

ANNEX A: LIST OF AI-ENABLING PRODUCTS AND ECONOMIC SECTORS

Annex A.1: Non-exhaustive list of AI-enabling products

HS Code	HS Description	Explanation	Type
280461	Silicon; containing by weight not less than 99.99% of silicon	Key raw material for making insulating layers in transistors and integrated circuits.	Raw materials
280421	Gases, rare; argon	Argon cleans metals, prevents oxidation, and enables non-reactive etching and deposition.	Raw materials
280429	Gases, rare; other than argon	Critical raw materials used in semiconductor manufacturing, often as a cleaning or reducing agent.	Raw materials
280440	Oxygen	Ultra-high purity oxygen is a critical raw material acting as an oxidizing agent in processes such as silicon layer deposition, etching and reactive gas neutralization.	Raw materials
711021	Metals; palladium, unwrought or in powder form	Key raw material for catalysts and components in AI hardware manufacturing.	Raw materials
281111	Hydrogen fluoride (hydrofluoric acid)	Specialty chemical used for cleaning and etching silicon wafers, removing silicon dioxide and preparing surfaces for further processing.	Processed chemicals
290919	Ethers; acyclic, and their halogenated, sulphonated, nitrated or nitrosated derivatives, other than diethyl ether	Solvents used in semiconductor manufacturing, including photoresist formulations and cleaning agents.	Processed chemicals
292990	Nitrogen-function compounds; n.e.c. in chapter 29, excluding isocyanates	A specialty chemical used in semiconductor manufacturing, often for deposition or etching processes.	Processed chemicals
280469	Silicon; containing by weight less than 99.99% of silicon	Essential raw material in AI semiconductor manufacturing with slightly lower silicon purity.	Processed chemicals
281119	Inorganic acids; other than hydrogen fluoride	Specialty chemical used for etching polysilicon to create fine grooves and holes on silicon wafers for electronic circuits.	Processed chemicals
281122	Silicon dioxide	Essential for AI chip manufacturing as a key insulating and protective material in semiconductors.	Processed chemicals
281129	Inorganic oxygen compounds; of non-metals, n.e.c. in item no. 2811.2	A specialty chemical used in semiconductor manufacturing, often for deposition or etching processes.	Processed chemicals

HS Code	HS Description	Explanation	Type
282560	Germanium oxides and zirconium dioxide	Used in AI semiconductor manufacturing for enhancing optical and electronic properties of devices.	Processed chemicals
284920	Carbides; of silicon, whether or not chemically defined	Essential in AI semiconductor production for creating durable, high-performance components.	Processed chemicals
285000	Hydrides, nitrides, azides, silicides and borides, whether or not chemically defined, other than compounds which are also carbides of heading no. 2849	Key chemicals for AI semiconductor fabrication, enabling advanced material properties and device performance.	Processed chemicals
391000	Silicones; in primary forms	Essential materials in AI chip manufacturing for insulation and protection.	Processed chemicals
711029	Metals; palladium, semi-manufactured	Essential intermediate for manufacturing AI hardware components and catalysts.	Processed chemicals
811292	Gallium, germanium, indium, niobium (columbium) and vanadium; articles thereof, unwrought, including waste and scrap, powders	Critical intermediate metals and powders for AI semiconductor manufacturing.	Processed chemicals
811299	Gallium, germanium, indium, niobium (columbium) and vanadium; articles thereof, other than unwrought including waste and scrap and powders	Processed metals and articles essential for AI semiconductor device fabrication.	Processed chemicals
847330	Machinery; parts and accessories (other than covers, carrying cases and the like) of the machines of heading no. 8471	Computer components and testing equipment – such as evaluation kits, graphics cards, memory modules, and cooling systems – for building, optimizing and validating AI hardware performance.	Intermediate inputs
852351	Semiconductor media; solid-state non-volatile storage devices, whether or not recorded, excluding products of Chapter 37	Inputs for AI systems as they provide the data storage and retrieval capabilities needed for training, running and storing AI models and datasets.	Intermediate inputs
853630	Electrical apparatus: for protecting electrical circuits, not elsewhere classified in heading no. 8536, for a voltage not exceeding 1000 volts	Circuit protection devices ensuring the safe and stable operation of AI hardware systems such as servers and data centres.	Intermediate inputs
853650	Electrical apparatus: switches not elsewhere classified in heading no. 8536, for a voltage not exceeding 1000 volts	Switches used to control electrical signals essential components in AI hardware for managing data flow and system operations.	Intermediate inputs
853669	Electrical apparatus; plugs and sockets, for a voltage not exceeding 1000 volts	Sockets for semiconductor load boards used for testing purposes.	Intermediate inputs
854110	Electrical apparatus; diodes, other than photosensitive or light-emitting diodes (LED)	Used in printed circuit board assemblies.	Intermediate inputs

