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# THE GLOBAL AI VIBRANCY TOOL

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### ABSTRACT

This paper presents the latest version of the Global AI Vibrancy Tool (GVT), an interactive suite of visualizations designed to facilitate the comparison of AI vibrancy across 36 countries, using 42 indicators organized into 8 pillars. The tool offers customizable features that allow users to conduct in-depth country-level comparisons and longitudinal analyses of AI-related metrics, all based on publicly available data. By providing a transparent assessment of national progress in AI, it serves the diverse needs of policymakers, industry leaders, researchers, and the general public. Using weights for indicators and pillars developed by AI Index's panel of experts and combined into an index, the Global AI Vibrancy Ranking for 2023 places the United States first by a significant margin, followed by China and the United Kingdom. The ranking also highlights the rise of smaller nations such as Singapore when evaluated on both absolute and per capita bases. The tool offers three sub-indices for evaluating Global AI Vibrancy along different dimensions: the Innovation Index, the Economic Competitiveness Index, and the Policy, Governance, and Public Engagement Index.

## 1 INTRODUCTION

This paper introduces the latest version of the Global AI Vibrancy Tool (GVT), a comprehensive collection of publicly available time series data and a suite of interactive visualizations that allow comparisons for up to 36 countries across 42 indicators related to Artificial Intelligence (AI). This update expands on previous versions, covering more countries and metrics. It now features one of the most extensive collections of AI-specific indicators<sup>1</sup> available, collectively assessing country-specific AI activity from 2017 to 2023. The revamped tool enhances the user experience with intuitive navigation, customizable visualizations, and download options. Additionally, the tool is structured to provide detailed and nuanced comparisons of countries through a user-customizable index of indicators in the Global and National AI Vibrancy Rankings section. The new GVT also offers an in-depth look at the evolution of specific indicators over time for selected countries in

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<sup>1</sup>In this framework, the terms "indicator" and "metric" are used interchangeably.

the AI Metrics over Time section. This new launch introduces additional AI vibrancy sub-indices, including the Innovation Index, the Economic Competitiveness Index, and the Policy, Governance, and Public Engagement Index.

In an era of rapid advancements in AI, various stakeholders require reliable metrics to gauge national progress in AI development. Policymakers need these metrics to build AI capacity by identifying effective policies, necessary research and development investments, and understanding the geopolitical impact of AI. Industry leaders seek insights for investment and strategy, aiming to understand which countries are emerging as AI hubs and where resources should be allocated. In addition, the general public may be interested in understanding how their country compares in AI activity and gaining insight into which nations are leading AI.

Existing AI national tracker tools often focus on narrow aspects such as investment levels or publication counts and may include broader, not necessarily AI-specific, indicators like the proportion of the population using the Internet or the number of STEM graduates. Although these metrics are valuable for understanding the general technological and educational infrastructure, they may not directly measure a country's AI-related progress and capabilities. The GVT addresses this gap by providing a holistic and interactive analysis platform that consolidates various AI progress indicators into a single, user-friendly interface, thereby promoting greater transparency, accountability, and knowledge sharing in the AI field. The design of the GVT involves a strategic selection of indicators organized into pillars and an overarching index, reducing AI metrics complexity. Users can also adjust indicator and pillar weights to reflect their own perspective.

The GVT will continually evolve, with future editions potentially incorporating new metrics and expanding country coverage. These changes will ensure that the tool remains a relevant and valuable resource for tracking global AI progress now and in the future.

The tool comes with a default set of weights for the indicators and pillars determined in consultation with a panel of experts. Using these weights, the United States has consistently held the top global position in AI vibrancy since 2018, maintaining a substantial lead over other nations and excelling across most dimensions, particularly in R&D, Infrastructure, and Economy. China and the United Kingdom follow, with China showing strength in R&D and Infrastructure, while the United Kingdom leads in Education as well as Policy and Governance. Interestingly, smaller nations like Singapore emerge as leaders in the ranking especially when adjusting the indicators on a per capita basis. These global rankings illustrate the diverse approaches countries are adopting to fostering AI growth, with both large and small nations making significant strides.

The remainder of this paper is organized as follows: In the [Related Work](#) section we review existing literature and tools related to AI metrics and comparisons. The [Conceptual Framework](#) section outlines the key concepts underlying the tool. The [Methodology](#) section details the processes involved in data collection, construction of the AI Vibrancy Index, and implementation within the tool. This is followed by a section providing a snapshot of the [Results of Country Rankings](#). Finally, the [Conclusion](#) provides a summary of the contributions and suggests directions for future improvements.

## 2 RELATED WORK

The development and refinement of composite indicators involve aggregating multiple individual metrics into a single comprehensive measure. This process draws on a diverse set of methodologies from statistics, economics, and technology assessment. Notable examples include the Human Development Index (HDI), introduced by the United Nations in 1990 [2], which integrates health, education, and income levels, and the Gender Inequality Index (GII), which measures gender disparities in health, empowerment, and labor market participation [36]. As the AI landscape

continues to evolve rapidly, the need for robust tools to measure and compare the AI capabilities of different countries has become increasingly evident.

The OECD et al. [27] have laid down significant foundational work in the study of composite index creation. Their guidance stresses the importance of a coherent theoretical structure, meticulous data selection and transformation, and robustness checks to ensure the reliability of these indicators. Similarly, Nardo et al. [26] discuss the potential pitfalls of selecting, normalizing, weighting, and aggregating indicators. They emphasize the importance of transparency and consistency in the methodology, which are crucial for enhancing the interpretability and comparability of composite indices.

More recent advances in the methodological framework for composite indicators are discussed in the comprehensive review by Greco et al. [21]. This review highlights the evolution in the adoption and methodological refinement of composite indicators due to their increased popularity in various research fields. Greco et al. [21] specifically focused on important aspects, such as weighting and aggregation, areas that attract substantial criticism and suggest avenues for future research. Their work explores the robustness analysis that follows the construction of these indicators, a less explored but significant phase, highlighting the need for robust methodologies that can withstand scrutiny and provide reliable and interpretable results.

In addition to foundational knowledge, the European Commission's COIN Tool User Guide [32] provides practical guidance for building composite indicators that are specifically designed for policy analysis. This guide serves as a useful resource for researchers and policymakers who aim to apply these metrics to evaluate and compare policy impacts across various regions or countries.

Drawing on these lessons, the Global AI Vibrancy Tool (GVT) applies best practices from the literature, which ensures a solid conceptual framework, transparent data handling, and thorough robustness checks. More details are provided in the [Methodology](#) Section.

There is also a well-established tradition of creating indices to track the technological progress of different nations. For example, the Technology Achievement Index (TAI), developed by Desai et al. [14], is a foundational framework for measuring cross-country technological advancement. The TAI evaluates countries according to several dimensions, including technology creation, diffusion, and human skill development. This index has set a foundation for more specialized tools designed to assess AI capabilities.

Incekara et al. [23] developed TAI-16 from the original TAI, categorizing countries by their tech adoption and innovation. This index stresses how the dynamic pace of technological development requires frequently updated criteria. TAI-16 also shows how countries adapt to technological changes and measures AI readiness.

Archibugi et al. [10] offer an extensive analysis of synthetic indicators for measuring the technological capabilities of nations. Their work reviews various composite indicators developed by entities such as the European Commission, the World Economic Forum, and the World Bank, discussing their methodologies, assumptions, and consistency in results. These authors illustrate the importance of these indicators for public policy, corporate strategy, and economic studies, while addressing the challenges and limitations inherent in their use, such as potential oversimplification and the difficulty in capturing the full complexity of technological change.

Shoham [34] was one of the first to propose systematically measuring and tracking the national progress and impact of Artificial Intelligence across various dimensions. Shoham [34] argues that there is a need for a multi-faceted country-level index of AI technologies, which includes factors such as investment, research output, and technological achievements. This proposed index set the ground for the AI Index [25] initiative.

The Oxford Insights' AI Readiness Index [22] evaluates a nation's readiness to use AI in public service, taking into consideration elements such as innovation potential, data availability, infrastructure, and human capital. Furthermore, the AI Preparedness Index [12] deals with a wider spectrum, including technological infrastructure, AI research communities, AI adoption by industry and government support. The Global AI Index by Tortoise Media [13] ranks countries based on research, development, talent, infrastructure, and operating environment.

The OECD AI Policy Observatory is another valuable resource [3] which offers a comprehensive catalog of national AI strategies and provides insight into the strategic priorities and policy measures adopted by various countries. The Observatory collects data on AI policies, research investments, and other relevant factors from various countries. This data facilitates the assessment of different regulatory environments on AI development. This platform is important for tracking the AI-readiness of various nations.

In conclusion, the related literature emphasizes the importance of composite indicators in providing structured and quantifiable assessments of complex phenomena such as AI development. However, it also cautions against oversimplification and stresses the need for continuous refinement of methodologies. These insights have informed the development of the GVT, which aims to deliver an authoritative and up-to-date measure of global AI vibrancy.

## 2.1 Comparison with Other AI Indices and Tools

Table 1 compares the GVT with other prominent AI indices and tools, summarizing the unique features, scope, indicators, and target audiences of each tool.

The new GVT serves the purpose of benchmarking national progress in AI and fills some of the gaps that currently exist in the AI national vibrancy tracking landscape. Unlike the Government AI Readiness Index [22], which primarily evaluates AI readiness in public services, or the AI Preparedness Index [12], which focuses on strategic areas for AI adoption, the GVT employs diverse indicators (for example in research and development, the economy or responsible AI) that are organized into distinct pillars housed under an overarching index. This structure facilitates broader possibilities of analysis and creates a tool that can be more widely and flexibly used by the broader AI community.

The tool's selectivity means that it presents reliable data on AI-related activities, mainly focusing on metrics specifically related to AI rather than broader technological metrics like "total amount of public spending in R&D" (as do other tools like the Global AI Index [13]). Moreover, the GVT excels in data presentation, offering interactive, customizable, and downloadable visualizations, which improves user engagement and comprehension. This feature contrasts with the more static presentations found in other indices. While the OECD AI Policy Observatory [3] is rich in data and interactive visualizations, it lacks an index or ranking system.

Moreover, a key differentiator of the GVT is its commitment to openness: all data is public and users are allowed to flexibly adjust pillar and indicator weights. This flexibility improves the tool's applicability across different use cases and allows users to bring their own perspectives to the question of which particular AI pillars (for instance research and development versus policy and governance) matter most in judging a nation's AI vibrancy.

The GVT is built to respond more effectively to the fast-evolving AI landscape compared to static indices. While some tools may have strong coverage in specific areas, they often lack the flexibility and AI-related focus offered by this tool.

Table 1. Comparison of the Global AI Vibrancy Tool with Other AI Indices and Tools

	Feature	Global AI Vibrancy Tool	Government AI Readiness Index	AI Preparedness Index	Global AI Index	OECD AI Policy Observatory
Overview	Scope	Cross-country comparisons of AI vibrancy	Government readiness for AI in public services	Readiness across strategic areas for AI adoption	Ranking of countries based on AI implementation, innovation, and investment	Comprehensive catalog of national AI strategies and policies
	Focus Areas	<ul style="list-style-type: none"> <li>Holistic view of AI development</li> <li>Detailed analysis of specific metrics over time</li> </ul>	<ul style="list-style-type: none"> <li>Government policy and implementation for public services</li> </ul>	<ul style="list-style-type: none"> <li>Comprehensive AI readiness</li> <li>Strategic areas</li> </ul>	<ul style="list-style-type: none"> <li>Practical implementation of AI, innovation, and investment</li> </ul>	<ul style="list-style-type: none"> <li>AI policy impacts</li> <li>Strategic priorities</li> <li>Policy measures</li> </ul>
	Target Audience	Policymakers, industry leaders, researchers, general public	Policymakers, government officials	Policymakers, industry leaders, researchers	Policymakers, industry leaders, researchers, general public	Policymakers, industry leaders, researchers, general public
Attributes	No. of Indicators*	42	39	29	122	118
	No. of Dimensions	8	10	4	3	11
	No. Countries	36	193	174	83	60
	Overarching Index	✓	✓	✓	✓	✗
	Absolute vs. Relative Rankings	✓	✗	✗	✓	✗
	Publicly Available Data	✓	✗	✗	✗	✓
	Data Presentation	<ul style="list-style-type: none"> <li>High number of AI-related indicators</li> <li>Adjustable weights</li> <li>Downloadable</li> </ul>	<ul style="list-style-type: none"> <li>Focused on public sector readiness</li> <li>Static rankings and scores</li> </ul>	<ul style="list-style-type: none"> <li>Broad strategic coverage</li> <li>Static scores</li> </ul>	<ul style="list-style-type: none"> <li>Broad AI and non-AI indicators</li> <li>Static rankings and scores</li> </ul>	<ul style="list-style-type: none"> <li>Broad policy catalog</li> <li>Some live data feeds</li> <li>Downloadable</li> </ul>
User Experience	<ul style="list-style-type: none"> <li>User-friendly navigation</li> <li>Detailed interface</li> <li>Dynamic and interactive features</li> </ul>	<ul style="list-style-type: none"> <li>Clear navigation</li> <li>Clean interface</li> <li>Simple features</li> </ul>	<ul style="list-style-type: none"> <li>Simple navigation</li> <li>Clean interface</li> <li>Simple features</li> </ul>	<ul style="list-style-type: none"> <li>Easy-to-use navigation</li> <li>User-friendly interface</li> <li>Informative features</li> </ul>	<ul style="list-style-type: none"> <li>Easy-to-use navigation</li> <li>Organized interface</li> <li>Dynamic and interactive features</li> </ul>	
Customization	✓	✗	✗	✓	✓	

\* Differences in indicator counts across sources may result from varying counting methods. Some sources count relative indicators (e.g., per capita or per GDP) as separate from their absolute counterparts, while others do not.

### 3 CONCEPTUAL FRAMEWORK

The primary objective of the Global AI Vibrancy Tool (GVT) is to facilitate cross-country comparisons of AI vibrancy in the field of AI. AI vibrancy can be defined as the level of activity, development, and impact of AI technologies within a country. This assessment provides a comprehensive understanding of the progress different countries are making in AI thereby highlighting strengths and areas for potential improvement.

The GVT captures country-level AI vibrancy through several key dimensions, each representing a critical aspect of AI development. The dimensions, henceforth referred to as pillars, include: Research and Development (R&D), Responsible AI, Economy, Education, Diversity, Policy and

Governance, Public Opinion, and Infrastructure. Each pillar is represented by a group of indicators that serve as proxies to capture the underlying concept.

