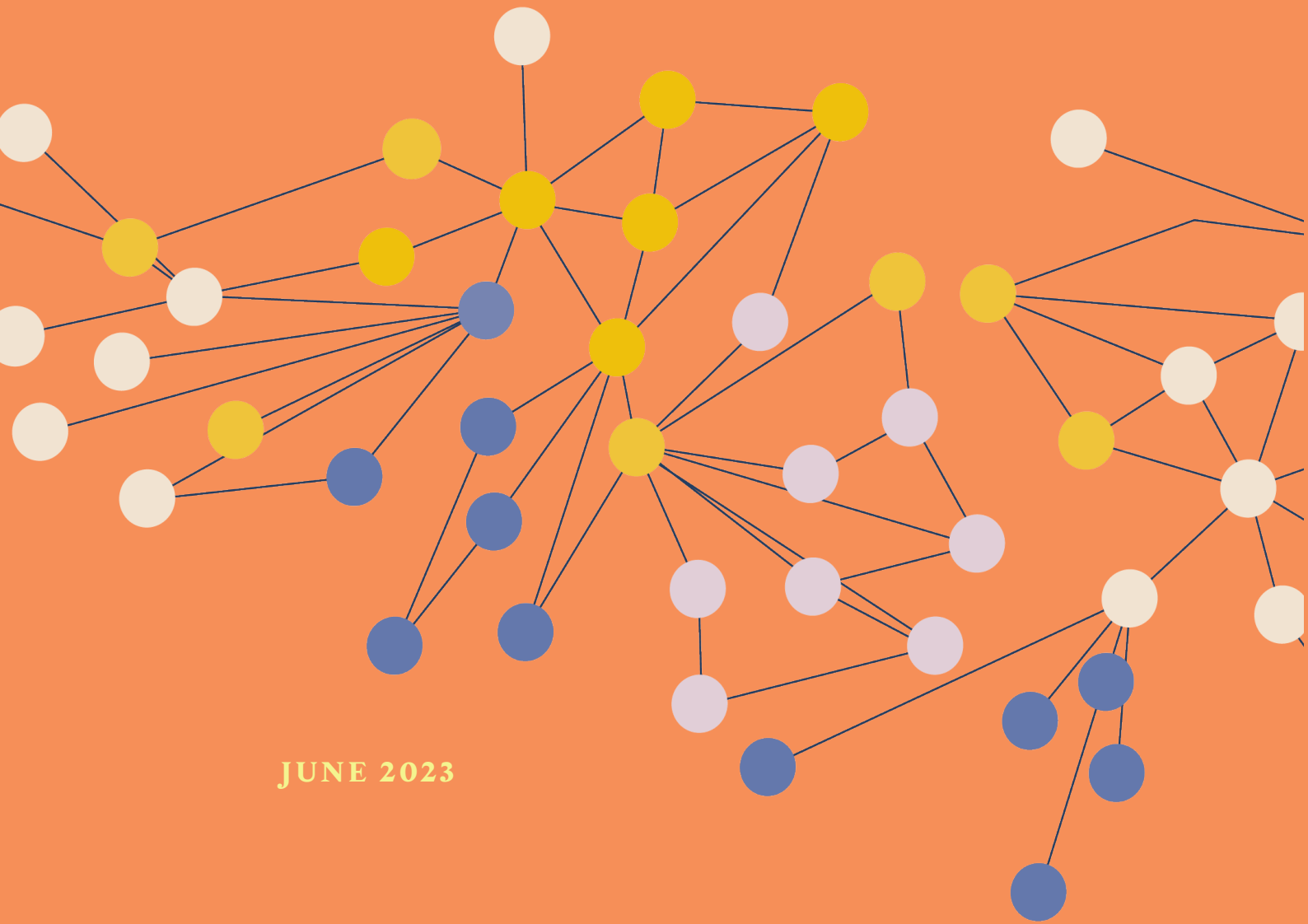
Tortoise

The Global AI Index

Methodology Report



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Overview

Launched in 2019, the Global AI Index (GAII) was the first to rank countries based on capacity for artificial intelligence, by measuring levels of investment, innovation and implementation. For the fourth iteration of the index, Tortoise has worked to further reflect the current international landscape across the areas of talent, infrastructure, operating environment, research, development, commercial ventures and government strategy. For the first time, this year the Global AI Index can also be explored by isolating per-capita indicators. This allows us to understand the degree of intensity of countries' AI development - benchmarking growth against themselves – and expand our analysis to small but dynamic countries, beyond the big global AI leaders.