HS Code	HS Description	Explanation	Type
854160	Crystals; mounted piezo-electric	Mounted piezoelectric crystals used in AI hardware for sensing, signal processing and precision control functions.	Intermediate inputs
854190	Electrical apparatus; parts for diodes, transistors and similar semiconductor devices and photosensitive semiconductor devices	Processed wafers serving as the foundation for manufacturing integrated circuits and microchips.	Intermediate inputs
854231	Processors and controllers, whether or not combined with memories, converters, logic circuits, amplifiers, clock and timing circuits, or other circuits	Essential components enabling data processing and computation in AI systems	Intermediate inputs
854239	Electronic integrated circuits; n.e.c. in heading no. 8542	Essential components in AI hardware for data storage, processing, and communication functions.	Intermediate inputs
854442	Insulated electric conductors; for a voltage not exceeding 1000 volts, fitted with connectors	Critical inputs for semiconductor equipment maintenance.	Intermediate inputs
854449	Insulated electric conductors; for a voltage not exceeding 1000 volts, not fitted with connectors	Critical inputs for semiconductor equipment maintenance.	Intermediate inputs
900110	Optical fibres, optical fibre bundles and cables	Inputs used for high-speed data transmission in AI data centres and communication infrastructure.	Intermediate inputs
903084	Other, with a recording device	Various equipment or tools needed for measuring or checking semiconductor wafers or devices.	Intermediate inputs
320820	Paints and varnishes; based on acrylic or vinyl polymers, dispersed or dissolved in a non-aqueous medium	Specialty coatings for equipment used in wafer cleaning, etching and rinsing.	Intermediate inputs
320890	Paints and varnishes; based on polymers n.e.c. in heading no. 3208, dispersed or dissolved in a non-aqueous medium	Specialty coatings for equipment used in wafer cleaning, etching and rinsing.	Intermediate inputs
340590	Polishes, creams and similar preparations; n.e.c. in heading no. 3405, excluding waxes of heading no. 3404	Specialty coatings for equipment used in wafer cleaning, etching and rinsing.	Intermediate inputs
370199	Photographic plates and film; (for other than colour photography), in the flat, sensitised, unexposed, with no side exceeding 255mm, of any material other than paper, paperboard or textiles	Photomask blanks used to transfer circuit patterns onto silicon wafers.	Intermediate inputs
370790	Photographic goods; chemical preparations other than sensitised emulsions, put up in measured portions or put up for retail sale in a form ready for use	Photoresists and related materials used in photolithography to create patterned coatings for transferring circuit designs onto silicon wafers.	Intermediate inputs