**1. Research and Development (R&D)**

R&D is the foundation of AI advancement, driving the creation of new algorithms, models, and technologies that in turn foster AI innovation. According to Furman et al. [17], national innovative capacity, defined as the long-term ability to produce and commercialize innovative technology, is significantly influenced by R&D efforts. Measures of innovative output, such as patenting activities and journal publications, serve as key indicators of this capacity.

**2. Responsible AI**

Building AI systems that adhere to ethical standards is important for gaining public trust and preventing harm. Responsible AI covers several dimensions including data governance, explainability, fairness, privacy, security and safety, and transparency among others [25]. The volume of conference submissions related to these aspects affiliated with a country can serve as a quantitative measure of ongoing research and discussion on responsible AI practices.<sup>2</sup>

**3. Economy**

The economic landscape surrounding AI is a key factor influencing how AI is developed and deployed. In their work on the economic implications of AI, Agrawal et al. [6] highlight factors such as research investment, infrastructure, applications, and labor market conditions, all of which play an important role in guiding AI innovation. Trends in investment volumes and job markets can capture some of these aspects.

**4. Education**

Education is essential for preparing a skilled AI workforce. As Pedro et al. [28] state, preparing the future workforce for AI involves more than just adopting advanced technologies. It necessitates a shift in curricula to emphasize “AI competencies.” Tracking the growth of AI-related degree programs can provide insights into the effectiveness of these efforts.

**5. Diversity**

Diversity in AI development means accommodating and working with a wide range of perspectives which can potentially reduce biases in AI systems. It includes gender, ethnicity, and socioeconomic diversity within the AI community. Integrating diversity and inclusion principles throughout the AI lifecycle is important for creating fair and transparent AI technologies [37]. Diverse teams bring varied experiences and viewpoints, which can be important in identifying and mitigating biases. One way to capture diversity is by measuring AI skills across genders.<sup>3</sup>

**6. Policy and Governance**

Policy and governance frameworks set the base for AI ecosystems, influencing everything from innovation and ethical standards to investments and education. National AI strategies, which are policy plans created by governments to guide the development and deployment

<sup>2</sup>As this is a relatively new field, currently the AI Index has relatively few Responsible AI indicators. The AI Index team is working to include more Responsible AI indicators for future iterations of the tool. The AI Index recognizes that many factors contribute to a country’s Responsible AI vibrancy—such as the extent to which businesses operationalize Responsible AI—beyond those currently captured in the tool. While the metrics featured, such as conference submissions, are not intended to fully represent a country’s Responsible AI vibrancy, the Index team included a Responsible AI pillar for two key reasons: first, to underscore the importance of Responsible AI within the broader AI ecosystem, and second, to encourage the AI research community to develop and contribute additional Responsible AI metrics in the future. To address the data limitations of the Responsible AI pillar, it has been assigned a lower weight, as detailed in the methodological section.

<sup>3</sup>While there are currently limited diversity metrics, the AI Index is working to include more in future iterations of the tool.

of AI within their country, often integrate efforts from both the public and private sectors, emphasizing ethics over rigid rule-based systems [31]. Some nations opt for self-regulation and market-based approaches, while others stress public responsibility and ethical considerations [15]. Tracking the number of AI-related legislation, strategies and legislative mentions can provide valuable insight into how different countries approach AI governance and regulation.

#### 7. **Public Opinion**

Public perception of AI influences its adoption and development. Understanding public opinion helps address concerns and improve AI literacy. The framing of AI in media affects public sentiment and, consequently, regulatory decisions and technology acceptance. Comprehending public opinion, including analyzing media conversations in terms of volume and sentiment, can reveal important insights on the level of public support for AI development within a nation. [33].

#### 8. **Infrastructure**

Robust infrastructure is a critical prerequisite for advancing AI research and deployment, with significant variations observed across countries. Infrastructure includes computational resources, data availability, and network connectivity. Amodei and Hernandez [9] demonstrate that the computational power used in the largest AI training runs has been increasing exponentially. Countries with superior data centers and cloud infrastructure gain a significant advantage in conducting large-scale AI experiments. Moreover, the quality and quantity of available data sets vary widely between nations, directly impacting their ability to develop accurate and generalizable AI models. Network connectivity further amplifies these disparities. Nations that possess faster and more reliable internet connections can more quickly process real-time data [22]. The number of supercomputers, compute capacity, and high-speed internet can capture some infrastructure-related concepts essential for AI advancements.

These dimensions can be combined to provide a comprehensive picture of a nation's AI vibrancy. High levels of R&D activity lead to research innovations, which can be translated into commercial success and widespread adoption in supportive economic environments. Responsible AI practices ensure that AI advancements are ethical and sustainable, which can lead to greater public acceptance. Higher rates of AI trust can in turn encourage regulatory and commercial environments that are more friendly towards AI.

Robust education ecosystems can provide a continuous supply of skilled professionals that can drive AI forward, while diversity within the AI community improves creativity and reduces biases. AI solutions that are less biased can be more effective and equitable. Robust policy and governance frameworks provide the necessary support and direction for AI development. On the one hand, these policies can safeguard the deployment of AI further engendering public trust. On the other hand they can create incentives for better commercial AI adoption and a more robust AI research and development ecosystem.

Public opinion shapes the adoption and integration of AI technologies into society, while strong infrastructure supports the efficient development and deployment of these technologies. Together, these dimensions have a synergistic effect: improvements in one dimension can drive progress in another, ultimately leading to an overall increase in a nation's AI vibrancy.

### 3.1 **Sub-Indices for Granular Comparison**

To facilitate the comparative analysis of countries at a granular level, we introduce sub-indices within the GVT. These sub-indices provide a more nuanced perspective on particular aspects of AI

development and are intended to enable a more precise evaluation of specific dimensions. While the overarching index offers a comprehensive overview of a country's aggregate AI development, the sub-indices facilitate a more in-depth examination of particular domains.

### 1. **Innovation Index**

This index measures a country's innovation potential by assessing its research and development (R&D) activities, academic output, technological advancements, intellectual property generation, and supporting technological infrastructure. It highlights a country's capacity to produce new knowledge, innovate, and contribute to global AI advancements. The index offers insights into which countries are leading in AI development and have the necessary infrastructure to support future progress.

### 2. **Economic Competitiveness Index**

This index measures the economic strength and market dynamism of a country in the AI sector by analyzing investment flows, talent concentration, and job creation. It captures how countries are leading in integrating AI into their economies, enhancing their competitive edge, and creating robust ecosystems for AI-driven growth.

### 3. **Policy, Governance, and Public Engagement Index**

This index evaluates the level of activity related to AI-related policies, legislative actions, and the broader public discourse surrounding AI. It identifies which countries are leaders in creating an enabling policy environment for AI and how public opinion is shaping the adoption and acceptance of AI technologies. Countries with a national strategy on AI and positive public sentiment are better positioned to leverage AI for national development, while those lagging may face challenges in governance, public trust, and AI deployment.

## 4 **METHODOLOGY**

### 4.1 **Data Collection**

Our data collection strategy works to achieve comprehensive and reliable data. We gather information from sources like CSET, QUID, GitHub, and LinkedIn, as well as our prepared datasets.

Maintaining data integrity is a top priority. Our approach includes implementing rigorous validation processes to cross-check data from multiple sources, in order to maintain consistency and accuracy. We periodically update our database to incorporate the most recent and comprehensive data, in order to guarantee that our tool reflects current trends and developments.

The selection of data to be included in our tool is based on the following criteria:

- **Relevance:** The data must be directly relevant to the dimensions of AI vibrancy we aim to measure, such as R&D, Economy, Education, etc.
- **Significance:** Indicators should have a significant impact on AI vibrancy, providing meaningful insights into a country's AI capabilities and development.
- **Accuracy:** Data must be accurate and reliable, sourced from reputable providers or validated through rigorous self-collection methods.
- **Coverage:** Indicators should have good geographical and temporal coverage, allowing for comprehensive comparisons across different countries and over time.
- **Traceability:** Data should be easy to track and updated annually, ensuring that our tool can provide up-to-date and consistent evaluations.

Despite our attentive data collection strategy, several challenges arise. Some indicators have limited coverage across countries or over time. For example, we considered including the percentage of businesses using AI technology as an indicator. However, available surveys containing this data



lack sufficient country coverage. Similarly, we aimed to include public opinion data on AI from surveys. Unfortunately, these surveys are not always repeated annually, and the questions change over time, leading to inconsistencies in the data. To maintain the global applicability of the tool, we prioritize indicators with the broadest possible country and time coverage.

Data quality can vary by country and over time. For instance, we attempted to gather data on the number of graduates in various countries by contacting official statistical offices. However, for some countries, the data was either incomplete, not available at a more detailed level, or no response was received. Additionally, changes in data collection methodologies over time can affect the consistency of some indicators. We carefully document and adjust for any methodological changes to maintain the integrity of our longitudinal analyses.

The 42 included indicators across 8 different pillars are described in Table 2.<sup>4</sup>

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<sup>4</sup>See the list of countries included in the Appendix, Section A. Data coverage by country and by indicator for each year is provided in the Appendix, Section F. Definitions of each indicator are provided in the Appendix, Section B.

Table 2. List of Indicators by Pillar.

Pillar	Indicator	Data Source
Research and Development	AI Journal Publications	Center for Security and Emerging Technology
Research and Development	AI Journal Citations	Center for Security and Emerging Technology
Research and Development	AI Conference Publications	Center for Security and Emerging Technology
Research and Development	AI Conference Citations	Center for Security and Emerging Technology
Research and Development	AI Patent Grants	Center for Security and Emerging Technology
Research and Development	Notable Machine Learning Models	Epoch AI [7]
Research and Development	Academia-Industry Model Production Concentration <sup>5</sup>	Epoch AI [7]; AI Index
Research and Development	Foundation Models	Ecosystem Graphs [11]; AI Index
Research and Development	Foundation Models Datasets	Ecosystem Graphs [11]; AI Index
Research and Development	Foundation Models Applications	Ecosystem Graphs [11]; AI Index
Research and Development	Open Access Foundation Models	Ecosystem Graphs [11]; AI Index
Research and Development	AI GitHub Projects	GitHub
Research and Development	AI GitHub Projects Stars	GitHub
Responsible AI	FAcCT Conference Submissions on RAI Topics	AI Index
Responsible AI	NeurIPS Conference Submissions on RAI Topics	AI Index
Responsible AI	ICML Conference Submissions on RAI Topics	AI Index
Responsible AI	ICLR Conference Submissions on RAI Topics	AI Index
Responsible AI	AIES Conference Submissions on RAI Topics	AI Index
Responsible AI	AAAI Conference Submissions on RAI Topics	AI Index
Economy	Total AI Private Investment	QUID
Economy	Total AI Merger/Acquisition Investment	QUID
Economy	Total AI Minority Stake Investment	QUID
Economy	Total AI Public Offering Investment	QUID
Economy	Newly Funded AI Companies	QUID
Economy	AI Hiring Rate YoY Ratio	LinkedIn
Economy	Relative AI Skill Penetration	LinkedIn
Economy	AI Talent Concentration	LinkedIn
Economy	AI Job Postings (% of Total)	Lightcast
Economy	Net Migration Flow of AI Skills	LinkedIn
Education	AI Study Programs in English	Studyportals
Education	AI Study Programs in English Penetration	Studyportals
Diversity	AI Talent Concentration Gender Equality Index <sup>6</sup>	LinkedIn; AI Index
Policy and Governance	National AI Strategy Presence	AI Index
Policy and Governance	AI Legislation Passed	AI Index
Policy and Governance	AI Mentions in Legislative Proceedings	AI Index
Public Opinion	Social Media Share of Voice on AI	QUID
Public Opinion	AI Social Media Posts	QUID
Public Opinion	AI-Related Social Media Conversations Net Sentiment	QUID
Infrastructure	Parts Semiconductor Devices Exports	BACI [18]
Infrastructure	Supercomputers	Top500 [5]
Infrastructure	Compute Capacity (Rmax)	Top500 [5]
Infrastructure	Internet Speed	Ookla [4]

## 4.2 AI Vibrancy Index Construction

The index construction process involves several key steps:<sup>7</sup> (1) normalizing the data, (2) calculating the pillar scores, and (3) aggregating these scores to form the overall AI vibrancy index. Below is a detailed explanation of each step.

*Normalization.* To ensure comparability across different scales and units of measurement, we use min-max normalization for all indicators. This method scales the values within the [0, 100] range. The normalized value for the  $i^{th}$  indicator is calculated using the formula:

$$x_{ijk} = \frac{x_{ijk}^{\text{raw}} - x_{ij,\min}}{x_{ij,\max} - x_{ij,\min}} \cdot 100 \quad (1)$$

where:

- $x_{ijk}^{\text{raw}}$  is the original value of the  $i^{th}$  indicator for pillar  $j$  and country  $k$ .
- $x_{ij,\min}$  and  $x_{ij,\max}$  are the minimum and maximum values of indicator  $i$  in pillar  $j$  across all countries.

*Pillar Score Calculation.* Let  $p_{jk}$  denote the score of pillar  $j$  for country  $k$ . This score is computed as the weighted average of various indicators associated with the pillar and the country. Specifically, the score is given by the formula:

$$p_{jk} = \frac{\sum_{i=1}^{N_j} (w_{ij} \cdot x_{ijk})}{\sum_{i=1}^{N_j} w_{ij}} \quad (2)$$

where:

- $N_j$  is the number of indicators for pillar  $j$ .
- $w_{ij}$  is the weight assigned to the  $i^{th}$  indicator for pillar  $j$ , ranging from 0 to 10, with higher values indicating greater importance of the indicator. We assume that these weights are non-negative and their sum is non-zero.
- $x_{ijk}$  is the normalized score of the  $i^{th}$  indicator for pillar  $j$  and country  $k$ .

*AI Vibrancy Index Calculation.* The AI vibrancy index for a country  $k$ , denoted as  $V_k$ , is calculated as the weighted average of the scores of all the pillars as follows:

$$V_k = \frac{\sum_{j=1}^M (W_j \cdot p_{jk})}{\sum_{j=1}^M W_j} \quad (3)$$

where:

- $M$  is the total number of pillars.
- $W_j$  is the weight assigned to pillar  $j$ , ranging from 0 to 10, with higher values indicating greater importance of the pillar. We assume that these weights are non-negative and their sum is non-zero.
- $p_{jk}$  is the score of pillar  $j$  for country  $k$ , as calculated above.