This report details the underlying methodology of the Global AI Index, including the rationale for its structure and the techniques behind the data collection, imputation, weighting and scoring. As a composite index, the GAII draws on a range of 28 different data sources, including government reports, public databases from international organisations, think-tanks and private companies, as well as Tortoise's own research, to measure the national ecosystems that determine capacity for artificial intelligence. The 111 indicators that comprise the Global AI Index Index have been selected because they:

- Reflect publicly-available information
- Use up-to-date data sources
- Relate to key issues in the artificial intelligence sector

The indicators are grouped by associative themes around three main pillars and seven sub-pillars:

- **Implementation.** Indicators within this pillar reflect the operationalising of artificial intelligence by practitioners in business, government and communities. This pillar contains the sub-pillars of talent, infrastructure and operating environment.
- **Innovation.** Indicators within this pillar reflect technology breakthroughs and advancements in methodology that are indicative of greater capacity for artificial intelligence in the future. This pillar contains the sub-pillars of research and development.
- **Investment.** Indicators within this pillar reflect financial and procedural commitments to artificial intelligence. This pillar contains the sub-pillars of commercial ventures and government strategy.

Why measure AI capacity?

Artificial intelligence holds enormous power to transform business, government and society. Measuring countries' AI capacity means understanding the extent to which they are set to harness such power.

Capacity – the amount of something that a system can contain or produce – is in fact the organising concept of the Global AI Index. It is an appropriate means of considering the relationship between the different relevant factors that exist within a given nation. Increased capacity, in this case, can be understood as an increased ability to generate and sustain artificial intelligence solutions, now and in the future.

At a national level, greater adoption of artificial intelligence means that more systems, initiatives and personnel are becoming active in the field, and the quality of these factors is also improving. In this way, capacity for artificial intelligence expresses both the breadth and depth of adoption as well as improvements in a given nation's ability to manage and sustain artificial intelligence systems in a productive, safe and fair way.

Within the Global AI Index, capacity is measured through composite indicators which meet the need to consolidate – through aggregation – a large amount of data into a set of simplified numbers that encompass and reflect the underlying complexity of information.

Guiding principles

The key methodological principles that underpin the Global AI Index are detailed below:

1. **Relevant.** Each of our variables speaks to a contemporary policy area, or ongoing conversation in business in the field of artificial intelligence. For example, 'Number of Paper in accepted IEEE Papers on artificial intelligence topics' is a factor that features regularly in contemporary discussion.
2. **Relatable.** Many of our variables are selected to be accessible to specialists and non-specialists alike. This accessibility makes the Index more transparent, allowing users to question inclusions and the relationships that they show. The phrasing of each indicator should be clear and understandable.
3. **Sizable contribution.** Finally, our indicators are selected due to the sizable contribution that they make to the overall level of capacity in a given nation. In this sense, we have aimed to include indicators that are widely referenced and considered on the basis of their significance. For example, the 'Number of Data Scientists/Engineers' is widely regarded in commentary as not only relevant and relatable as a means of measuring some nations' capacity, but it is also seen as making a significant contribution to that capacity.

The Global AI Index includes mainly quantitative data (e.g. the number of data scientists, artificial intelligence startups or GitHub commits). In a small number of cases, qualitative data is included (e.g. IPSOS "I do not trust artificial intelligence survey" response data) and is packaged as quantitative for comparability purposes.

Update for the Global AI Index 4.0

All changes made to the methodology for this fourth edition of the Index and rankings are detailed in this report.

Gross Capacity and Intensity

The Global AI Index has always been composed of both gross and proportional (per-capita) indicators. For many indicators, it is therefore possible to create both a gross, and a proportional score relative to population or national GDP. This has allowed us to compare nations of vastly different sizes, when considering capacity. This year we have presented the Index both as a combined score (i.e. featuring both combined, gross and proportional indicators) and as an intensity-only score. We believe it is worthwhile to highlight both the gross capacity for artificial intelligence according to our data, as well as the intensity - a measure in which many smaller nations will rise to the top.

Pillars and sub-pillars

This section shows the organisation of the sub-pillars and offers a justification for their inclusion in the Global AI Index, along with their constituent indicators. These justifications reflect our understanding of the interrelated factors that contribute to capacity on a national scale, knowing that the fast-changing processes of innovation and implementation in artificial intelligence will require constant re-examination.

Implementation Talent

Artificial intelligence is implemented by people. This refers to the everyday practitioners of artificial intelligence who are employed by the public and private sector to apply technology to specific problems. Capacity, therefore, is based substantially on the personnel able to deploy, manage and implement technology systems.

The geographical concentration of AI specialists, their movements, and the changing supply and demand for them across the field is the focus of the 'Talent' sub-pillar. The purpose of measuring talent is to define the level of capacity offered by human capital within a given nation.