HS Code	HS Description	Explanation	Type
381800	Chemical elements; doped for use in electronics, in the form of discs, wafers or similar forms; chemical compounds doped for use in electronics	Silicon wafers.	Intermediate inputs
392310	Plastics; boxes, cases, crates and similar articles for the conveyance or packing of goods	Plastic trays and containers used for handling and protecting semiconductor components during manufacturing and testing.	Intermediate inputs
392390	Plastics; articles for the conveyance or packing of goods n.e.c. in heading no. 3923	Packaging supplies for semiconductors.	Intermediate inputs
392690	Plastics; other articles n.e.c. in chapter 39	Packaging supplies for semiconductors.	Intermediate inputs
401693	Rubber; vulcanised (other than hard rubber), gaskets, washers and other seals, of non-cellular rubber	Packaging supplies for semiconductors.	Intermediate inputs
401699	Rubber; vulcanised (other than hard rubber), articles n.e.c. in heading no. 4016, of non-cellular rubber	Packaging supplies for semiconductors.	Intermediate inputs
621143	Track suits and other garments n.e.c.; women's or girls', of man-made fibres (not knitted or crocheted)	Cleanroom garments that prevent contamination and maintain a controlled environment to ensure high-quality semiconductor manufacturing.	Intermediate inputs
680421	Millstones, grindstones, grinding wheels and the like; of agglomerated synthetic or natural diamond	Diamond dresser discs used to condition and restore polishing pads and ensure uniform surface profiles.	Intermediate inputs
690912	Ceramic wares; for laboratory, chemical or other technical uses, articles having a hardness equivalent to 9 or more on the Mohs scale	Ceramic Semiconductor Production Components/Parts that have high strength, thermal, and electrical insulation and corrosion resistance.	Intermediate inputs
702000	Glass; articles n.e.c. in chapter 70	Quartz components such as reactor tubes and holders used in semiconductor manufacturing for thermal processing and maintaining clean environments.	Intermediate inputs
841350	Pumps; reciprocating positive displacement pumps, n.e.c. in heading no. 8413, for liquids	Pumps essential for handling fluids like corrosive chemicals and ultra-pure water in semiconductor manufacturing.	Intermediate inputs
841410	Pumps; vacuum	Pumps crucial for vacuum creation and gas handling in deposition and etching processes.	Intermediate inputs
841459	Fans; n.e.c. in item no. 8414.51	Fans and compressors essential for cooling, cleanroom control and maintaining semiconductor process purity.	Intermediate inputs

HS Code	HS Description	Explanation	Type
841480	Pumps and compressors; for air, vacuum or gas, n.e.c. in heading no. 8414	Compressors and vacuum pumps used in semiconductor manufacturing to maintain cleanroom conditions, control gases and support critical processes like etching and deposition.	Intermediate inputs
841490	Pumps and compressors; parts, of air or vacuum pumps, air or other gas compressors and fans, ventilating or recycling hoods incorporating a fan	Parts of compressors and vacuum pumps used in semiconductor manufacturing to maintain cleanroom conditions, control gases and support critical processes like etching and deposition.	Intermediate inputs
841950	Heat exchange units; not used for domestic purposes	Heaters essential for controlled temperature processes in semiconductor manufacturing, such as wafer processing and thin-film deposition.	Intermediate inputs
841989	Machinery, plant and laboratory equipment; for treating materials by change of temperature, other than for making hot drinks or cooking or heating food	Specialized heating or cooling equipment used in semiconductor manufacturing processes requiring precise thermal control.	Intermediate inputs
842121	Machinery; for filtering or purifying water	Water purification systems essential for maintaining ultra-clean environments in semiconductor manufacturing.	Intermediate inputs
842129	Machinery; for filtering or purifying liquids, n.e.c. in item no. 8421.2	Filtration systems used to purify specialty chemicals and process fluids critical for semiconductor fabrication.	Intermediate inputs
842139	Machinery; for filtering or purifying gases, other than intake air filters, catalytic converters or particulate filters for internal combustion engines	Gas filtration systems essential for ensuring the purity of process gases in semiconductor manufacturing environments.	Intermediate inputs
844391	Printing machinery used for printing by means of plates, cylinders and other printing components of heading 8442; parts and accessories	Include heatsink – device attached to a heat-generating component to prevent overheating.	Intermediate inputs
847160	Units of automatic data processing machines; input or output units, whether or not containing storage units in the same housing	Input/output units critical for connecting and controlling AI and semiconductor devices during data processing and testing.	Intermediate inputs
847180	Units of automatic data processing machines; n.e.c. in item no. 8471.50, 8471.60 or 8471.70	Specialized data processing units essential for AI computation, control and processing tasks in semiconductor manufacturing and AI systems.	Intermediate inputs
847950	Machinery and mechanical appliances; industrial robots, n.e.c. or included	Robots that automate certain tasks to increase efficiency in semiconductor manufacturing.	Intermediate inputs
848180	Taps, cocks, valves and similar appliances; for pipes, boiler shells, tanks, vats or the like, including thermostatically controlled valves	Valves for controlling fluids in precise, corrosive, or semiconductor manufacturing processes.	Intermediate inputs