This formulation allows for a comprehensive assessment of a country's vibrancy, taking into account a range of factors across different dimensions.

<sup>5</sup>See calculation details in the Appendix, Section E.1.

<sup>6</sup>See calculation details in the Appendix, Section E.2.

<sup>7</sup>For more details on standard composite indicator construction practices, see OECD et al. [27].

*Ranking Countries.* After calculating the AI vibrancy score for each country, we rank the countries for each year by their resulting weighted index scores. This ranking offers an annual comparison of AI vibrancy across different countries, whether in absolute or per capita terms.

*Time Dimension.* The AI Vibrancy index computation detailed above is calculated for data aggregated over a calendar year. The tool then permits tracking the evolution of the absolute scores as well as the relative rankings across time.<sup>8</sup>

This process is applied to each sub-index: Innovation, Economic Competitiveness, and Policy, Governance, and Public Engagement. We aggregate only the relevant indicators listed in the corresponding tables provided in the Appendix, Section C, ensuring each sub-index provides a focused analysis of a specific AI vibrancy dimension.

### 4.3 Implementation

*4.3.1 Handling Missing Values.* Missing values have been imputed with the median of each indicator across all countries for each year. If an indicator is missing for all countries in a specific year, it is excluded from the calculation and its weight is proportionally redistributed among the other available indicators. As a result, the total weight assigned to the remaining indicators sums to the original total, thus maintaining the overall balance of importance among indicators.

This approach ensures that the data remains as complete as possible, minimizing the loss of information due to missing values. By imputing with the median, we preserve the integrity of the data while reducing potential biases that might arise from more complex imputation methods. Excluding indicators entirely when data is unavailable for all countries in a year prevents the introduction of inaccuracies and ensures that the analysis reflects the best available data.

However, this methodology has its trade-offs, including the potential exclusion of key indicators that could impact the overall assessment. Additionally, variability in data availability across years may complicate temporal comparisons. Future enhancements could include a feature for users to run sensitivity analyses, allowing them to assess the impact of different imputation strategies on the ranking. Promoting comprehensive and consistent data reporting across more countries will further enhance the tool's accuracy and reliability over time.

*4.3.2 Weights Selection.* The inclusion of all indicators in the GVT is based on the criteria defined in Section 4.1. However, in assessing a country's level of AI vibrancy, some pillars and indicators are admittedly more relevant than others. We set the default weights of the GVT using an expert budget allocation approach, where four senior AI Index team members individually allocated weights according to their relative perceived relevance, while also considering specific features of some indicators, such as coverage.<sup>9</sup> For instance certain pillars such as Education and Responsible AI were deemed to be relatively important by the "expert group" as components of a nation's AI vibrancy. However, because the data for these pillars was limited in its international coverage (certain nations

<sup>8</sup>Note that the interpretation of the index over time may be influenced by the availability of data for specific indicators. In some cases, certain indicators may not be available for all years or countries, potentially affecting the comparability of the index across time periods. The index values for these periods should be interpreted with caution, as they may reflect variations in data coverage. For detailed information on data availability, refer to the accompanying data coverage tables in the methodology section of the tool webpage.

<sup>9</sup>Alternative approaches exist, such as Principal Component Analysis (PCA), which statistically transforms correlated variables into a set of uncorrelated variables and derives weights based on the variance each component explains. However, this method can reduce the interpretability of the resulting metrics. A hybrid method involves using regression coefficients, where weights are determined through regression analysis guided by a theoretical model. Another common approach is to assign equal weights, which may oversimplify and introduce potential bias. See OECD et al. [27] for a comparison of different weighting methods.

were better represented than others), these pillars were assigned a lower weight.<sup>1011</sup> The median weight was then selected for each pillar and indicator. We recognize that this choice impacts the AI Vibrancy Index. The tool’s interface allows users to adjust the weights using interactive sliders, with values ranging from 0 to 10, where 0 represents lowest importance and 10 represents highest importance. This feature improves the tool’s adaptability, enabling users to customize the assessment according to their own perspective on the relative importance of pillars and indicators.

## 5 TOOL INTERFACE OVERVIEW

In this section we present an overview of the tool interface, highlighting its components and functionalities. The interface is designed to be user-friendly and interactive. Users can explore and customize views according to their preferences.

### 5.1 Main Components

*5.1.1 Global and National AI Vibrancy Rankings.* This section allows users to toggle between global and national rankings, providing a comparative view of AI vibrancy across different countries. The “View Type” component of the tool interface allows users to choose how to visualize the data that best suits their needs. The available view types are:

- **Bar:** The bar chart (Figure 1) view presents the AI vibrancy ranking of different countries for a selected year. This view is particularly useful in comparing where each country stands in the ranking and which countries are leading or lagging in specific pillars.
- **Table:** The table view (Figure 2) allows for comparisons of AI vibrancy across up to four selected countries simultaneously for a selected year. It includes information on each indicator within corresponding pillars, such as raw data values, normalized indicator scores, each country’s overall rank, and the contribution of each indicator relative to other countries.
- **Slope:** The slope view (Figure 3) displays changes in the global AI vibrancy ranking over time, showing the trajectory of each country.

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<sup>10</sup>For more details on how weights were attributed, refer to the default weights selected for pillars and indicators in Appendix, Section D.

<sup>11</sup>The sub-indices use the same default weights as those applied in calculating the AI vibrancy index.

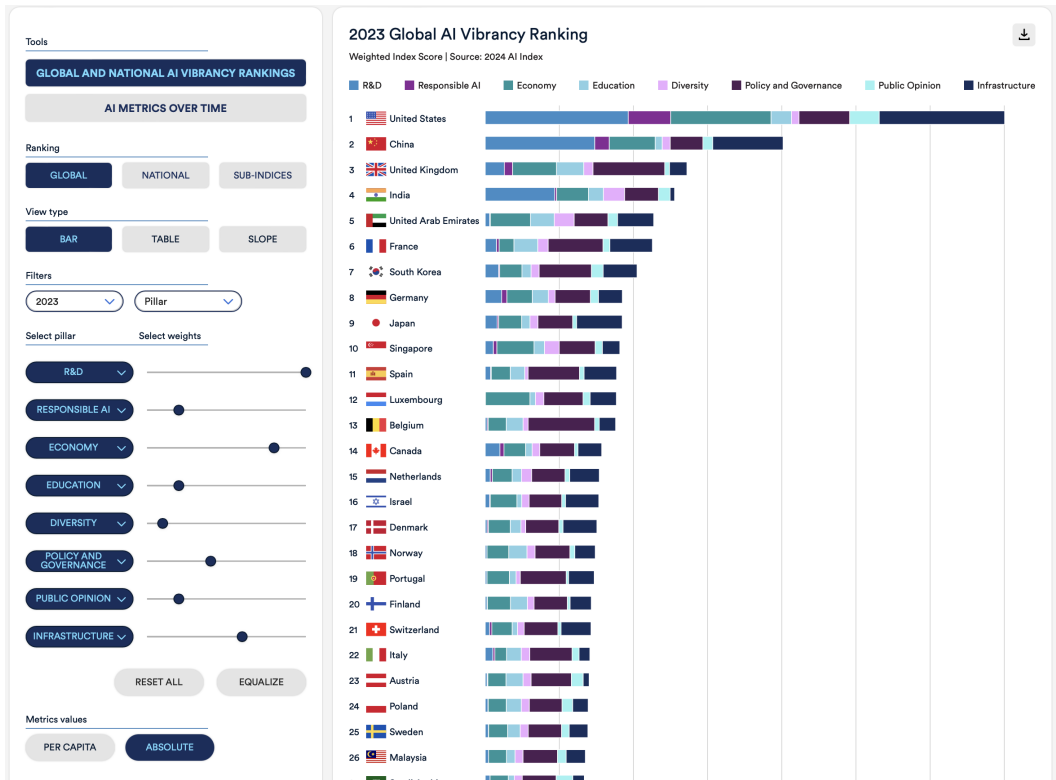


Fig. 1. Global AI Vibrancy Ranking: Bar View.

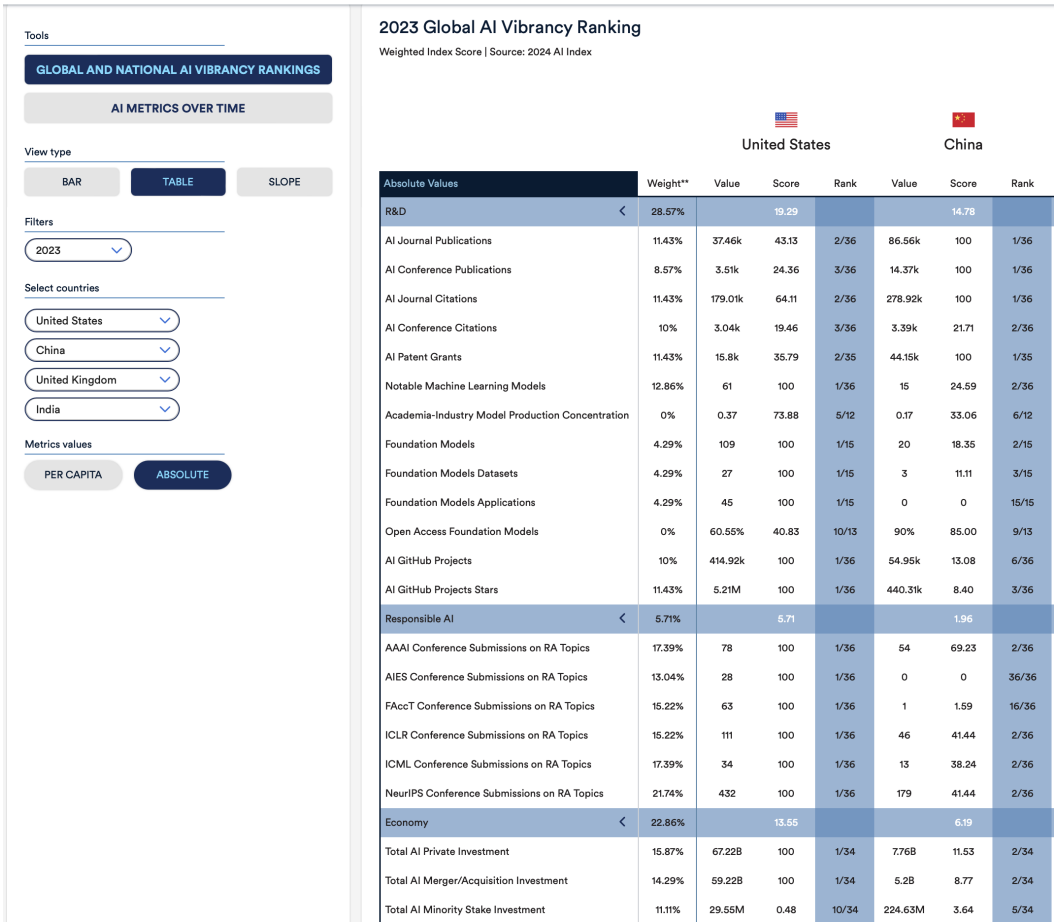


Fig. 2. Global AI Vibrancy Ranking: Table View.



Fig. 3. Global AI Vibrancy Ranking: Slope View.



The tool interface includes various filters and customization options (Figure 4) to enhance user experience and data analysis. Users can select the year for which they want to view the data, and toggle between per capita or absolute values. Additionally, controls allow users to color each bar according to pillar, region, and income group as per the World Bank country classification [1].

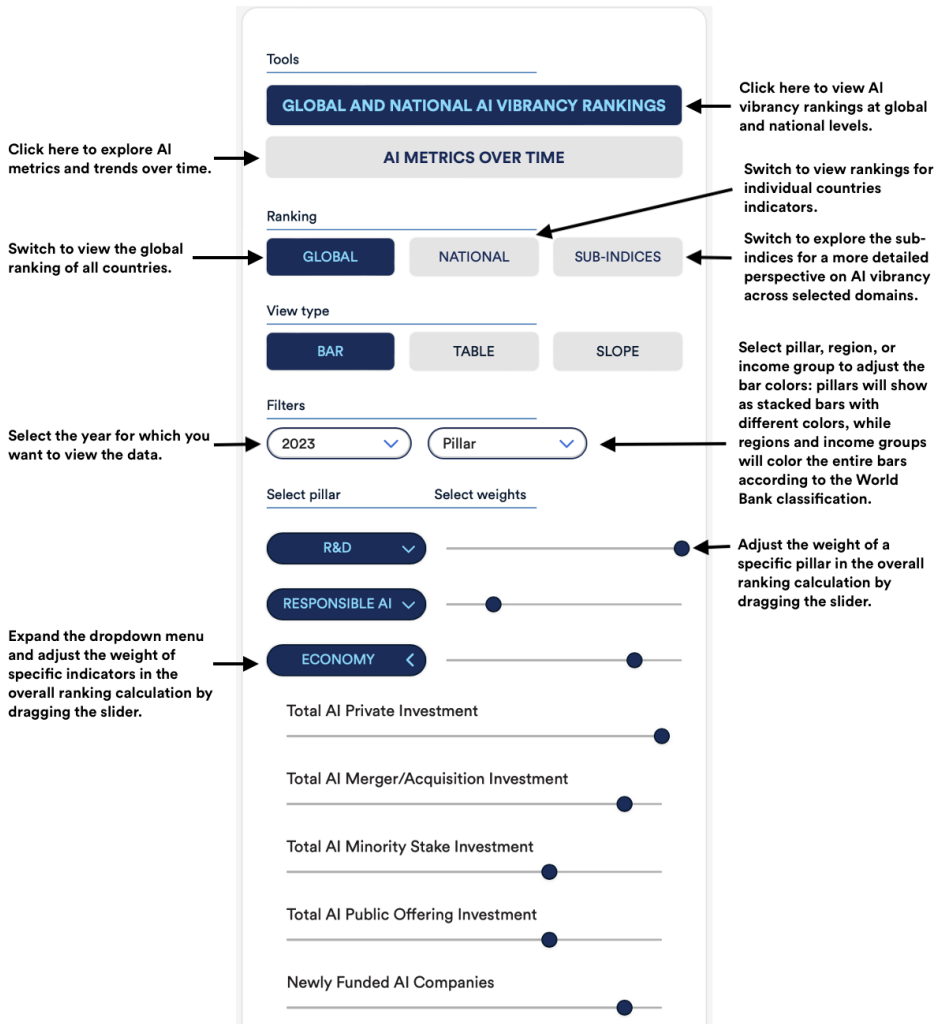


Fig. 4. Interactive Filters and Customization Interface.

