference: LSE Capstone Group

20th November 2024

1. **Policy problem**

   How should FCDO/UK work with the multilateral system and technology development ecosystem to ensure maximum influence in worldwide technology development priorities and standards setting? In particular, understanding the positioning of middle-powers to current US-China competition, to support the UK in creating a technological innovation and regulation strategy that aligns with its goals and values.

2. **Expected results:**

   An interactive visualisation tool to analyse patterns of engagement within multilateral fora, international trade and scientific production, for the UK to determine:

2.1 Countries' voting, trade and scientific research patterns and their relative positions in relations to other countries, to support UK influence. This would reflect strategic advantage through possible collaborative partnerships rather than individually ranked nations.

2.2 Trends over time and by technology field of non-aligned middle-powers towards China and the US, to understand developing geopolitical balances of power.

2.3 Country-level language surrounding technology standards, regulations, and international strategy, evaluating whether this has a predictive power over changing voting patterns and attitudes.

3. **Policy project items**

    3.1 Create a curated repository of cleaned databases from multiple sources.

    3.2 Process datasets using various machine learning models and statistical techniques.

    3.3 Develop an interactive data synthesis and visualisation web application to inform the decision-making process.

    3.4 Write brief reports for two application use cases with different objectives and time horizons.

        3.4.1 Intelligence analysis for short to mid-term decision-making. (e.g., "*Which mid-level powers has been aligned with China's interests and vision over the last five years?").*

        3.4.2 Research to support long term strategic planning (e.g., *"Which countries have experienced radical shifts in a technological field or geopolitical positioning and what lessons could be drawn for the UK?").*

4. **Final deliverables**

    4.1 Technical documentation including:

4.1.1. Manuals for each database, describing individual variables and data cleaning procedures.

4.1.2. Description of analytical model and implementation steps. (Data pre-processing, models used, outputs features).

4.1.3. User manual for the web application.

4.2 Example reports for two use cases.

4.3 Final presentation slides, including next steps and recommendations for further development.

4.4 Final capstone report (primarily for LSE).

Appendix: Relevant technical parameters

5. Proof-of-concept: all items (data repository, models, visualization app, and reports) should be functional and informative but are experimental.

6. Data structured by country and year. Technology fields defined by available data labels. Preliminary datasets include patents, academic papers, trade, industrial production, and standards voting data.

7. Models are primarily unsupervised. Dimensionality reduction and clustering methods will be used to uncover complex, non-obvious relationships among countries and technological fields.

8. Visualisation app expected to include:

8.1 Tables and bar charts representing summary statistics.

8.2 Maps showing geographic distributions of summary statistics and relationships.

8.3 Abstract network representations across countries

8.4 Interactive elements with filters or sliders for:

8.4.1 Time

8.4.2 Countries

8.4.3 Technological fields

8.4.4 Relevant measure (Trade volume, patents, etc)

8.5 Natural Language Processing of Governmental Standards for a chosen group of key countries that work as a case study in changing attitudes towards technology regulation and geopolitical alignment or non-alignment with values and rules-based order.