HS Code	HS Description	Explanation	Type
848190	Taps, cocks, valves and similar appliances; parts thereof	Parts of valves used to control the flow of liquids and gases in various semiconductor manufacturing processes.	Intermediate inputs
848640	Machines and apparatus of a kind used solely or principally for the manufacture or repair of masks and reticles, assembling semiconductor devices or electronic integrated circuits, or for lifting, handling, loading or unloading items of heading 8486	Equipment for processing semiconductor wafers, such as photolithography tools and wafer cleaning systems.	Intermediate inputs
848690	Machines and apparatus of heading 8486; parts and accessories	Parts and accessories for semiconductor manufacturing tools, including pellicles that protect photomasks during lithography.	Intermediate inputs
850132	Electric motors and generators; DC, of an output exceeding 750W but not exceeding 75kW	Motors used in the automation of semiconductor manufacturing processes such as wafer handling and positioning.	Intermediate inputs
850432	Transformers; n.e.c. in item no. 8504.2, having a power handling capacity exceeding 1kVA but not exceeding 16kVA	Power supplies used to power various semiconductor manufacturing equipment.	Intermediate inputs
850440	Electrical static converters	Power supplies used to power various semiconductor manufacturing equipment.	Intermediate inputs
853400	Circuits; printed	Used in printed circuit board assemblies.	Intermediate inputs
853690	Electrical apparatus: not elsewhere classified in heading no. 8536, for switching or protecting electrical circuits, for a voltage not exceeding 1000 volts	Electrical apparatus for switching or protecting electrical circuits, essential for controlling semiconductor equipment and ensuring operational safety.	Intermediate inputs
853710	Boards, panels, consoles, desks and other bases; for electric control or the distribution of electricity, (other than switching apparatus of heading no. 8517), for a voltage not exceeding 1000 volts	PCB assemblies serve as the foundation for mounting and connecting various semiconductor components.	Intermediate inputs
853810	Electrical apparatus: parts (e.g. boards, panels, consoles, desks, cabinets, other bases), for goods of heading no. 8537, not equipped with their apparatus	Lighting and signalling devices essential for AI hardware systems.	Intermediate inputs
854121	Electrical apparatus; transistors, (other than photosensitive), with a dissipation rate of less than 1W	Transistors that enable AI chip processing and computations.	Intermediate inputs
854129	Electrical apparatus; transistors, (other than photosensitive), with a dissipation rate of 1W or more	Semiconductor switches used in AI circuits for signal control.	Intermediate inputs

HS Code	HS Description	Explanation	Type
854130	Electrical apparatus; thyristors, diacs and triacs, other than photosensitive devices	LEDs used in AI device displays and indicators.	Intermediate inputs
854151	Electrical apparatus; photosensitive semiconductor devices, semiconductor-based transducers	Photovoltaic cells supporting energy needs in AI sensors.	Intermediate inputs
854159	Electrical apparatus; photosensitive semiconductor devices n.e.c. in heading no. 8541	Photosensitive semiconductors for AI vision and sensing.	Intermediate inputs
854232	Electronic integrated circuits; memories	Integrated circuits powering AI processors and memory.	Intermediate inputs
854233	Electronic integrated circuits; amplifiers	Specialized integrated circuits for AI applications.	Intermediate inputs
854290	Parts of electronic integrated circuits	Miscellaneous semiconductor components used in AI hardware.	Intermediate inputs
854390	Electrical machines and apparatus; parts of the electrical goods of heading no. 8543	Critical inputs for semiconductor equipment maintenance.	Intermediate inputs
854420	Insulated electric conductors; co-axial cable and other co-axial electric conductors	Critical inputs for semiconductor equipment maintenance.	Intermediate inputs
854470	Insulated electric conductors: optical fibre cables	Electronic capacitors critical for AI circuit performance and stability.	Intermediate inputs
854710	Insulating fittings; of ceramics, for electrical machines, of insulating material only (except minor assembly parts), excluding those of heading no. 8546	Insulating fitting for semiconductor production equipment/tool.	Intermediate inputs
854790	Insulating fittings; (other than of ceramics or plastics), for electrical machines, appliances and equipment, excluding insulators of heading no. 8546	Insulating fitting for semiconductor production equipment/tool.	Intermediate inputs
902519	Thermometers and pyrometers; (other than liquid filled, for direct reading), not combined with other instruments	Crucial for monitoring and controlling semiconductor manufacturing processes such as thin film deposition, annealing and lithography.	Intermediate inputs
902620	Instruments and apparatus; for measuring or checking pressure	Instruments that control the flow and distribution of ultra-high purity gases and liquids used for semiconductor manufacturing.	Intermediate inputs
902730	Spectrometers, spectrophotometers and spectrographs; using optical radiations (UV, visible, IR)	Used for process monitoring and material analysis in semiconductor manufacturing.	Intermediate inputs