**5.1.2 AI Metrics Over Time.** This section provides users with a dynamic way to analyze changes in metrics included in the AI vibrancy index over time. Users can choose a country from a drop-down menu and select a metric from a specific pillar, allowing for a more focused analysis of a particular area of interest.

The tool offers two chart types for visualization:

- **Bar:** This option shows AI metrics in a bar chart format (Figure 5), making it easy to compare values over different years.

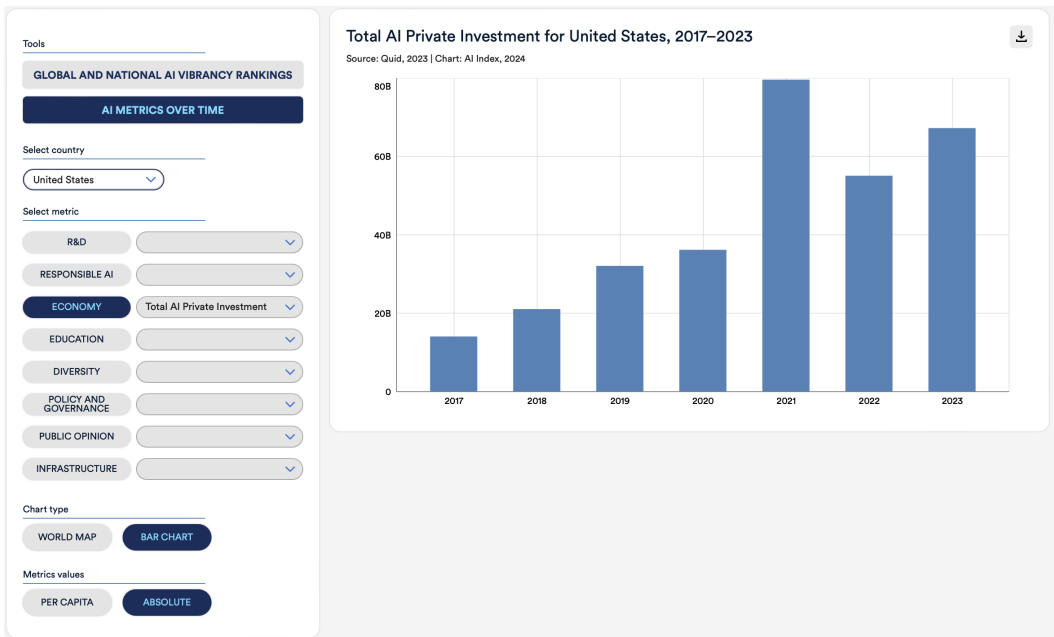


Fig. 5. AI Metrics Over Time: Bar View.

- **World Map:** This option provides a geographical visualization of AI Metrics, showing the distribution and intensity of AI-related activities across countries (fig. 6).

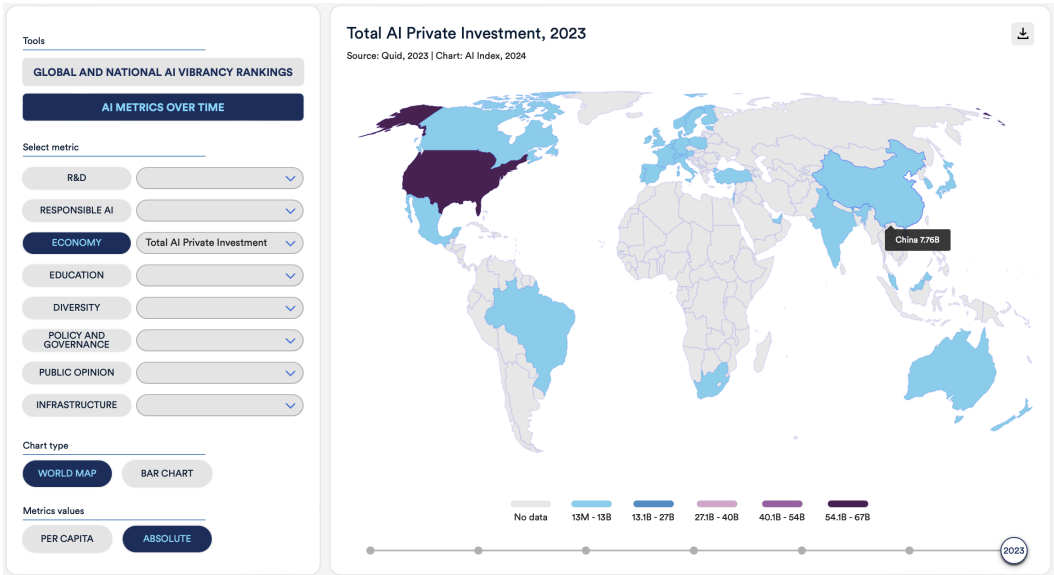


Fig. 6. AI Metrics Over Time: World Map View.

## 6 RESULTS OF COUNTRY RANKINGS

### Global AI vibrancy ranking: top ten countries, 2023

Source: AI Index, 2024

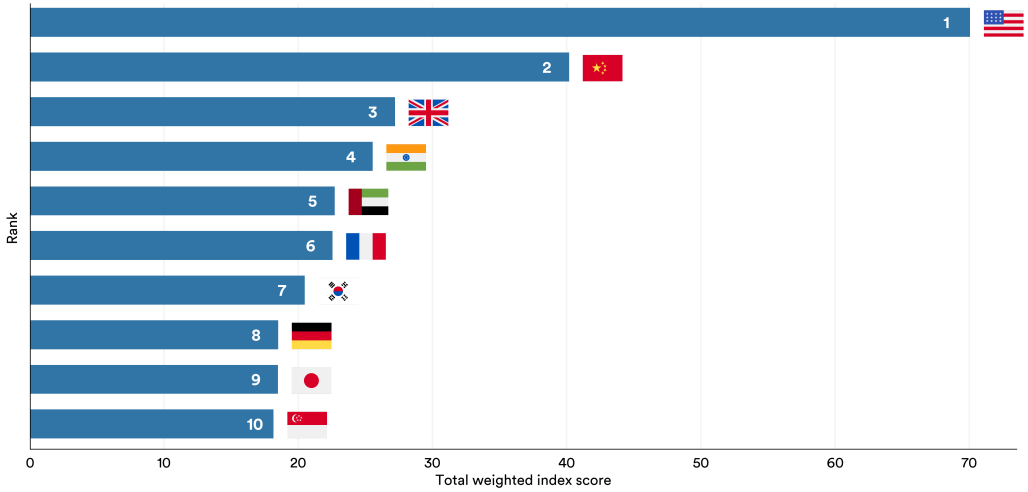


Fig. 7

In this section, we present the results of the 2023 Global AI Vibrancy Ranking. Figure 8 provides a snapshot of the current state of AI vibrancy in the top ten countries, evaluated across the eight key dimensions introduced in section 3.<sup>12</sup> Each country’s overall score is a weighted sum of these dimensions, computed using the absolute values of the metrics, reflecting their performance in AI-related activities and infrastructure.

<sup>12</sup>For a complete view of rankings using absolute values for all countries included in the analysis, refer to the Appendix G.1, Figure 20.

**Global AI vibrancy ranking (absolute): top ten countries, 2023**

Source: AI Index, 2024

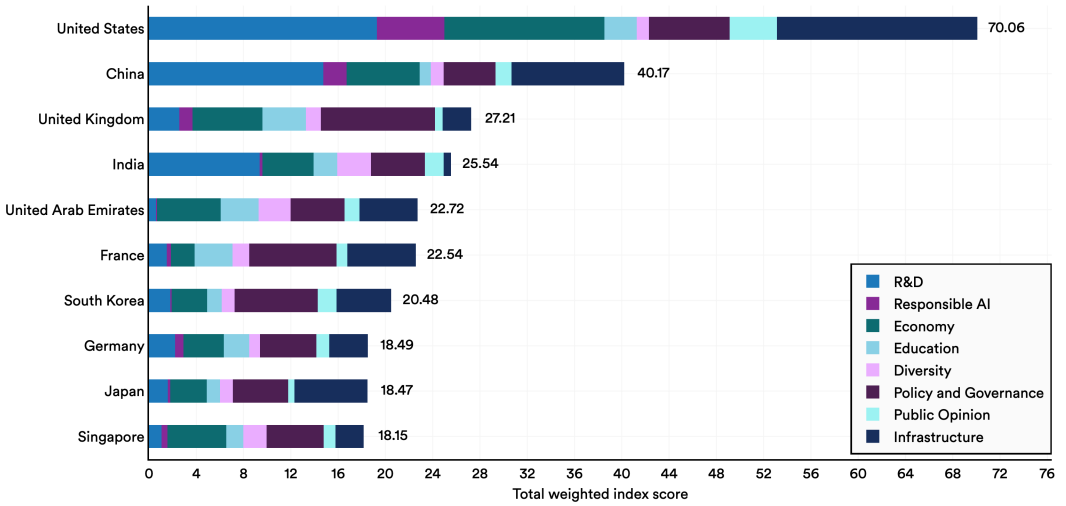


Fig. 8

The United States leads the 2023 ranking by a significant margin, with a total weighted index score of 70.06, reflecting its dominance across nearly all dimensions. The country’s strengths lie in its robust R&D ecosystem, advanced infrastructure, and active policy and governance frameworks. The high scores in Economy and Responsible AI further solidify its position as a global leader in AI. The United States is the global leader in several key indicators of AI vibrancy. For instance, in 2023, it produced more notable machine learning models, had more total AI private investment, and submitted more responsible AI papers to leading conferences than any other country included in the analysis. Several notable AI companies, such as OpenAI, Meta, and Google, are headquartered in the United States. Additionally, many leading computer science universities, including Stanford, MIT, and Carnegie Mellon, are also based in the U.S.

China holds the second position with a score of 40.17. It demonstrates substantial strengths in R&D, Economy, and Infrastructure. China’s focus on developing cutting-edge AI technologies and increasing its R&D investments has positioned it as a major AI powerhouse. In 2023, China led the world in AI journal and conference publications. China’s strength in research and development is unsurprising, given that many Chinese universities, such as the Chinese Academy of Sciences, Tsinghua University, and the University of Chinese Academy of Sciences, have traditionally produced a high number of AI-related publications [24]. Additionally, China is home to corporations like Baidu, which have developed significant large language models like Ernie 4.0. In terms of notable machine learning models and total private AI investment, China ranked second only to the United States. However, as detailed in the following section, despite China’s strong position, there remains a significant gap between the two nations. The United States not only leads but also surpasses China (in absolute terms) by a considerable margin in many key metrics.

The United Kingdom ranks third with a score of 27.21, demonstrating particular strength in the Research and Development, Education, and Policy and Governance pillars. Home to top computer science universities like Oxford, Cambridge, and Imperial, the UK also hosts DeepMind, a Google subsidiary which in recent years has been a leader in AI research. Additionally, the UK leads in the number of AI study programs and, in 2023, had more mentions of AI in parliamentary proceedings

than any other country. The UK has been quite politically engaged with AI, hosting the world's first international AI Safety Summit in 2023 [20] and was among the first countries to launch an institute dedicated to AI safety [19].

India's fourth-place position with 25.54 points is driven by strong performance in R&D and recent improvements in the Economy pillar. India boasts a strong AI research community, ranking first in AI conference citations and third in total AI journal publications. Additionally, India ranked second globally in the number of AI GitHub projects. Public discourse around AI is also robust in India, as the country ranks second in both AI-related social media voice share and total AI social media posts.

The United Arab Emirates ranks fifth with a score of 22.72. The UAE ranked highly for the Economy pillar, as in 2023 it was among the top three nations globally for AI minority stake and public offering investments. It also scores highly on other economic indicators such as net migration of AI talent and has a fairly diverse AI workforce in terms of gender. In the last year, the UAE has also produced a significant number of notable machine learning as well as foundation models. On the infrastructure side, it reports very fast internet speed. The UAE's strong position in the vibrancy ranking highlights the Middle East's growing influence in the global AI landscape and is reflective of the UAE government's deliberate efforts to position the country as a significant global AI player [29].

Other European countries, including France and Germany, feature prominently in the top ten, indicating Europe's collective commitment to AI development. Europe was among the first regions to pass significant AI legislation, with the EU enacting the AI Act in 2024. France ranks 6<sup>th</sup> with 22.54 points, showing strength in Policy and Governance, Education, and Infrastructure. In 2023, France ranked second (tied with South Korea and the United Kingdom) in passing AI-related legislation. French policymakers have increasingly engaged in AI discussions, and the country has committed to hosting the next AI Safety Summit in 2025 [30]. Additionally, Mistral, one of Europe's most prominent LLM developers, is headquartered in France and has contributed several notable machine learning models. Germany also fairs well-coming in 8<sup>th</sup>: Germany is a significant contributor to AI research, ranking fourth in producing notable machine learning models. It has also published extensively on responsible AI and ranks fourth in total AI private investment.

Smaller countries like Singapore have made it into the top ten, suggesting that population and geographic scale are not the sole determinants of AI vibrancy. The presence of South Korea (7<sup>th</sup> with 20.48 points) alongside Japan (9<sup>th</sup> with 18.47 points) and Singapore (10<sup>th</sup> with 18.15 points) in the top ten highlights the growing importance of AI in Asian economies. South Korea hosted the 2nd AI safety summit in 2024, and is home to many leading AI universities and companies, such as the Korea Advanced Institute of Science and Technology (KAIST) and NAVER.

The varied geographic representation in this ranking highlights the global nature of AI, as well as the diverse strategies different countries are adopting to stimulate growth and deployment in this field. Many national leaders have become aware of the geopolitical significance of AI and are working to improve levels of AI development within their own countries.

Figure 9 illustrates the evolving competitive dynamics in global AI vibrancy between 2017 and 2023. It reveals three distinct tiers of competition: the top tier, consistently dominated by the United States and China; a more stable middle tier including the United Kingdom and India; and a more volatile lower tier where countries like France, Germany, Japan, Singapore, and South Korea frequently exchange positions.<sup>13</sup>

<sup>13</sup>Note that the interpretation of the rankings over time may be influenced by the availability of data for specific indicators. In some cases, certain indicators may not be available for all years or countries, potentially affecting the comparability of the index across time periods. For detailed information on data coverage, see the Appendix F.