Implementation Infrastructure

Reliable infrastructure from basic electricity and internet access, as well as super computing capabilities and deep databases are required to sustain the operationalisation of different artificial intelligence solutions, and increase AI adoption.

The baseline infrastructure needed to maintain and expand artificial intelligence initiatives includes a steady electricity supply and fast broadband speeds in cities, smaller towns and rural areas, while more advanced infrastructure includes supercomputing capacity.

Implementation Operating environment

Technologies thrive when the wider society approves of them. Countries should also focus on developing strong public information initiatives, trust, and recognition in the public sphere. Capacity results from a conducive operating environment.

The operating environment stands for political, social, legislative, economic, cultural and natural environmental factors that significantly affect the implementation of AI technologies. The 'Operating Environment' sub-pillar focuses on survey data indicating trust in artificial intelligence, the diversity of practitioners, visa processing and data governance as facilitating factors.

Innovation Research

Research and researchers generate new ideas in artificial intelligence. Capacity as a result of research is substantially based upon the level of activity amongst research communities and the extent to which they share and propagate ideas.

Measuring the level of research includes an assessment of the number of papers, and the citations, their impact according to the Computer Science H-Index, as well as attendance at conferences and contributions to IEEE journals, among others. The 'Research' sub-pillar is indicative of the advances in capability that contribute to capacity through new innovations.

Innovation Development

Innovation is demonstrated by the development of new techniques and advancements – especially in the field of artificial intelligence.

The 'Development' sub-pillar focuses on collaboration on open source artificial intelligence platforms, the ISO Artificial Intelligence Committee status, and several indicators describing the level of patentable innovation.

Investment Commercial ventures

Commercial ventures - businesses that are providing goods and services through the combination of financial and industrial aspects - are responsible for a large proportion of the implementation of artificial intelligence around the world. The scale, funding and volume of these businesses is a contributor to capacity.

The increases in productivity, efficiency and reliability that machine learning can provide are all significant enhancements to business performance in many sectors. The 'Commercial Ventures' sub-pillar is focused on the industrial environment surrounding artificial intelligence in a given country, analysing the number, scale and funding of ventures.

Investment Government strategy

Government strategies - often a collection of publications outlining approaches to digital transformation, innovation and artificial intelligence – detail commitments to invest and align interests in research communities.

The content, presentation and apparent urgency of these national strategies is the focus of the 'Government strategy' sub-pillar, with indicators measuring AI spending and targets.

Geographical scope

The rapid transformation of public and private sector activities by artificial intelligence is a global phenomenon. Whilst the pace of change is faster in some regions than others, the Global AI Index is global in scope. With the aim of including as many nations as possible whilst maintaining the robustness and relevance of the underlying dataset, the fourth edition of the Index includes 62 countries. These are: Argentina, Armenia, Australia, Austria, Bahrain, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Iceland, Ireland, Israel, Italy, Japan, Kenya, Lithuania, Luxembourg, Malaysia, Malta, Mexico, Morocco, Nigeria, Norway, New Zealand, Pakistan, Poland, Portugal, Qatar, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sri Lanka, Switzerland, Sweden, Taiwan, The Netherlands, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States of America, Uruguay, Vietnam.

In future editions we hope to expand the geographical scope of the Global AI Index to include more countries. This will deepen the comparative relevance of the GAII, and further acknowledge the role played by countries outside the global north and the OECD in the rise of artificial intelligence solutions.

We validated the list of nations included in the Index in discussion with experts, as well as through literature review. Beginning with countries that published stated initiatives related to artificial intelligence provided a basis for selecting countries with sufficient data available for ranking.

Missing values

Missing values represent approximately 5% of the collected dataset for the Global AI Index. There was a limited amount of data available with which to train an imputation model – although this was strongly considered as an option – and as such there are a variety of imputation techniques employed. Each indicator has been individually considered and one of the following strategies applied:

- **Imputation by zero** – used when data is not pre-defined but is the logical or necessary value. E.g. if the number of Kaggle Grandmasters is empty it is most likely because a country has never had one. For certain indicators where a lower score indicated better performance (e.g. Top Rank in H-Index table of Computer Science Academics), the "highest" (i.e. worst) score was imputed as zero would be.
- **Imputation by average value** – used when the variable in question is independent of a country's population size or GDP, placing the mean or median value in place of a missing value.
- **Imputation by last observation carried forward** – used when alternative data sources show only values from previous years. In some cases previous values are taken as indicators of a country's current state.
- **Imputation by model** – used in observation of obvious relationships between a country's demographics – population, GDP, employment rates, etc. In some cases it was necessary to build a generalised linear model to predict what value should be used.

- **Imputation by aggregated k-nearest neighbour** - used in the several cases where a model is inadequate, an average of all countries is not sensible or there are no previous values for an indicator. In these cases we implemented a K-Nearest Neighbours Regression model with k=3, in search of the most similar countries (using national econometric as independent variables) to impute the value.