HS Code	HS Description	Explanation	Type
903090	Instruments, apparatus for measuring, checking electrical quantities, not meters of heading no. 9028; parts and accessories, for measuring or detecting alpha, beta, gamma, x-ray, cosmic and other radiations	Evaluation kits/boards used for testing performance and functionality.	Intermediate inputs
960350	Brushes; constituting parts of machines, appliances or vehicles	Chemical mechanical polishing brushes for cleaning and slurry distribution.	Intermediate inputs
847149	Automatic data processing machines; presented in the form of systems, n.e.c. in item no. 8471.30 or 8471.41	Tools and equipment used for the design, verification, optimization, debugging and testing of semiconductors.	Equipment
847150	Units of automatic data processing machines; processing units other than those of item no. 8471.41 or 8471.49, whether or not containing in the same housing one or two of the following types of unit: storage units, input units or output units	Tools and equipment used for the design, verification, optimization, debugging and testing of semiconductors.	Equipment
847170	Units of automatic data processing machines; storage units	Data storage units required to handle the massive datasets and model outputs used in AI training and inference processes	Equipment
847989	Machines and mechanical appliances; having individual functions, n.e.c. or included in this chapter	Machines often used in AI hardware manufacturing and integration to support the assembly, testing or deployment of AI-enabled equipment.	Equipment
848620	Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor devices or of electronic integrated circuits	Highly specialized equipment for producing the semiconductor chips that power AI hardware.	Equipment
903040	Instruments and apparatus; specially designed for telecommunications (e.g. cross-talk meters, gain measuring instruments, distortion factor meters, psophometers)	Tools and equipment used for the design, verification, optimization, debugging and testing of semiconductors.	Equipment
903082	Instruments and apparatus; for measuring or checking semiconductor wafers or devices (including integrated circuits)	Various equipment or tools needed for measuring or checking semiconductor wafers or devices.	Equipment
903141	Optical instruments and appliances; for inspecting semiconductor wafers or devices or for inspecting photomasks or reticles used in manufacturing semiconductor devices, n.e.c. in chapter 90	System level test equipment to test the operation of semiconductors in final user environments.	Equipment

HS Code	HS Description	Explanation	Type
847130	Automatic data processing machines; portable, weighing not more than 10kg, consisting of at least a central processing unit, a keyboard and a display	Devices serving as platforms for developing, testing or running lightweight AI models locally, and accessing AI tools and performing computations.	Equipment
847141	Automatic data processing machines; comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined, n.e.c. in item no. 8471.30	Systems used for training, developing or deploying AI applications.	Equipment
848610	Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers	Machines for making semiconductor wafers, essential for producing AI chips like GPUs and accelerators.	Equipment
851762	Communication apparatus (excluding telephone sets or base stations); machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus	Essential machines for AI systems that rely on high-speed data exchange, cloud computing and connected devices.	Equipment
851769	Communication apparatus (excluding telephone sets or base stations); machines for the transmission or reception of voice, images or other data (including wired/wireless networks), n.e.c. in item no. 8517.6	Other communication devices supporting AI applications.	Equipment

Source: WTO Secretariat compilation. The list of AI-enabling raw materials and chemical elements is based on Baskaran and Schwartz (2024). The list of AI-enabling semiconductors and intermediate inputs is based on comments submitted by the Semiconductor Industry Association (SIA) as part of the Section 232 investigation on semiconductors (SIA, 2025). More detailed HS codes have been aggregated to the sub-heading six-digit level.

Note: n.e.c. stands for “not elsewhere classified”.