### Global AI vibrancy ranking over time, 2017—23

Source: AI Index, 2024

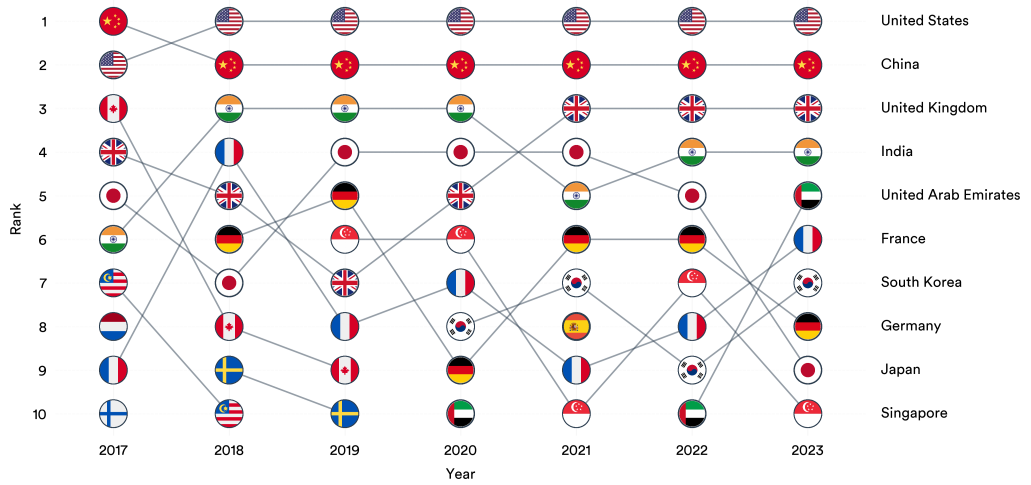


Fig. 9

### Global AI vibrancy ranking (per capita): top ten countries, 2023

Source: AI Index, 2024

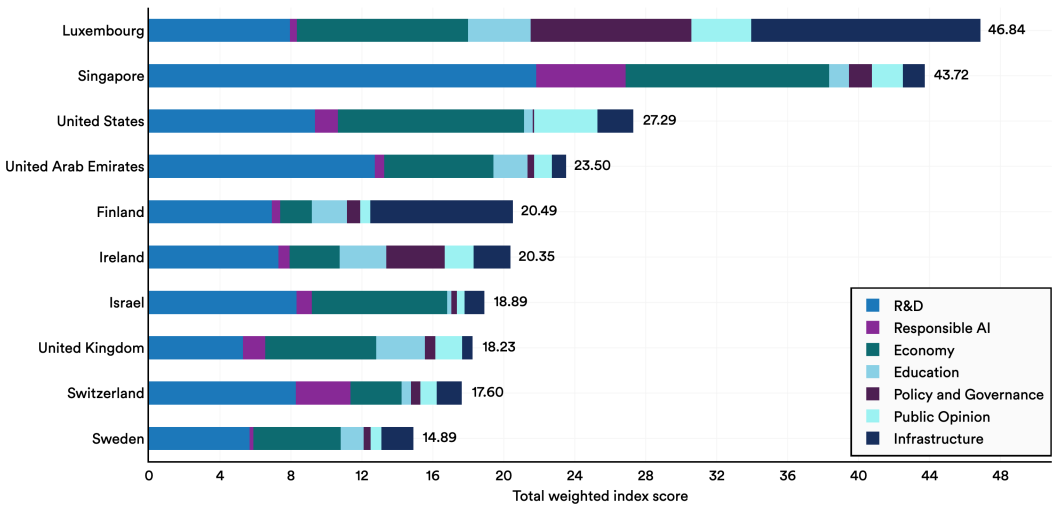


Fig. 10

The GVT also includes a “per capita” view that adjusts levels of AI vibrancy based on a country’s population. When viewed from this perspective, Luxembourg holds the top position, achieving a total index score of 46.84. Luxembourg’s strong per capita ranking is driven by balanced contributions across almost all dimensions, particularly Economy, Policy and Governance, and Infrastructure (Figure 10). Singapore follows in second place with a score of 43.72, followed by the United States

with a score of 27.29. Other countries that score especially well according to the per capita view are Finland, Ireland, Israel, the UK, Switzerland, and Sweden.<sup>14</sup>

### 6.1 Insights from the Sub-Indices

A closer examination of the AI Vibrancy Index’s sub-indices introduced in Section 3.1, reveals a nuanced landscape where national strengths vary across dimensions. In the Innovation domain for 2023 (Figure 11), the United States leads with a score of 79.20, substantially outperforming its nearest competitor, China (53.08). The U.S. especially excels in both R&D and infrastructure. India comes in third place. The gap between Japan (16.96) the fourth place country and Spain, which comes in tenth (11.18) is fairly small in comparison to the gap that exists between the U.S. and China or U.S. and India. This contrast highlights a closer grouping among countries outside the top three, suggesting that modest investments in AI capacity could lead to substantial shifts in rankings.

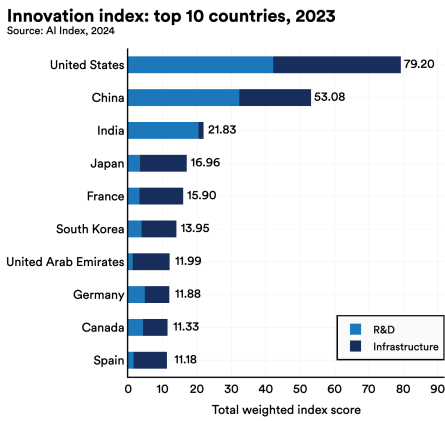


Fig. 11

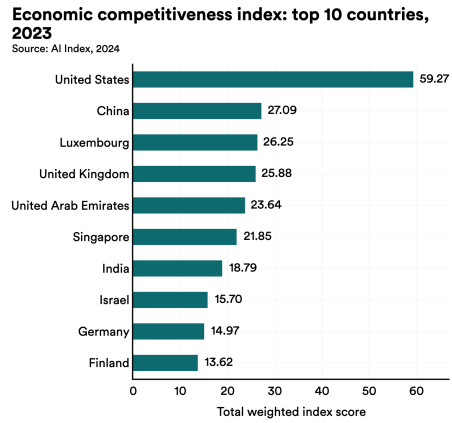


Fig. 12

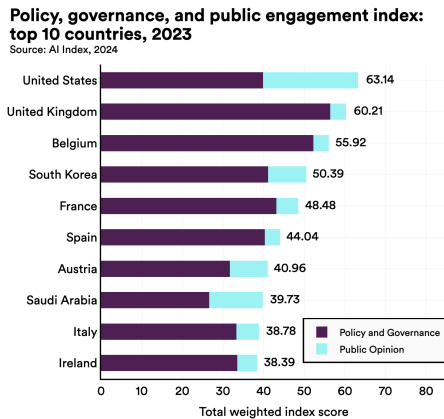


Fig. 13

<sup>14</sup>For a complete view of rankings using per capita values for all countries included in the analysis, refer to the Appendix G.1, Figure 21.



The Economic Competitiveness sub-index for 2023 (Figure 12) captures a country's capacity to foster AI market dynamism, attract investments, and cultivate specialized talents. The United States again leads decisively with a score of 59.27. In the AI space, the U.S. leads in being able to attract AI investments, concentrate specialized talent, and generate employment opportunities. Luxembourg's third place position (26.25), coming narrowly behind China in second (27.09), is a remarkable achievement for a smaller nation. Luxembourg's relatively high ranking reflects the fact that it scores highly on several rate based metrics of AI economic vibrancy, such as AI hiring rate, AI talent concentration and the net migration of AI skills. For all of those indicators, Luxembourg occupies a top three global position. Singapore (21.85) and Israel (15.70) also perform strongly.

The Policy, Governance, and Public Engagement sub-index for 2023 (Figure 13), which measures the intensity of AI-related policy activities, legislative initiatives, and public discourse, reveals the most geographically diverse leadership landscape among the three sub-indices. The United States again leads, with a score of 63.14, though its margin of advantage is narrower compared to other sub-indices. Close are the United Kingdom (60.21) and Belgium (55.92), which demonstrate similarly high levels of policy dynamism and stakeholder engagement. This tight clustering reflects the intense focus on AI governance across multiple regions, particularly in Europe, where legislative activity has increased in response to the rapid pace of AI development and deployment. South Korea (50.39) also scores well on this sub-index. Saudi Arabia's emergence in the top ten, with a score of 39.73, signals growing momentum in AI public engagement and governance in the Middle East. The rise of countries in the Middle East further highlights how the scope of AI leadership is moving beyond traditional centers.<sup>15</sup>

## 6.2 United States and China

As AI has gained geopolitical importance, commentators and policymakers have increasingly focused on the comparative strengths of the two leading AI nations: the United States and China. This focus is evident in popular discussions about the geopolitical race between these countries and its implications, as well as in policy actions like the CHIPS and Science Act which were designed to bolster the U.S.-made semiconductor ecosystem [8, 16, 35]. Given this context, it is natural to closely compare the AI positioning of these two nations and examine how it has evolved over time.

In 2018, the United States overtook China as the nation with the greatest global AI vibrancy. Since then, it has further reinforced its lead position. In 2017, the two countries were relatively close in several key areas, including research and development and investment. However, by 2023, the United States had pulled ahead, achieving a vibrancy index score of 70.06, nearly double China's score of 40.17 (Figure 14).

The relative strength of the United States in comparison to China is evident when you look at a selection of significant AI indicators. The United States outpaced China in private investment, reaching \$67.22 billion in 2023 compared to China's \$7.76 billion (Figure 16). It also led in developing notable machine learning models, producing 61 models in 2023 compared to China's 15 (Figure 18). However, China showed strong growth in AI innovation, particularly in patent generation, granting nearly three times as many AI patents as the United States (Figure 17). Additionally, the United States took a proactive stance in AI regulation, passing a total of 23 AI-related laws since 2017 (Figure 19).<sup>16</sup>

<sup>15</sup>For a complete view of results for all countries included in the analysis, refer to the Appendix G.2.

<sup>16</sup>For more detailed methodological information on any specific indicator, refer to the most recent AI Index report [25].

**AI vibrancy index score, 2017–23**

Source: AI Index, 2024

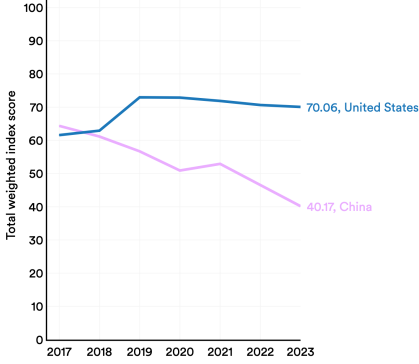


Fig. 14

**Global AI vibrancy ranking, 2017–23**

Source: AI Index, 2024

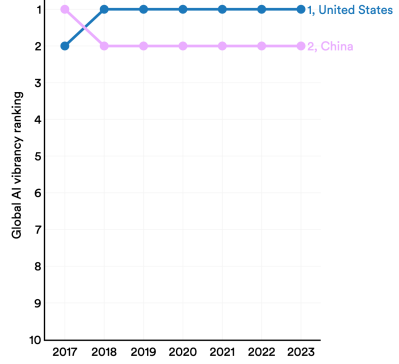


Fig. 15

**Private investment in AI, 2017–23**

Source: Guid, 2023 | Chart: AI Index, 2024

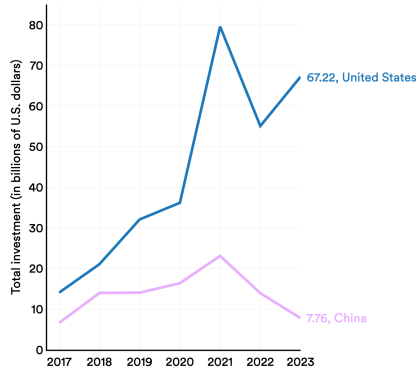


Fig. 16

**Number of AI patents granted, 2017–23**

Source: Center for Security and Emerging Technology, 2024 | Chart: AI Index, 2024

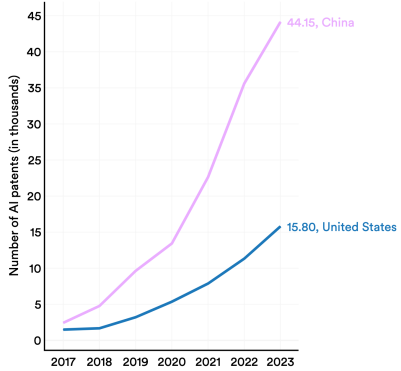


Fig. 17

**Number of notable machine learning models, 2017–23**

Source: Epoch AI, 2023 | Chart: AI Index, 2024

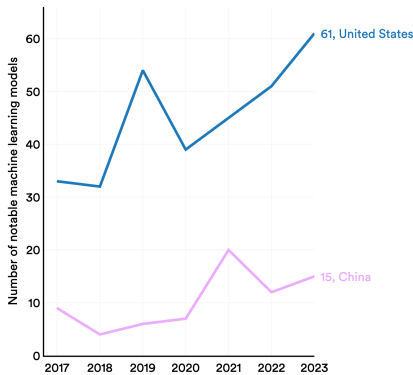


Fig. 18

**Number of AI-related bills passed into law, 2017–23**

Source: AI Index, 2024

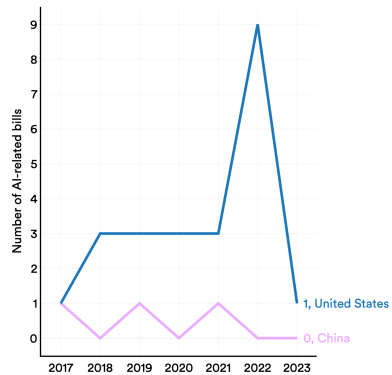


Fig. 19

### 6.3 Additional Notes and Limitations

When interpreting the AI vibrancy rankings, it is essential to consider a few nuances. As outlined in the [Methodology](#) section, the rankings heavily rely on the weighting schema applied to each pillar and indicator. The AI Index has selected a weighting approach that it believes best represents the significance and coverage of the various components.<sup>17</sup> However, users of the vibrancy tool may have different views on the relative importance of specific pillars or indicators. The AI Index encourages users to explore the weight adjuster feature in the live tool to tailor the rankings to their own perspectives.