Normalisation and data processing

To ensure that the data underlying the Index rankings is comparable, it was necessary to normalise each data point to a [0,1] scale. In the processing of this normalisation, it was occasionally necessary to transform the distribution of values. For example, a square root transformation is relevant if the higher end of the values for a particular indicator are having a disproportionate impact on the distribution and therefore the scoring.

The remaining variables were also normalised to comparable scales, but due to the distribution of the data, it was sometimes deemed necessary to transform the value (e.g. square/square root transformations) before normalising.

Many of the variables are treated in comparison to other values to ensure relevance and comparability.

Currency

When dealing with currency values, we have converted all values to USD so that they are comparable. As our values come from various time periods, we used an appropriate average for each country.

Temporal coverage

The Global AI Index uses the most recent available values when possible. All values carried forward are done so from no earlier than 2016, and a data-collection cut off from 2016 onwards was also enforced.

For the purposes of our analysis, we have also considered the temporal range for a 'Startup Company' to be 'foundation since 2016'.

Scoring and weighting methodology

A country's total score is made up of the weighted sum of its sub-pillar scores. The score for a sub-pillar is composed of the normalised weight of categories (or "sub-sub-pillars") within the sub-pillar. For example, the Implementation pillar breaks down into the Talent, Infrastructure and Operating Environment sub-pillars - the Talent sub-pillar then breaks down further into the Learning Platforms, GitHub Activity and Talent Pool categories.

This allows us to compare indicators within a given sub-pillar, such as Talent, rather than comparing all individual indicators separately. In the final presentation of the Index, the overall score and the score for each sub-pillar are normalised between 100 and the minimum original score. We have chosen to keep the minimum normalised score as the minimum original score rather than normalising to 0, as giving a country "0" in the overall or sub-pillar scores may inaccurately imply that there is no AI capacity or activity taking place in the country at all.

Weighting for relevance

Each indicator has been considered according to its relevance to the investment, innovation and implementation specific to artificial intelligence. Whilst we maintain that all inclusions in the Index can be justified by this relevance, it is important to reflect in the weightings that some factors are more closely related than others. Our assessment of relevance is based on the apparent connections between the indicator itself, and the overall change in artificial intelligence capacity. For example, we consider 'Existing Number of 'AI Professionals' to be a highly relevant factor in contributing to capacity – and are therefore heavily weighted in the 'Talent' sub-pillar of the Index. Whereas 'Percentage access to electricity' is considered a less relevant factor, whilst still being clearly connected to capacity. It is, therefore, less heavily weighted in the 'Infrastructure' sub-pillar of the Index.

Weighting for contribution

Each indicator has also been considered according to its contribution to overall capacity through investment, innovation and implementation. Again, we maintain that all inclusions make a contribution towards capacity in some way, but it is important to reflect that some factors contribute more heavily. For example, we consider 'Total funding of AI startups' to be a significant contributor to capacity – and therefore weigh this indicator more heavily than others. Whereas 'Proportion of Total Integrated Circuits Exports' is an indicator that highlights an important and relevant factor, but is not as great a contribution to capacity.

Weighting for comprehensiveness

Finally, each indicator is considered on the basis of the comprehensiveness of the source data-set from which it is drawn. Some sources are more complete than others – alongside the process of imputation for missing values – it is also necessary to account for the completeness of the data in the weighting system. In the case that data availability is limited, we have reduced the relative weight of the indicator. The degree of confidence that we have in the representativeness of the data means that we can weigh this factor more heavily.

Pillar	Weighting
Talent	15%
Infrastructure	11%
Operating Environment	6%
Research	26%

Development 14%

Government strategy 4%

Commercial ventures 24%

The purpose of weighting for comprehensiveness is to ensure that the overall scoring in the Global AI Index is, as far as possible, based upon reliable information; reducing the relative impact of more unreliable data on the rankings.

What is the effect of the weightings?

Each layer of the weighting system for the Global AI Index adds to the accuracy, completeness and explanatory value of the comparative rankings. It is intended to account for the fact that contributions to capacity for artificial intelligence take many different forms, and have varying degrees of impact at present and future levels. We recognise, however, that our weightings are based on subjective assumptions, and judgements applied in order to improve the coherence of the data. These subjective judgements affect the composite scoring for each company and therefore their position in the rankings.