9. General policy use cases are expected to be :

9.1 Informing day to day decision making, and

9.2 Input material for research in long term strategic planning.

10.2 Technical Appendix reflecting further explanations of methodology.

10.2.1 UN Voting Data

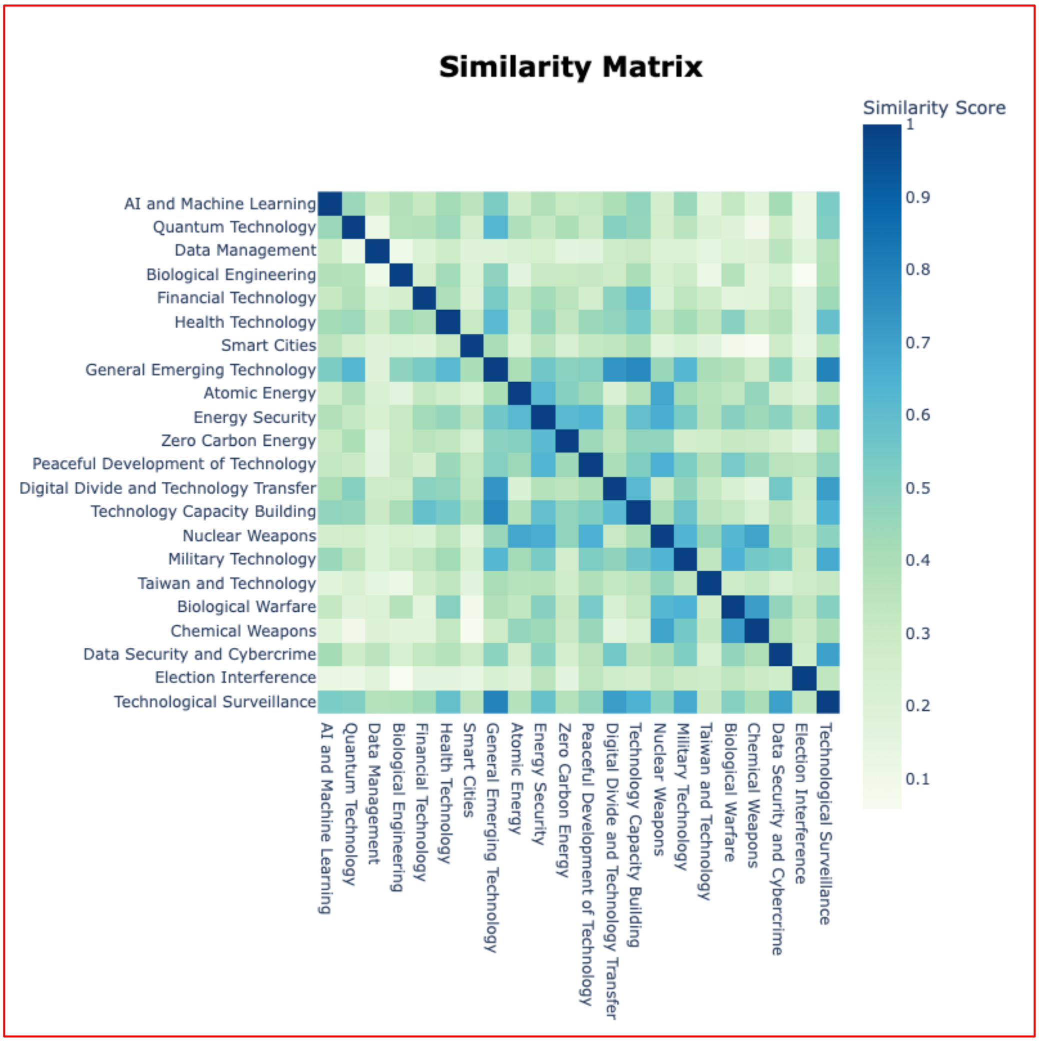
Most research focuses on US Congressional votes, primarily using the W-NOMINATE algorithm, which calculates 2D positions through logistic regression (Poole et al., 2011). However, this method requires a user-defined "extreme position." Principal Component Analysis (PCA) helps identify key votes shaping data structure, revealing drivers of international alignments and divergences. Expanding beyond two principal components can uncover more complex relationships. Applying clustering techniques with additional components may expose hidden alliances or regional blocs, providing deeper insights into voting patterns.