For many countries outside the top two or three in any given index in this paper, the score gaps between neighboring countries are relatively small. For instance, while the gap between the United States and China (the top two countries) was roughly 30 points on the weighted index score, the difference between the United Kingdom and Singapore (ranked third and tenth) was only about 9 points. As such, the rankings for countries outside the top positions (e.g., top three or ten) should be interpreted with more flexibility than those in the top few spots. Countries in the middle or lower tiers of the Index are often closely grouped, meaning that slight adjustments in weighting can significantly affect their ranks. This close clustering also indicates that countries can improve their standings through active policies and strategic planning that directly improve the strength of their AI ecosystem.

Since the AI Index provides annual rankings, it is also important to recognize that a country's yearly position can be sensitive to outlier values. A high or low score in certain indicators one year might place a country out of alignment with its historical rankings. Future versions of the AI Vibrancy tool will include three- or five-year weighted averages to offer a more stable view of each country's average position over time.

Finally, the AI Index recognizes that some data sources contributing to the rankings provide more comprehensive coverage for certain types of nations than others. To address this potential imbalance, the AI Index has down-weighted indicators or pillars with limited coverage. Efforts are underway to expand data coverage, and the AI Index encourages collaboration from governments and representatives worldwide to improve the representativeness of these rankings.

## 7 CONCLUSION

The Global AI Vibrancy Tool (GVT) is a robust and versatile platform for assessing and comparing AI vibrancy across countries. By incorporating a comprehensive set of indicators across various dimensions, it provides a nuanced and dynamic understanding of over time trends in AI development at the national level. This tool is intended to serve as a valuable resource for policymakers, industry leaders, researchers, and the general public in guiding their understanding of the geopolitical dynamics that surround the AI ecosystem. The interactivity and customizability of the Global Vibrancy Tool allows users to explore and interpret AI data in meaningful ways, which can facilitate informed, flexible and strategic decision-making. As AI continues to evolve rapidly, the GVT will grow and expand in scope, with the intention of remaining an essential resource for tracking progress and identifying areas for improvement.

Future work will focus on expanding the range of indicators and countries, and improving data collection methods to ensure greater accuracy and coverage. Additionally, incorporating user feedback and enabling more sophisticated analytics capabilities will be important in maintaining

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<sup>17</sup>For more details on how weights were attributed, refer to the default weights selected for pillars and indicators in Appendix, Section D.

the tool's relevance and utility.<sup>18</sup> Collaborations with international organizations and AI research communities will also be pursued to enrich the tool's data sources and validation processes. These efforts are in the service of establishing the GVT as a comprehensive and authoritative measure of global AI vibrancy.

We encourage the AI community to suggest indicators and contribute data sources that are currently missing and require more effort to be collected. This collective input will be valuable in enhancing the tool's comprehensiveness and ensuring it meets the evolving needs of all stakeholders.

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<sup>18</sup>Note that the AI Index may introduce new indicators and modify the interface throughout the year. Additional data for the new year will be incorporated during the summer following the release of the AI Index report. Any changes will be communicated on the AI Index website.

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## APPENDIX

### A LIST OF COUNTRIES

To ensure the quality and representativeness of the analysis, a data coverage threshold of 70%, averaged over the last three years, was applied. This threshold was chosen to balance the need for comprehensive data with the goal of including a diverse set of countries. However, Estonia, Malaysia, Mexico, Russia, Saudi Arabia, and Turkey did not meet this threshold but have been included due to their strategic importance such as geopolitical influence, economic impact, or contributions to global trends. Therefore, these countries are included, but users should interpret their results with caution. For more details, see tables 11 and 12.

Table 3. List of Countries

Country
Australia
Austria
Belgium
Brazil
Canada
China
Denmark
Estonia
Finland
France
Germany
India
Ireland
Israel
Italy
Japan
Luxembourg
Malaysia
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Russia
Saudi Arabia
Singapore
South Africa
South Korea
Spain
Sweden
Switzerland
Turkey
United Arab Emirates
United Kingdom
United States

## B LIST OF INDICATORS AND DESCRIPTIONS

Table 4. List of Indicators and Descriptions

Indicator	Description
AI Journal Publications	Number of published AI journal publications in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Conference Publications	Number of published AI conference publications in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Journal Citations	Number of published AI journal citations in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Conference Citations	Number of published AI conference citations in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Patent Grants	Number of AI patent grants in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Notable Machine Learning Models	Number of notable machine learning models in a given country. For more details, refer to Epoch AI's webpage [7].
Academia-Industry Model Production Concentration	Indicator quantifying the balance between the number of notable machine learning models produced by academia and industry within each country. For more details, refer to the Appendix, Section E.
Foundation Models	Number of foundation models in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Foundation Models Datasets	Number of foundation models' datasets in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Foundation Models Applications	Number of foundation models' applications in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Open Access Foundation Models	The proportion of foundation models that are openly accessible compared to the total number of foundation models in a given country.
AI GitHub Projects	Total number of AI-related projects on GitHub in a given country, consisting of a collection of files such as source code, documentation, configuration files, and images that together form a software project. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI GitHub Projects Stars	Total number of stars for AI-related projects on GitHub in a given country. Users can "star" a repository to show interest, similar to liking a post on social media, indicating support for the project. For more details, refer to the Appendix of the 2024 AI Index Report [25].



<b>Indicator</b>	<b>Description</b>
AAAI Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the AAAI conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AIES Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the AIES conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
FAccT Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the FAccT conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
ICLR Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the ICLR conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
ICML Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the ICML conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
NeurIPS Conference Submissions on RAI Topics	Number of responsible AI-related academic submissions to the NeurIPS conference in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Total AI Private Investment	Total amount of private investment received for AI startups (nominal USD) in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Total AI Merger/Acquisition Investment	Total amount of merger/acquisition investment received for AI startups (nominal USD) in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Total AI Minority Stake Investment	Total amount of minority stake investment received for AI startups (nominal USD) in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Total AI Public Offering Investment	Total amount of public offering investment received for AI startups (nominal USD) in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Newly Funded AI Companies	Total number of newly funded AI companies in the given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].

Indicator	Description
Relative AI Skill Penetration	This indicator measures the intensity of AI skills within a country. It involves computing skill frequencies from LinkedIn members (2015-2023), re-weighting them using a TF-IDF model to identify the top 50 representative skills (the “skill genome”), and calculating the proportion of AI skills among these top skills. This rate indicates the prevalence and intensity of AI skills used by LinkedIn members in their jobs. To allow for skills penetration comparisons across countries, skill genomes are calculated and compared to a benchmark (e.g., global average). A ratio is then constructed between a country’s AI skills penetration and the benchmark, controlling for occupations. A relative AI skills penetration of 1.5 indicates that AI skills are 1.5 times more frequent than in the benchmark for similar occupations. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Hiring Rate YoY Ratio	This indicator measures the year-over-year change in the AI Hiring Rate relative to the Overall Hiring Rate in the same country. Each month, the AI Hiring Rate is calculated and divided by the Overall Hiring Rate. The year-over-year change of this ratio is then determined, followed by calculating a 12-month moving average. Interpretation: In 2023, India saw a 16.8% year-over-year growth in the ratio of AI talent hiring relative to overall hiring. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Talent Concentration	This indicator identifies AI talent as LinkedIn members who have explicitly added AI skills to their profile or work in AI-related occupations. AI Talent Concentration is calculated using the counts of AI talent relative to the total number of LinkedIn members in a given country. It is important to note that these metrics may be influenced by the level of LinkedIn coverage in different countries and should be interpreted with caution. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Job Postings (% of Total)	The percentage of job postings that require AI skills in a given country. Lightcast collects postings from over 51,000 online job sites to develop a comprehensive, real-time portrait of labor market demand. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Net Migration Flow of AI Skills	AI talent migration per 10,000 LinkedIn members in a given country. This metric tracks AI talent with AI skills or jobs. For a specific country (country A), net talent flows are calculated by dividing the net AI talent migration by the Member Count, normalized per 10,000 members. This indicates the relative migration of AI talent to and from country A. For more details, refer to the Appendix of the 2024 AI Index Report [25].

Indicator	Description
AI Study Programs in English	The number of English-language AI-related study programs in a given country. A study program, or degree program, comprises a series of courses designed to enable students to earn a relevant qualification, such as a degree or diploma. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Study Programs in English Penetration	The proportion of AI-related study programs offered in English in a given country. A study program, or degree program, comprises a series of courses designed to enable students to earn a relevant qualification, such as a degree or diploma. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Talent Concentration Gender Equality Index	This indicator measures the distribution of AI talent between females and males among LinkedIn members in a given country, indicating gender equality within the AI talent pool. For more details, refer to the Appendix, Section E.
National AI Strategy Presence	This is a binary indicator showing whether a country has an AI strategy. This is a policy plan created by governments to guide the development and deployment of AI within their country. The AI Index conducted a web search to identify national AI strategies. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Legislation Passed	The number of AI-related bills that have been enacted in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
AI Mentions in Legislative Proceedings	The number of times AI is mentioned in governmental and parliamentary proceedings in a given country. For more details, refer to the Appendix of the 2024 AI Index Report [25].
Social Media Share of Voice on AI	The proportion of social media discussions that mention or discuss AI attributed to a specific country compared to other countries.
AI Social Media Posts	The number of social media posts that mention or discuss AI in a given country.
AI-Related Social Media Conversations Net Sentiment	The overall sentiment of social media conversations about AI in a given country, calculated as the difference between positive and negative mentions. A net sentiment score of +100 means that all conversations are positive; a score of -100 means that all conversations are negative.
Parts Semiconductor Devices Exports	Total amount of exports in USD of electrical apparatus parts, including diodes, transistors, similar semiconductor devices, and photosensitive semiconductor devices for a given country.
Supercomputers	The number of supercomputers in a given country.
Compute Capacity (Rmax)	The compute capacity, measured as Rmax (GFlops), representing the performance of supercomputers in a given country.

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<b>Indicator</b>	<b>Description</b>
Internet Speed	This indicator represents the median internet download speed in Mbps in a given country.

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## C INDICATORS INCLUDED IN SUB-INDICES

Table 6. Innovation Index Indicators

<b>Key indicators included</b>
AI Journal Publications
AI Journal Citations
AI Conference Publications
AI Conference Citations
AI Patent Grants
Notable Machine Learning Models
Foundation Models
Foundation Models Datasets
Foundation Models Applications
AI GitHub Projects
AI GitHub Projects Stars
Parts Semiconductor Devices Exports
Supercomputers
Compute Capacity (Rmax)
Internet Speed

Table 7. Economic Competitiveness Index Indicators

<b>Key indicators included</b>
Total AI Private Investment
Total AI Merger/Acquisition Investment
Total AI Minority Stake Investment
Total AI Public Offering Investment
Newly Funded AI Companies
AI Hiring Rate YoY Ratio
Relative AI Skill Penetration
AI Talent Concentration
Net Migration Flow of AI Skills

Table 8. Policy, Governance, and Public Engagement Index Indicators

<b>Key indicators included</b>
National AI Strategy Presence
AI Legislation Passed
AI Mentions in Legislative Proceedings
Social Media Share of Voice on AI
AI Social Media Posts
AI-Related Social Media Conversations Net Sentiment

## D WEIGHTING: BUDGET ALLOCATION METHOD

In assigning weights to pillars and indicators, careful consideration was given to data availability, quality, and the scope of coverage across countries to ensure a reliable representation of AI vibrancy. Indicators with limited coverage—such as *Academia-Industry Model Production Concentration*, *Open Access Foundation Models*, and *AI Job Postings (% of Total)*—were assigned a weight of zero, as their availability (only covering 33%, 36%, and 39% of countries respectively in 2023) undermines their utility in cross-country comparisons. Data enhancement efforts are underway for these indicators to improve future analyses. Similarly, weights for indicators like *AI Hiring Rate YoY Ratio*, *Relative AI Skill Penetration*, *AI Talent Concentration*, and *Net Migration Flow of AI Skills* were reduced due to partial data coverage (69% in 2023). Further, foundational AI indicators, including *Foundation Models (count)*, *Foundation Model Applications*, and *Foundation Model Datasets*, were assigned a moderate weight of 3 to balance their importance with the underrepresentation of some countries due to the predominance of English-language data sources, with ongoing efforts to enhance data accuracy across more countries. Pillar weights were also adjusted to reflect data quality and relevance. For example, the *Responsible AI* pillar was assigned a low weight of 2 due to potential overlap with the *R&D* pillar, though the search for additional country-specific metrics continues. The *Economy* pillar’s weight was adjusted to 8 to indicate a need for more indicators on AI technology adoption, while the *Education* pillar, weighted at 2, requires further development to mitigate English-language biases. Other adjustments include reducing the weight of the *Diversity* pillar to 1, due to its limited indicators and low data coverage, and the *Policy and Governance* pillar to 4, addressing the gap in both qualitative and quantitative metrics, such as AI-dedicated government budgets. The *Public Opinion* pillar received a weight of 2, acknowledging its lesser relevance compared to pillars like *Policy and Governance*, while the *Infrastructure* pillar was weighted at 6. Although critical, this adjustment reflects missing metrics on infrastructure specifics, like data center availability, with plans to expand data collection underway. This calibration provides a comprehensive view of global AI vibrancy, accounting for some data limitations. The approach prevents skewed assessments from data gaps or overemphasis, resulting in a more balanced analysis.