Example weighting case

"Number of Data Scientists and Engineers" is gathered from LinkedIn returns. This means that the level of comprehensiveness is questionable; mostly due to the fact that many data engineers or equivalent may not be listed on LinkedIn or have sufficiently identified themselves as such. The weighting for comprehensiveness is therefore set at a 4. The contribution made by Data Scientists and Engineers to capacity for artificial intelligence is significant as artificial intelligence is a generic and multidisciplinary domain in many ways and so Data Engineers are able to work in collaboration with practitioners in many different sectors. For these reasons, the weighting for contribution is set at 5. Finally, the title 'Data Scientist/Engineer' is not specific to artificial intelligence, in that many data engineers work across a range of tasks that do not specifically involve artificial intelligence. However, Data Science & Engineering work is essential to the development of AI concerning the preparation and analysis of large datasets necessary for training Machine Learning and Large Language Models. The relevancy is therefore set at 4.

FAQs

Why have we built the Index?

Tortoise is fundamentally committed to data-driven news. We pursue a deep understanding of processes to inform our journalism and our conversation with members. We are also responding to the need amongst governments for a more comprehensive tool for identifying these processes. The Global AI Index is part of our investigation of artificial intelligence – recognising that it is one of the defining forces shaping our world today.

Why is it an index then? And not just a set of presentations of data?

At Tortoise we believe in the agenda setting power of indices. Not only do they allow for tracking of important processes through carefully selected metrics, but they also invoke repeated comparison. In future editions, and by refining our methodology in open discussion with our members, experts and any other interests we hope to base policy recommendations, stories and observations about artificial intelligence on relevant data. Comparison is key to this, highlighting factors that affect change in some places.

We see this journalistic intent as complementary to a further set of strengths of the index format; following a framework provided in the OECD review "Composite Indicators – A review Michaela Saisana Group of Applied Statistics Joint Research Centre European Commission"

- To summarise complex or multi-dimensional issues.
- To place countries' performance at the centre of the policy arena.
- To offer a rounded assessment of countries' performance.
- To enable judgments to be made on countries' efficiency.
- To facilitate communication with ordinary citizens.
- To be used for benchmarking countries of best performance.
- To indicate which countries represent the priority for improvement efforts.
- To stimulate the search for better data and better analytical efforts.
- To set local priorities, and to seek out improvements along dimensions of performance where gains are most readily secured.

How did you carefully select your metrics?

We selected our metrics through consultation with expert advisors, who helped us build an understanding of the development of artificial intelligence. Next, we conducted a careful investigation of available national strategies, highlighting the common features and deriving a list of indicators.

Why have you presented an index ranking on capacity?

Capacity is the concept we selected as an organisational tool, bringing together the many interconnected factors involved in developing and deploying artificial intelligence. It refers to the amount of artificial intelligence-related factors in a given nation. Capacity is also suitable given that the Index measures a range of inputs, outputs and outcomes – this is because capacity refers both to the present and potential level of development in the future.

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Indicators

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Coursera Data Science score	Implementation	Talent	The Coursera Global Skills Index score for machine learning	4	3	4	0.57
Stack Overflow Questions related to AI	Implementation	Talent	The total number of questions related to artificial intelligence posed on Stackoverflow, by users from a given country.	5	1	5	1.14
Stack Overflow Answers to AI related Questions	Implementation	Talent	The total number of answers to artificial intelligence related questions on Stackoverflow, by users from a given country.	5	1	5	1.14
Stack Overflow Questions related to AI per capita	Implementation	Talent	The number of questions related to artificial intelligence posed on Stackoverflow, by users from a given country per capita	5	1	5	0.57
Stack Overflow Answers to AI related Questions per capita	Implementation	Talent	The number of answers to artificial intelligence related questions on Stackoverflow, by users from a given country per capita	5	1	5	0.57
Github Commits	Implementation	Talent	The total number of all GitHub Commits to public AI-related project repositories in a given country.	5	3	4	1.37
Github Commits per capita	Implementation	Talent	The total number of all GitHub Commits to public AI-related project repositories in a given country per capita	5	2	4	0.63
Number of IT Graduates per capita	Implementation	Talent	The total number of IT Graduates, in a given country per capita.	1	3	2	0.45
Number of STEM Graduates per capita	Implementation	Talent	The total number of STEM Graduates, in a given country per capita	2	3	2	0.52
Number of IT Graduates	Implementation	Talent	The total number of IT Graduates, in a given country	1	3	2	0.9
Number of STEM Graduates	Implementation	Talent	The total number of STEM Graduates, in a given country	2	3	2	1.05
Existing number of Data Scientists and Engineers	Implementation	Talent	The total number of people currently describing themselves as a Data Scientist or Engineer in a given country	4	5	4	1.95
Number of Data Scientists and Engineers per capita	Implementation	Talent	The total number of people currently describing themselves as a Data Scientist or Engineer in a given country per capita	4	5	4	0.97
Existing number of AI professionals	Implementation	Talent	The total number of people who describe themselves as currently working as an “Engineer”, “Researcher” or “Scientist” in the fields of AI, Machine Learning, Deep Learning, Computer Vision, Natural Language Processing or Robotics on Linkedin, in a given country.	5	5	4	2.1
Number of AI professionals per capita	Implementation	Talent	The total number of people who describe themselves working as an “Engineer”, “Researcher” or “Scientist” in the fields of AI, Machine Learning, Deep Learning, Computer Vision, Natural Language Processing or Robotics Linkedin per capita.	5	5	4	1.05
Number of researchers	Innovation	Research	The total number of full-time-equivalent jobs as researchers in STEM, in a given country.	4	4	3	0.84
Number of researchers per capita	Innovation	Research	The number of full-time-equivalent jobs as researchers in STEM, in a given country per capita	4	4	3	0.42
Max Rank on H-Index	Innovation	Research	The highest rank reached by a contributor from a given country on the Computer Science H-Index of top 1000 CS academics.	3	3	2	0.3