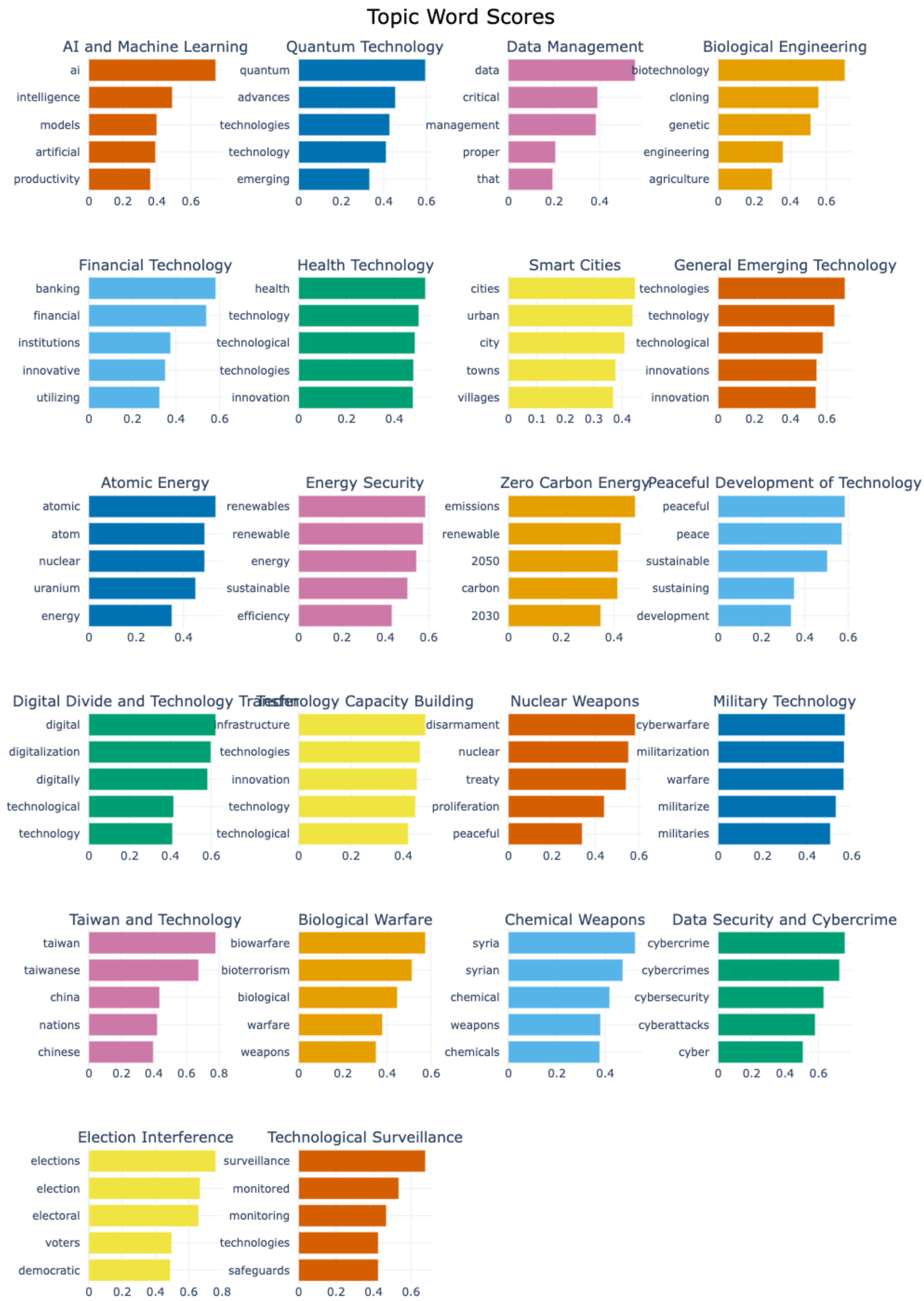
10.2.2 UN Discourse Data

A key challenge in selecting a base year, particularly for dual-use technologies, was data sparsity, with some countries making only one or two statements per year.

To address this, we compared each country's base-year statements to its overall discourse on the same topic, ensuring consistency. We used cosine similarity to calculate “similarity”. Which was calculated in the following (standard) way:

$$\cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum\limits_{i=1}^{n} A_i B_i}{\sqrt{\sum\limits_{i=1}^{n} A_i^2} \sqrt{\sum\limits_{i=1}^{n} B_i^2}}$$