Table 9. Pillar Weights

Pillar	Pillar Weight (0 - 10)	Pillar Weight (%)
Research and Development	10	28.57%
Responsible AI	2	5.71%
Economy	8	22.86%
Education	2	5.71%
Diversity	1	2.86%
Policy and Governance	4	11.43%
Public Opinion	2	5.71%
Infrastructure	6	17.14%

Table 10. Indicator Weights

<b>Indicator</b>	<b>Indicator Weight (0 - 10)</b>	<b>Indicator Weight (%)</b>
AI Journal Publications	8	11.43%
AI Journal Citations	8	11.43%
AI Conference Publications	6	8.57%
AI Conference Citations	7	10.00%
AI Patent Grants	8	11.43%
Notable Machine Learning Models	9	12.86%
Academia-Industry Model Production Concentration	0	0.00%
Foundation Models	3	4.29%
Foundation Models Datasets	3	4.29%
Foundation Models Applications	3	4.29%
Open Access Foundation Models	0	0.00%
AI GitHub Projects	7	10.00%
AI GitHub Projects Stars	8	11.43%
FAccT Conference Submissions on RAI Topics	7	15.22%
NeurIPS Conference Submissions on RAI Topics	10	21.74%
ICML Conference Submissions on RAI Topics	8	17.39%
ICLR Conference Submissions on RAI Topics	7	15.22%
AIES Conference Submissions on RAI Topics	6	13.04%
AAAI Conference Submissions on RAI Topics	8	17.39%
Total AI Private Investment	10	15.87%
Total AI Merger/Acquisition Investment	9	14.29%
Total AI Minority Stake Investment	7	11.11%
Total AI Public Offering Investment	7	11.11%
Newly Funded AI Companies	9	14.29%
AI Hiring Rate YoY Ratio	6	9.52%
Relative AI Skill Penetration	3	4.76%
AI Talent Concentration	6	9.52%
AI Job Postings (% of Total)	0	0.00%
Net Migration Flow of AI Skills	6	9.52%
AI Study Programs in English	6	46.15%
AI Study Programs in English Penetration	7	53.85%
AI Talent Concentration Gender Equality Index	10	100.00%
National AI Strategy Presence	10	38.46%
AI Legislation Passed	10	38.46%
AI Mentions in Legislative Proceedings	6	23.08%
Social Media Share of Voice on AI	8	34.78%
AI Social Media Posts	6	26.09%
AI-Related Social Media Conversations Net Sentiment	9	39.13%
Parts Semiconductor Devices Exports	10	27.03%
Supercomputers	9	24.32%
Compute Capacity (Rmax)	10	27.03%
Internet Speed	8	21.62%

## E METRICS CALCULATION

### E.1 Academia-Industry Model Production Concentration

The *Academia-Industry Model Production Concentration* indicator quantifies the balance between the number of notable machine learning models produced by academia and industry within each country and year. The indicator is calculated using the inverted Herfindahl-Hirschman Index (HHI), a measure commonly used to assess market concentration.

$$\text{Inverted HHI} = 1 - (\alpha^2 + \iota^2) \quad (4)$$

where:

- $\alpha$  is the proportion of models produced only by academia.
- $\iota$  is the proportion of models produced only by industry.

A higher normalized value indicates a more balanced model production environment, suggesting a favorable condition for AI development due to collaboration and diversity between academia and industry. Conversely, a lower normalized value indicates a concentration in model production by either academia or industry, suggesting less diversity.

### E.2 AI Talent Concentration Gender Equality Index

The *AI Talent Concentration Gender Equality Index* measures how evenly the proportion of LinkedIn members who are AI talent are distributed between female and males in a country  $k$ .<sup>19</sup> The index is calculated using the following formula:

$$\frac{\min(\text{Female}_k, \text{Male}_k)}{\max(\text{Female}_k, \text{Male}_k)} \quad (5)$$

where:

- $\text{Female}_k$  is the AI talent concentration of females.
- $\text{Male}_k$  is the AI talent concentration of males.

The index ranges from 0 to 1, where 1 means perfect equality and 0 means complete inequality. A higher value of the index means a more balanced distribution of AI talent between females and males, reflecting greater gender equality in AI talent concentration within that country.

<sup>19</sup>Refer to the 2024 AI Index Report [25] for detailed information on the definition and calculation of the metric.



## F DATA COVERAGE

Table 11. Data Coverage by Country and Year

Country	2017	2018	2019	2020	2021	2022	2023
Australia	60%	62%	81%	88%	88%	88%	86%
Austria	48%	45%	64%	76%	74%	74%	71%
Belgium	50%	57%	71%	81%	81%	86%	88%
Brazil	50%	57%	76%	86%	86%	86%	83%
Canada	60%	62%	79%	90%	98%	100%	98%
China	52%	52%	67%	76%	86%	86%	83%
Denmark	50%	52%	69%	79%	79%	79%	86%
Estonia	45%	45%	60%	69%	69%	69%	67%
Finland	55%	57%	74%	83%	83%	83%	93%
France	57%	64%	88%	88%	88%	90%	98%
Germany	57%	62%	81%	90%	98%	98%	98%
India	55%	62%	76%	86%	86%	86%	86%
Ireland	55%	62%	74%	86%	83%	83%	83%
Israel	55%	55%	74%	88%	90%	90%	90%
Italy	55%	62%	79%	88%	88%	88%	86%
Japan	52%	50%	64%	76%	74%	74%	71%
Luxembourg	50%	52%	69%	79%	71%	83%	81%
Malaysia	45%	45%	60%	69%	69%	69%	67%
Mexico	50%	45%	60%	57%	69%	69%	67%
Netherlands	52%	60%	79%	86%	83%	86%	86%
New Zealand	48%	60%	71%	81%	81%	81%	79%
Norway	55%	57%	74%	86%	83%	86%	83%
Poland	52%	50%	64%	74%	74%	74%	71%
Portugal	50%	52%	69%	79%	79%	81%	79%
Russia	45%	48%	60%	69%	69%	79%	55%
Saudi Arabia	36%	36%	62%	71%	71%	74%	57%
Singapore	57%	62%	76%	83%	83%	86%	93%
South Africa	55%	57%	69%	81%	79%	81%	79%
South Korea	50%	48%	64%	76%	86%	83%	81%
Spain	55%	62%	79%	88%	88%	88%	95%
Sweden	55%	60%	79%	88%	86%	88%	95%
Switzerland	55%	62%	81%	88%	90%	90%	98%
Turkey	26%	38%	40%	62%	62%	62%	60%
United Arab Emirates	45%	48%	69%	79%	79%	83%	88%
United Kingdom	62%	64%	81%	90%	100%	100%	98%
United States	62%	64%	90%	100%	100%	100%	98%

Table 12. Data Coverage by Indicator and Year

Indicator	2017	2018	2019	2020	2021	2022	2023
Academia-Industry Model Production Concentration	31%	28%	25%	25%	17%	28%	33%
AI Job Postings (% of Total)	14%	39%	39%	39%	39%	39%	39%
AI Mentions in Legislative Proceedings	89%	89%	89%	89%	89%	89%	89%
AI-Related Social Media Conversations Net Sentiment	N/A	N/A	N/A	100%	100%	100%	100%
AI Social Media Posts	N/A	N/A	N/A	100%	100%	100%	100%
AI Study Programs in English Penetration	92%	92%	92%	92%	92%	92%	92%
AI Talent Concentration	69%	69%	69%	69%	69%	69%	69%
AI Talent Concentration Gender Equality Index	69%	69%	69%	69%	69%	69%	69%
Compute Capacity (Rmax)	72%	69%	69%	69%	72%	75%	75%
Internet Speed	N/A	N/A	N/A	97%	97%	97%	97%
Total AI Merger/Acquisition Investment	92%	97%	97%	97%	97%	100%	94%
Total AI Minority Stake Investment	92%	97%	97%	97%	97%	100%	94%
National AI Strategy Presence	100%	100%	100%	100%	100%	100%	100%
Net Migration Flow of AI Skills	N/A	N/A	69%	69%	69%	69%	69%
AI Legislation Passed	100%	100%	100%	100%	100%	100%	100%
AI Study Programs in English	94%	94%	94%	94%	94%	94%	94%
Foundation Models	N/A	N/A	6%	6%	19%	22%	42%
Foundation Models Applications	N/A	N/A	6%	6%	19%	22%	42%
Foundation Models Datasets	N/A	N/A	6%	6%	19%	22%	42%
AI GitHub Projects	100%	100%	100%	100%	100%	100%	100%
AI GitHub Projects Stars	100%	100%	100%	100%	100%	100%	100%
Newly Funded AI Companies	94%	97%	97%	97%	97%	100%	94%
Notable Machine Learning Models	100%	100%	100%	100%	100%	100%	100%
AAAI Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
AIES Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
FAccT Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
ICLR Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
ICML Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
NeurIPS Conference Submissions on RAI Topics	N/A	N/A	100%	100%	100%	100%	100%
Supercomputers	72%	69%	69%	69%	72%	75%	75%
AI Conference Citations	100%	100%	100%	100%	100%	100%	100%
AI Conference Publications	100%	100%	100%	100%	100%	100%	100%
AI Journal Citations	100%	100%	100%	100%	100%	100%	100%
AI Journal Publications	100%	100%	100%	100%	100%	100%	100%
AI Patent Grants	97%	97%	97%	97%	97%	97%	97%
Parts Semiconductor Devices Exports	97%	97%	97%	97%	97%	97%	N/A
Open Access Foundation Models	N/A	N/A	3%	3%	17%	19%	36%
Total AI Private Investment	92%	97%	97%	97%	97%	100%	94%
Total AI Public Offering Investment	92%	97%	97%	97%	97%	100%	94%
AI Hiring Rate YoY Ratio	N/A	69%	69%	69%	69%	69%	69%
Relative AI Skill Penetration	11%	36%	44%	50%	39%	56%	67%
Social Media Share of Voice on AI	N/A	N/A	N/A	100%	100%	100%	100%