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Proportional R&D Spend	Innovation	Research	The total amount of public spending, proportional to the total GDP in that country, spent annually on research and development.	3	5	5	0.49
Total R&D Spend	Innovation	Research	The total amount of public spending spent annually on research and development.	3	5	5	0.99
Number of Significant Machine Learning Systems	Innovation	Research	The total number of Significant Machine Learning Systems developed within a Country	5	4	4	0.99
Number of Significant Machine Learning Systems per capita	Innovation	Research	The total number of Significant Machine Learning Systems developed within a country by capita	5	4	4	0.49
Number of Authors of Significant Machine Learning Systems by	Innovation	Research	The total number of authors of Significant Machine Learning Systems by Country	5	4	4	0.99
Number of Authors of Significant Machine Learning Systems per capita	Innovation	Research	The total number of authors of Significant Machine Learning Systems by Country, per capita	5	4	4	0.49
Number of Paper Citations	Innovation	Research	The total number of citations received by top 'CS academics'.	2	5	4	1.83
Number of Paper Citations per capita	Innovation	Research	The total number of citations received by top 'CS academics' per capita	2	5	4	0.92
Number of AI Articles	Innovation	Research	The total number of academic articles published by top 'CS academics' in a given country	3	5	1	1.5
Number of AI Articles per capita	Innovation	Research	The total number of academic articles published by top 'CS academics' in a given country per capita	3	5	1	0.75
Number of Submissions to AI Conferences	Innovation	Research	The number of contributors, from a given country, accepted at established Artificial Intelligence Conferences.	5	5	4	2.33
Number of Submissions to AI Conferences	Innovation	Research	The number of contributors, from a given country, accepted at established Artificial Intelligence Conferences per capita	5	5	4	1.17
Number of AI Related Papers	Innovation	Research	The cumulative number of "AI" related research articles and papers per country.	4	5	4	2.17
Number of AI Related Papers Per Capita	Innovation	Research	The cumulative number of "AI" related research articles and paper per country per capita	4	5	4	1.08
Number of Citations on AI Related Papers	Innovation	Research	The cumulative number of citations on "AI" related research articles and papers per country.	4	5	4	2.17
Number of Citations on AI Related Papers Per Capita	Innovation	Research	The cumulative number of citations on "AI" related research articles and papers per capita, per country.	4	5	4	1.08
Number of Universities in Times Higher Education Top 100 Computer Science Universities	Innovation	Research	The number of Universities in the Top 100 of the Times Higher Education Computer Science, in a given country.	5	5	4	3.33