Topic Word Scores
AI and Machine Learning
ai
intelligence
models
artificial
productivity
Quantum Technology
quantum
advances
technologies
technology
emerging
Data Management
data
critical
management
proper
that
Biological Engineering
biotechnology
cloning
genetic
engineering
agriculture
Financial Technology
banking
financial
institutions
innovative
utilizing
Health Technology
health
technology
technological
technologies
innovation
Smart Cities
cities
urban
city
towns
villages
General Emerging Technology
technologies
technology
technological
innovations
innovation
Atomic Energy
atomic
atom
nuclear
uranium
energy
Energy Security
renewables
renewable
energy
sustainable
efficiency
Zero Carbon Energy
emissions
renewable
2050
carbon
2030
Peaceful Development of Technology
peaceful
peace
sustainable
sustaining
development
Digital Divide and Technology Transfer
digital
digitalization
digitally
technological
technology
Technology Capacity Building
infrastructure
technologies
innovation
technology
technological
Nuclear Weapons
disarmament
nuclear
treaty
proliferation
peaceful
Military Technology
cyberwarfare
militarization
warfare
militarize
militaries
Taiwan and Technology
taiwan
taiwanese
china
nations
chinese
Biological Warfare
biowarfare
bioterrorism
biological
warfare
weapons
Chemical Weapons
syria
syrian
chemical
weapons
chemicals
Data Security and Cybercrime
cybercrime
cybercrimes
cybersecurity
cyberattacks
cyber
Election Interference
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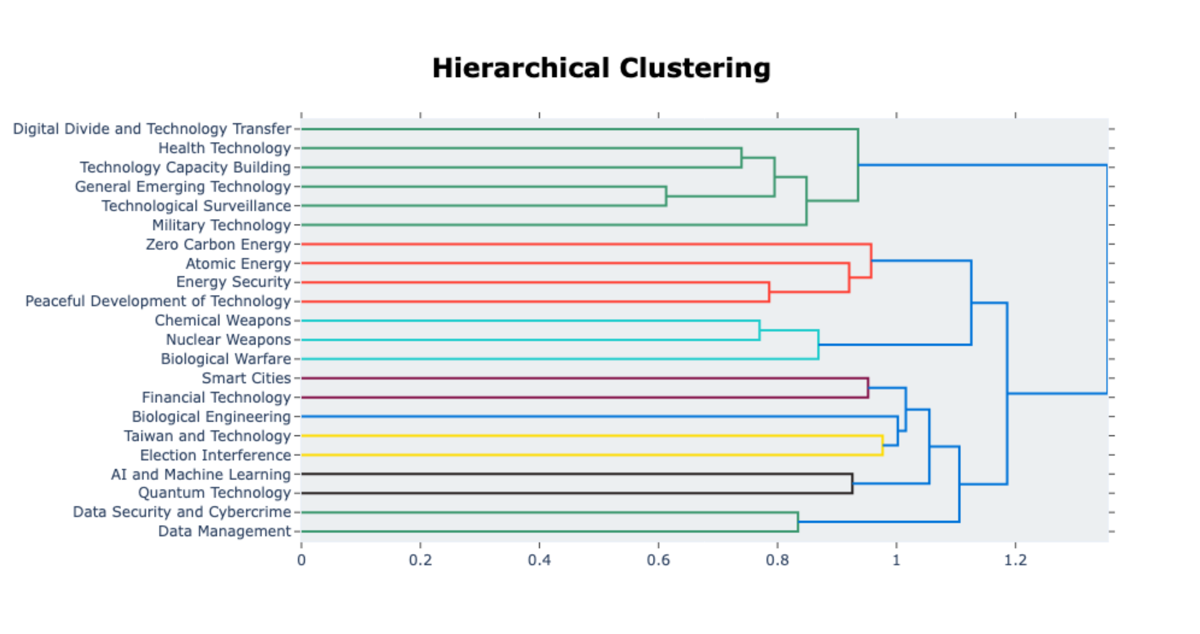
technologies
safeguards



10.2.3 Open Alex Research Data

Institutional names were standardised, and country affiliations validated against ISO 3166 codes for accurate cross-national analysis. Records lacking institutional affiliations were excluded, and duplicates removed using author-work pairings. Country-level affiliation data was aggregated from individual author metadata to ensure reliable country-to-country research linkages. This cleaning process minimised noise and redundancy while preserving meaningful relationships.

OpenAlex's metadata quality varied across institutions, requiring extensive post processing, particularly in normalising affiliations and handling missing data. Despite this, its API-based accessibility and scalability made it the most suitable tool for this analysis.

10.2.4 Trade Data

To ensure accuracy, we conducted data pre-processing by:

1. Standardising country names (e.g., changing "China, Hong Kong SAR" to "Hong Kong SAR") for consistency.
2. Filtering out missing, zero, or unreliable trade values, selecting the most comprehensive metric (CIF, FOB, or reported value).
3. Excluding non-country regions (e.g., "World," "Other Asia, nes") to focus on national-level UK partnerships.

This refinement eliminated inconsistencies and provided a robust foundation for trade analysis.