## G RESULTS OF COUNTRY RANKINGS

### G.1 Global AI Vibrancy

#### Global AI vibrancy ranking (absolute), 2023

Source: AI Index, 2024

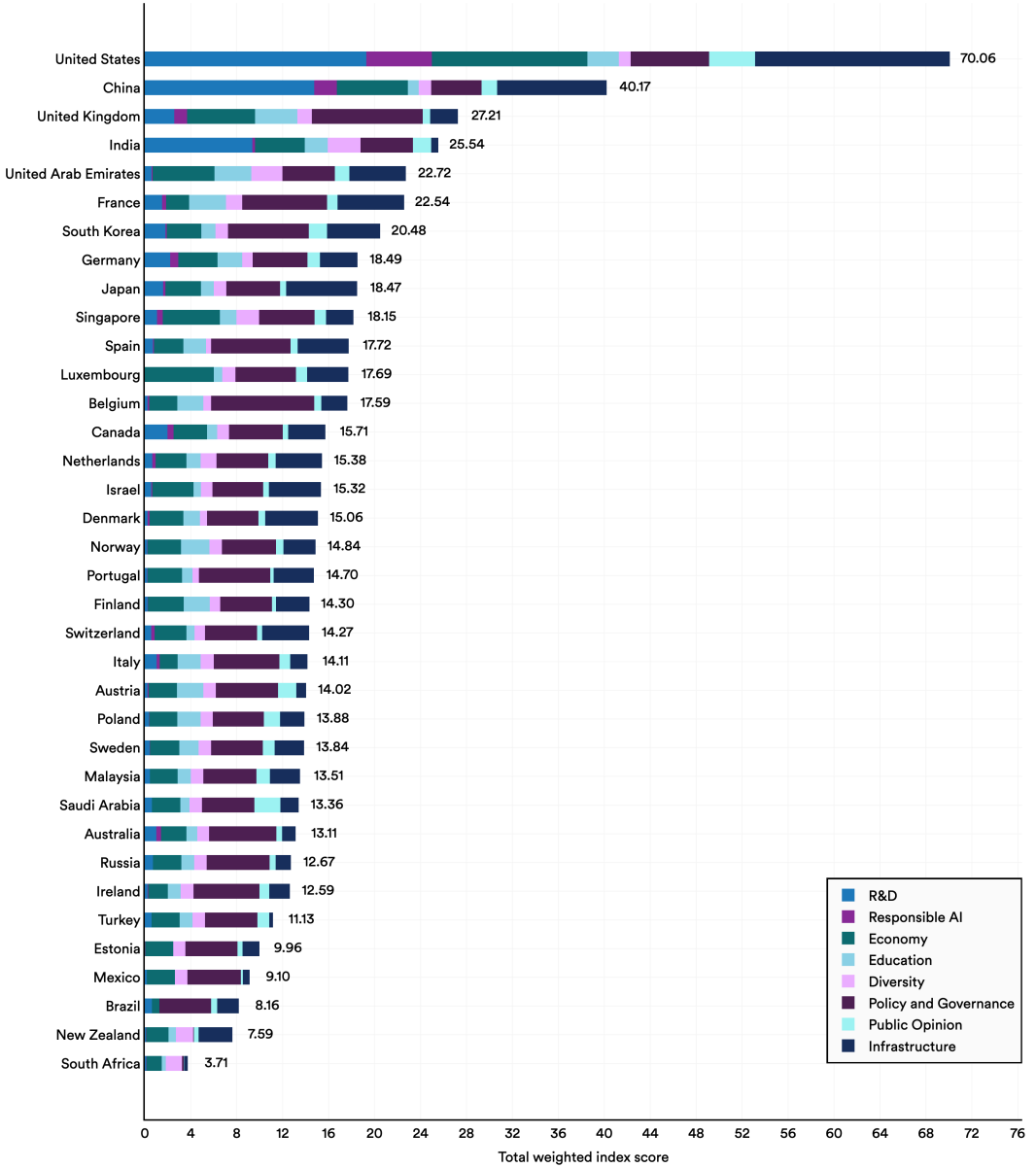


Fig. 20

### Global AI vibrancy ranking (per capita), 2023

Source: AI Index, 2024

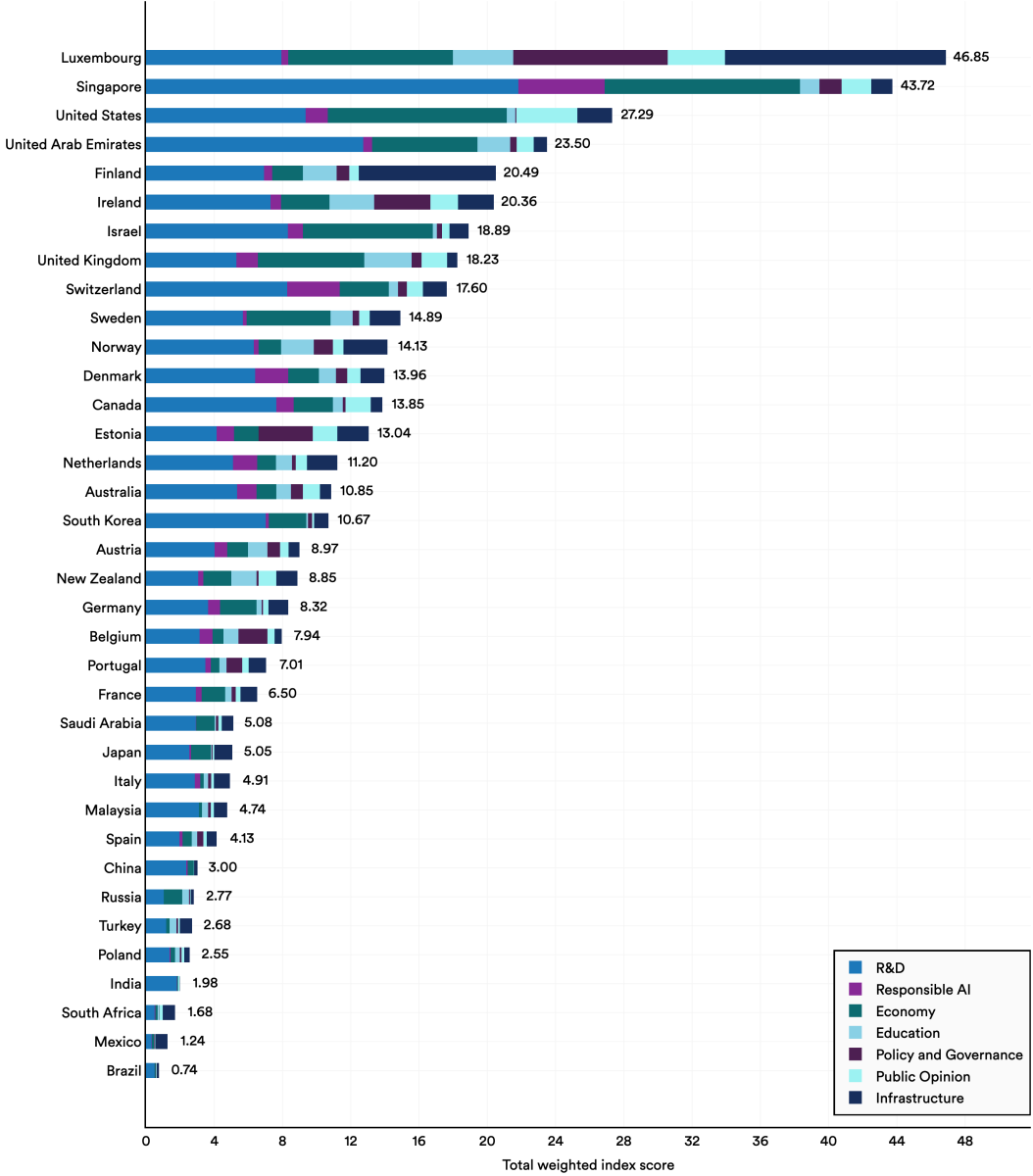


Fig. 21

## G.2 Sub-Indices

### Innovation index, 2023

Source: AI Index, 2024

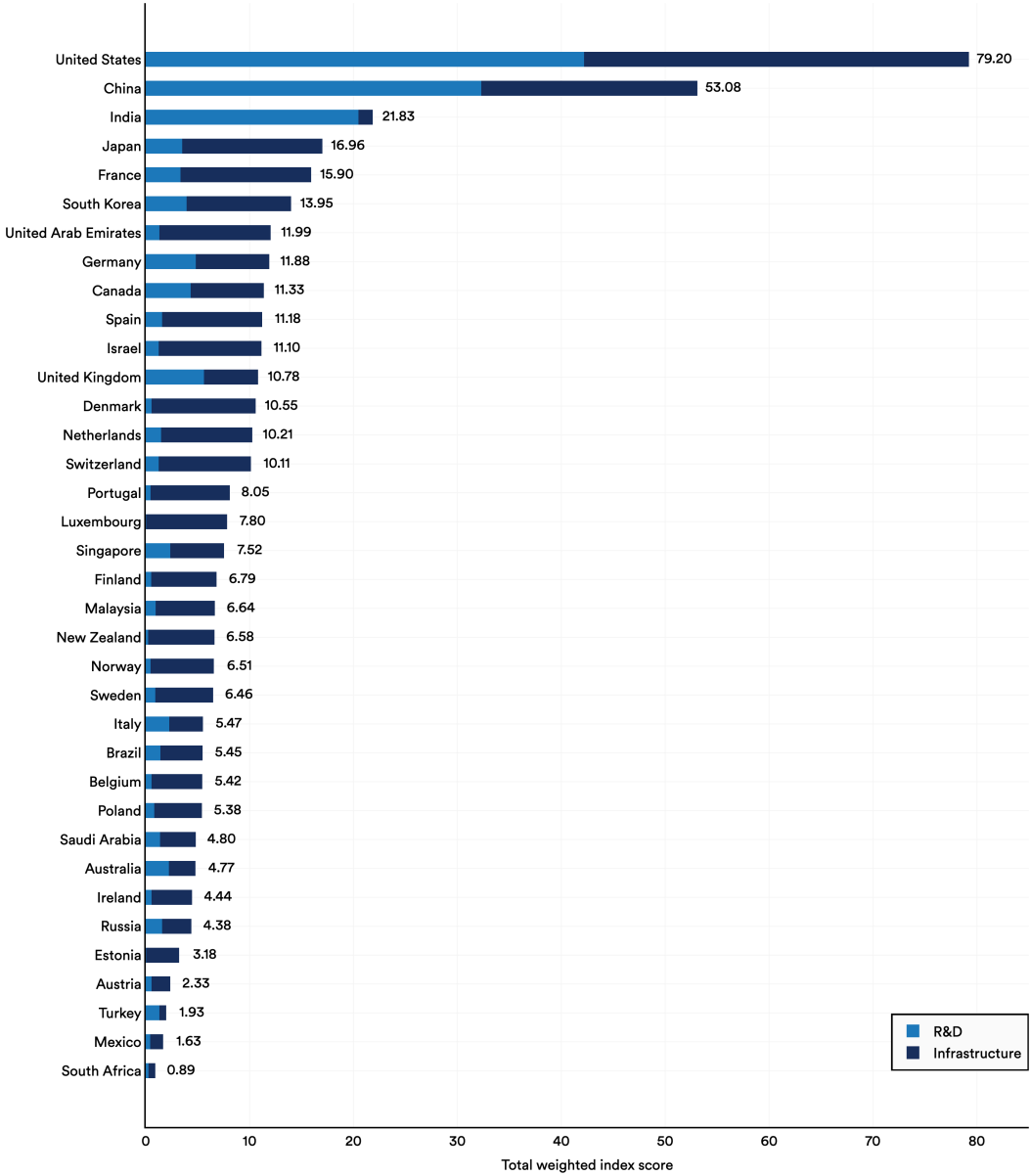


Fig. 22

**Economic competitiveness index, 2023**

Source: AI Index, 2024

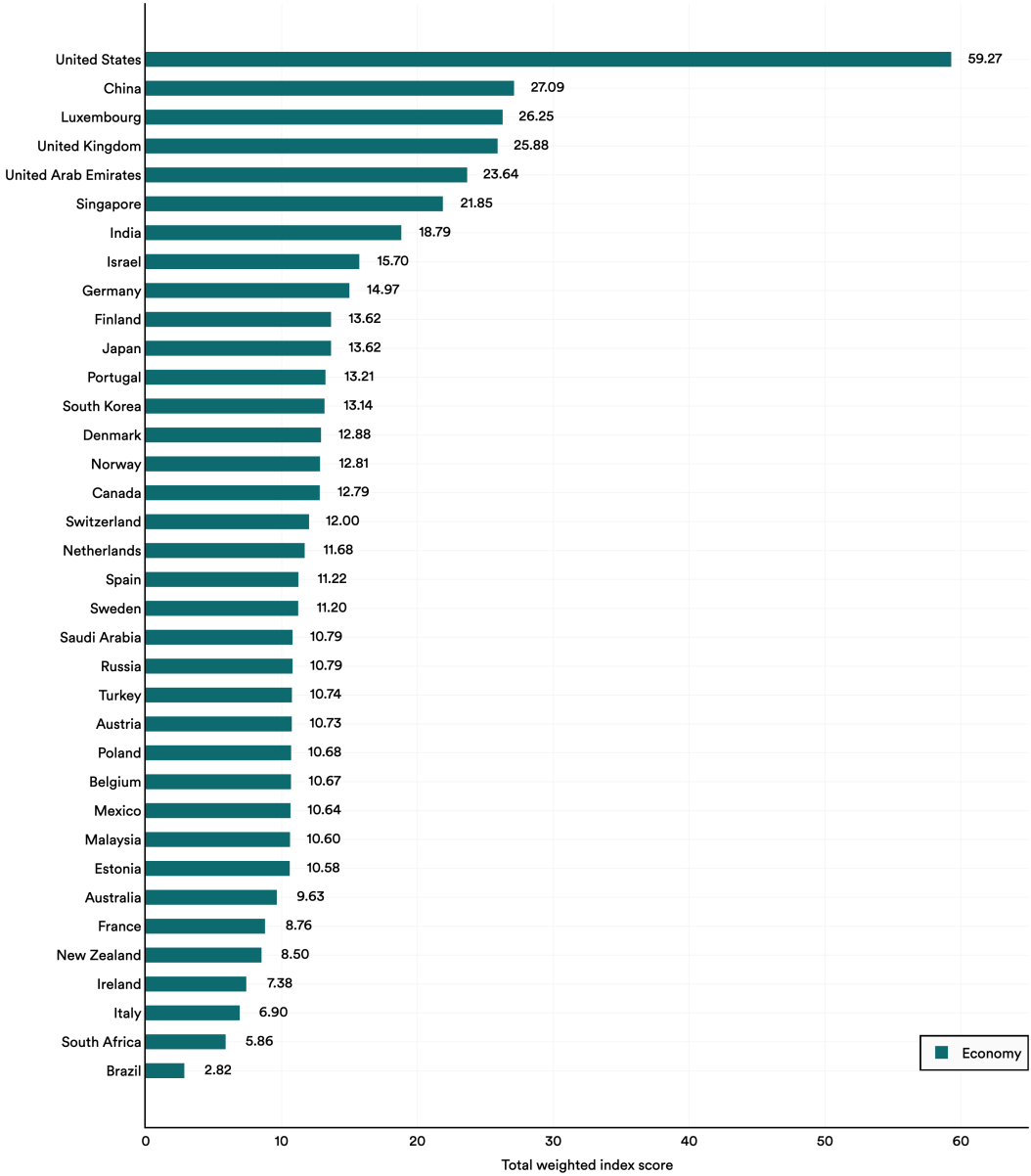


Fig. 23

## Policy, governance, and public engagement index, 2023

Source: AI Index, 2024

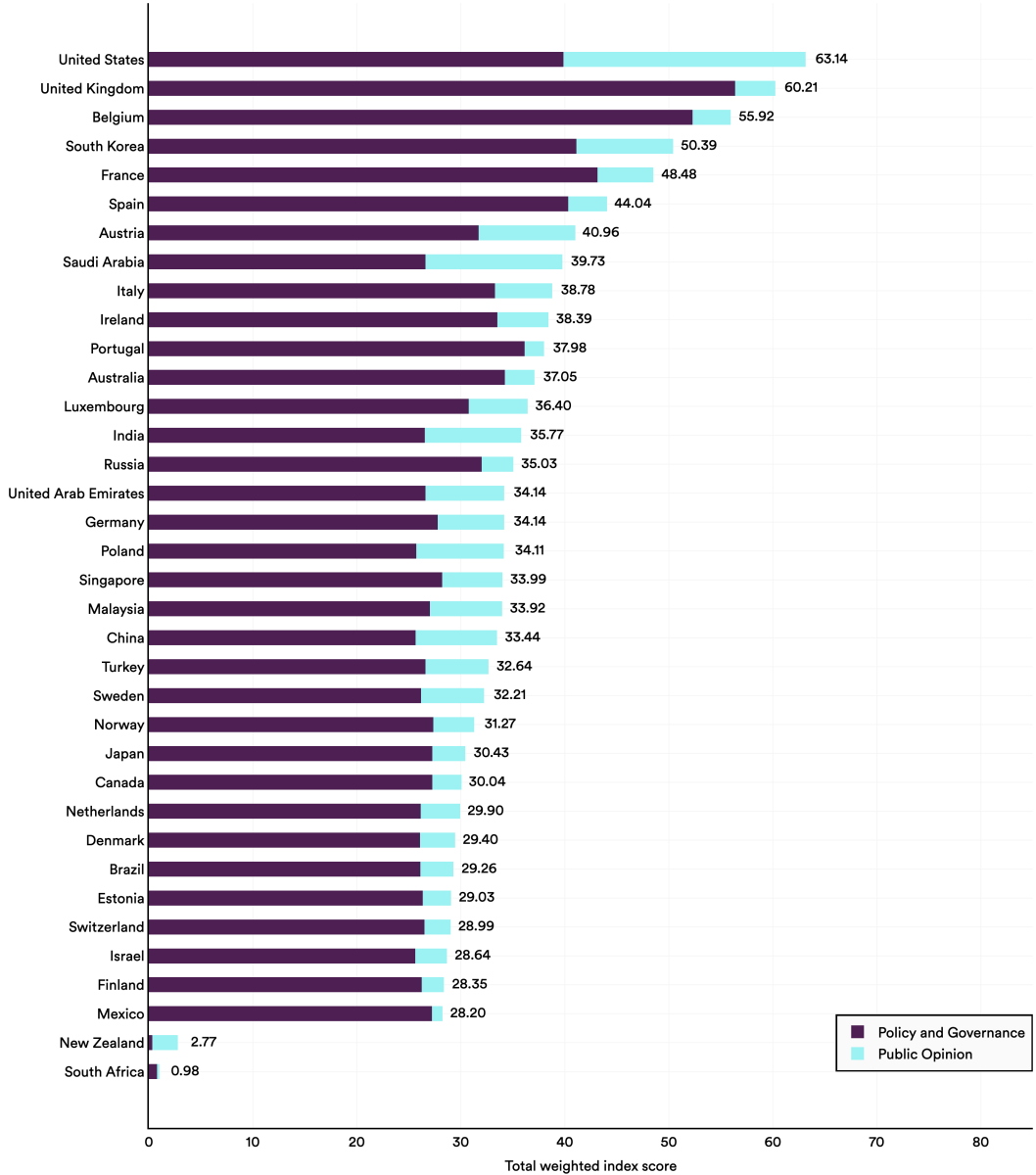


Fig. 24