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Number of Universities in Times Higher Education Top 100 Computer Science Universities per capita	Innovation	Research	The number of Universities in the Top 100 of the Times Higher Education Computer Science, in a given country per capita	5	5	4	1.67
Proportion of Population that Trusts AI	Implementation	Operating Environment	The share of people, from a given country, who answered: "Yes" to the question: "Do you trust AI?"	5	3	3	0.5
Proportion of Population who think AI is more helpful than harmful	Implementation	Operating Environment	The share of people who, when asked whether "Artificial Intelligence Will Help or Harm People in Next 20 Years" answered "Mostly help"	5	3	3	0.5
Cost of Visa	Implementation	Operating Environment	The cost in USD ($) of getting the fastest visa processing for high-skilled tech workers	2	4	3	1.5
Super computers per capita" with "Number of Large Non-Distributed Super Computers per capita	Implementation	Infrastructure	The number of Top Supercomputers, according to Top500, in a given country.	3	5	5	1.33
Super computers	Implementation	Infrastructure	The number of Top Supercomputers, according to Top500, in a given country per capita	3	5	5	0.67
Total flops of Large Non-Distributed Super Computers per Capita	Implementation	Infrastructure	The total combined Petaflops of the Top Supercomputers, according to Top500, in a given country.	3	5	5	1.33
Total flops of Large Non-Distributed Super Computers per Capita	Implementation	Infrastructure	The total combined Petaflops of Top Supercomputers, according to Top500, in a given country by capita	3	5	5	0.67
Total Integrated Circuits Imports	Implementation	Infrastructure	Total global imports of Integrated Circuits by country.	3	2	4	0.38
Total Integrated Circuits Imports proportional to GDP	Implementation	Infrastructure	Total global imports of Integrated Circuits by country proportional to GDP.	3	2	4	0.19
Proportion of Total Integrated Circuits Exports	Implementation	Infrastructure	Total global exports of Integrated Circuits by country.	1	2	4	0.29
Proportion of Total Integrated Circuits Exports proportional to GDP	Implementation	Infrastructure	Total global imports of Integrated Circuits by country proportional to GDP	1	2	4	0.15
Average Download Speed	Implementation	Infrastructure	The average monthly download speed by country.	3	5	4	1.41
Proportion of Population using Internet	Implementation	Infrastructure	The proportion of the total population with access to the internet.	5	5	5	1.76
Proportion of Population with Access to Electricity	Implementation	Infrastructure	The proportion of the total population with access to electricity.	5	5	5	1.76

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Mobile Penetration Rate per 100 persons	Implementation	Infrastructure	The total number of mobile subscriptions per 100 people in a given country.	2	3	4	1.06
Dedicated Spending on Artificial Intelligence	Investment	Government Strategy	The amount of dedicated investment on artificial intelligence by government in a given nation.	5	5	5	0.52
Dedicated Spending on Artificial Intelligence proportional to GDP	Investment	Government Strategy	The amount of dedicated investment on artificial intelligence by government in a given country, proportional to that country's GDP.	5	5	3	0.22
Spend Period of Dedicated AI Budgets	Investment	Government Strategy	The length of time, in years, that is identified as a specific spending window in which the government will commit funding to building capacity for artificial intelligence.	5	5	5	0.26
Time Scale of Dedicated Strategy	Investment	Government Strategy	The total length of time, in years, of the national strategy for a given country.	5	2	4	0.25
Government has Dedicated AI Strategy	Investment	Government Strategy	A categorical indicator of whether a country has drafted or published a specific, dedicated artificial intelligence strategy report.	5	3	5	0.3
Government has Dedicated AI Minister	Investment	Government Strategy	A binary indicator of whether a country has a specific ministry, and ministerial head, dedicated to implementing 'artificial intelligence' in the public sector and beyond. In this case, a 'Dedicated AI Minister' is identified as distinct from other Digital, and Technology Ministers.	2	2	5	0.21
Government has Dedicated AI governmental body	Investment	Government Strategy	A binary indicator showing whether or not a country's government has a dedicated body, or working group, on addressing the national-level requirements for building capacity in artificial intelligence.	5	2	5	0.28
Government has Publically Dedicated Money to AI	Investment	Government Strategy	A binary indicator of whether a country has committed specific funding towards building capacity in artificial intelligence.	5	5	5	0.35
Government has Measurable AI Targets	Investment	Government Strategy	A binary indicator of whether a country has measurable Targets and KPI's for the advancement of their artificial intelligence strategies.	5	3	5	0.3
Tracking of Previous Years efforts on AI	Investment	Government Strategy	A binary indicator on whether or not a country's government has created tracking mechanisms to keep abreast of progress on their artificial intelligence strategy.	5	3	5	0.3
Dedicated Strategy received External Consultation	Investment	Government Strategy	A binary indicator showing whether or not a country's government strategy in 'Artificial Intelligence' has received external consultation from academic, business executives or other specialists external to government.	5	4	5	0.32
Dedicated Strategy mentions Training or upskilling	Investment	Government Strategy	A binary indicator of whether a country's National AI Strategy mentions training or upskilling of the public through dedicated initiatives.	5	5	5	0.35
Dedicated Strategy was Signed by Senior Member of Government	Investment	Government Strategy	This indicator shows whether the national AI strategy in a given country has received sign-off from a senior member of government. 0 for no signoff, 1 for signoff from a minister, and 2 for signoff from a head of state or equivalent.	5	5	5	0.35

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Commits on High-Popularity Open Source AI Packages	Innovation	Development	The total number of commits to the most widely developed open source AI packages from Github	5	4	4	2.67
Commits on High-Popularity Open Source AI Packages per capita	Innovation	Development	The total number of commits to the most widey developed open source AI packages from Github per capita.	5	4	4	1.33
Number of Filed AI Patents by applicant	Innovation	Development	Number of patents relating to AI filed by applicants from a given country since 2017.	5	2	3	1.37
Number of Filed AI Patents by inventor	Innovation	Development	Number of patents relating to AI filed by inventors from a given country since 2017	5	3	3	1.51
Number of Granted AI Patents by applicant	Innovation	Development	Number of patents relating to AI granted to applicants since 2017.	5	4	4	1.78
Number of Granted AI Patents by inventor	Innovation	Development	Number of patents relating to AI granted, by inventor since 2017.	5	5	4	1.92
Number of Filed 'AI Patents' by applicant per capita	Innovation	Development	Number of filed patents relating to AI filed by applicants from each countryper capita.	5	2	4	0.75
Number of Filed 'AI Patents' by inventor per capita	Innovation	Development	Number of patents relating to AI filed by inventors from each country per capita.	5	3	4	0.82
Granted patents by applicants per capita	Innovation	Development	Number of patents relating to AI granted to applicants from each country as a share of the population.	5	4	4	0.89
Granted patents by inventors per capita	Innovation	Development	Number of patents relating to AI granted to inventors from each country as a share of the population.	5	5	4	0.96
Businesses using Artificial Intelligence	Investment	Commercial	Percentage of Businesses reporting the use of AI in their business operations	5	5	3	1.6
Total Funding of AI Companies	Investment	Commercial	The total sum of all funding rounds to 'AI companies'.	5	5	3	3.19
Total Funding of AI Companies proportional to GDP	Investment	Commercial	The average amount of funding per 'AI company' in a given country, proportional to GDP in that country.	5	3	3	1.35
Number of AI Companies	Investment	Commercial	The estimated total number of companies in a given country implementing artificial intelligence as a key part of their business process.	5	5	3	3.19
Number of AI Companies per capita	Investment	Commercial	The estimated total number of companies in a given country implementing artificial intelligence as a key part of their business process, per capita.	5	3	3	1.35
Average Funding of AI Company	Investment	Commercial	The average amount of funding per 'AI company' in a given country.	3	1	3	0.86
Number of Listed AI Companies	Investment	Commercial	The total number of 'AI companies' from a given country that are listed on a stock exchange, either in that country or elsewhere in the world.	5	2	3	1.23

Indicator Name	Pillar	Sub Pillar	Short descriptions	Relevance	Contribution	Reliability	Overall Weight
Number of AI Companies on Country's Stock Exchange	Investment	Commercial	The total number of Initial Public Offerings (IPOs) of 'AI companies' on a country's stock exchange.	5	2	3	1.23
Total Funding of AI Startups	Investment	Commercial	The sum of all funding rounds to 'AI startups' in a given country.	5	5	3	2.6
Total Funding of AI Startups proportional to GDP	Investment	Commercial	The sum of all funding rounds to 'AI startups' in a given country proportional to GDP	5	5	3	1.3
Number of AI Startups	Investment	Commercial	The estimated total number of 'AI startups' in a given country.	5	5	3	2.6
Number of AI Startups per capita	Investment	Commercial	The estimated total number of 'AI startups' in a given country per capita	5	3	3	1.1
Average Startup Funding	Investment	Commercial	The average amount of funding per 'AI startup' in a given country.	5	3	3	1.1
Number of AI Unicorns	Investment	Commercial	The total number of companies valued at over 1 Billion (USD $) in a given country.	5	4	4	1.3
Gender Diversity of Science Graduates	Implementation	Operating Environment	The share of Science graduates, from a given country, that identify as female.	3	3	3	0.5
Gender Diversity of IT Graduates	Implementation	Operating Environment	The share of IT graduates, from a given country, that identify as female.	3	3	3	0.5
Level of Data Protection Regulation	Implementation	Operating Environment	The level of data privacy legislation in a country including GDPR equivalent, full legislation, draft legislation or no legislation.	3	5	5	0.58
Presence of Right to Explanation	Implementation	Operating Environment	Whether a country has agreed to a stipulation of the right to an explanation of decisions made predominantly using artificial intelligence.	3	2	2	0.31
Open Data Charter	Implementation	Operating Environment	A binary indicator of whether a country has signed The International Open Data Charter, or is a G20 country with the same responsibilities.	3	3	4	0.44
Kapersky Cybersecurity Score	Implementation	Operating Environment	The score for a given country on the Cybersecurity Index, based largely on data from cybersecurity company Kaspersky.	2	2	3	0.5
Level of Participation of ISO AI Committee	Implementation	Operating Environment	The status of a given country as to whether it is participating, observing or not involved with the ISO's Standards Committee Dedicated to Artificial Intelligence.	5	5	5	0.67

In addition, we used 16 econometric indicators taken from the World Bank, Unesco and the Economist Group in our modelling for imputing missing values.