Annex A.2: List of sectors by AI intensity

Sector	Industry (ISIC Rev.4)	AI intensity – summary indicator
Computer & electronics	26	High
Media	58-60	High
Telecommunications	61	High
IT services	62-63	High
Finance & insurance	64-66	High
Legal & accounting	69-71	High
Scientific R&D	72	High
Chemicals	20	Medium
Pharmaceuticals	21	Medium
Electrical equipment	27	Medium
Machinery & equipment	28	Medium
Transport equipment	29-30	Medium
Other manufactures	31-33	Medium
Wholesale & retail	45-47	Medium
Transportation & storage	49-53	Medium
Real estate	68	Medium
Other business services	73-75	Medium
Admin. & support services	77-82	Medium
Food products	10-12	Low
Textiles & apparel	13-15	Low
Wood & paper	16-18	Low
Rubber, plastics, minerals	22-23	Low
Metal products	24-25	Low
Construction	41-43	Low
Hotels & food services	55-56	Low

Source: Calvino et al. (2024)

Annex B: Key AI terms

The report makes references to several key concepts in AI. To facilitate comprehension of these terms, we provide definitions for the following key concepts:

- **General AI** or **artificial general intelligence (AGI)** represents a type of AI system that possesses a broad range of capabilities that matches or outmatches those of humans (Morris et al., 2024). True AGI systems do not yet exist. The concept of AGI remains a visionary goal, but the rapid pace of development of AI hints at the possibilities and potential directions that AGI might take.
- **Narrow AI** refers to a type of AI system that is designed to address specific tasks or solve particular problems. Unlike AGI, which aims for broad capabilities, narrow AI focuses on defined tasks and exhibits expertise within a limited domain. Narrow AI systems are tailored to excel in specific applications or problem domains.
- **Generative AI**, also known as gen AI, is a type of AI that creates new content, such as text, images, audio, videos or software code, based on prompts or inputs. Generative AI relies on sophisticated machine learning models, called deep learning models, that simulate the learning and decision-making processes of the human brain. It works by learning patterns from large datasets and subsequently generating new content that mimics those patterns.
- **Agentic AI** refers to AI systems composed of autonomous agents that can make decisions and act independently to achieve specific goals, often with limited human supervision. It consists of AI agents – machine learning models that mimic human decision-making to solve problems in real time. Examples include an AI-powered trading bot that analyses real-time stock prices and economic indicators to generate predictions and execute trades, or an AI system that streamlines supply chain management by automating processes, such as placing orders with suppliers or adjusting production schedules, to maintain optimal inventory levels.

AI technologies

- **Machine learning** is a subset of AI that focuses on the development of algorithms and statistical models which enable computers to perform tasks

without being explicitly programmed to do so. In other words, machine learning algorithms learn from data, identify patterns, and make decisions or predictions based on that data.

- A **neural network** is a computational model inspired by the structure and function of the human brain, composed of interconnected nodes, or artificial neurons, organized in layers. Through a process called training, neural networks learn from examples by adjusting the weights of connections to minimize the difference between predicted and actual outputs, thereby enabling them to recognize patterns, make predictions, and perform complex tasks across a wide range of domains.
- **Deep learning** is a subset of machine learning that involves training artificial neural networks with many layers of processing units, or neurons, to learn representations of data. The term “deep” refers to the depth of the neural networks, which typically consist of multiple hidden layers between the input and output layers.
- **Large language models (LLM)** are advanced AI systems that are trained on massive amounts of text data to understand and generate human-like language. These models are characterized by their vast size, often containing hundreds of millions to billions of parameters, which enables them to capture intricate patterns and nuances in language.

Supervised versus unsupervised learning

- **Supervised learning** is a machine learning approach defined by its use of labelled datasets. These datasets are designed to train or “supervise” algorithms into classifying data or predicting outcomes accurately. Using labelled inputs and outputs, the model can measure its accuracy and learn over time.
- **Unsupervised learning** uses machine learning algorithms to analyse and cluster unlabelled data sets. These algorithms discover hidden patterns in data without the need for human intervention.
- **Reinforcement learning** is a type of machine learning whereby an agent learns to make decisions by interacting with an environment and receiving feedback in the form of rewards or

punishments. The goal is for the agent to learn an optimal policy – a strategy for making decisions – that maximizes its cumulative reward over time.

Openness in AI models

- **Open-source AI** is an AI system that is made available according to certain terms that allow users free use of the system for any purpose and without having to ask for permission; that allow users to study how the system works and to inspect its components; that allow users to modify the system for any purpose, including changing its output; and that allow users to share the system for others, to use with or without modification, for any purpose (OSI, 2025).
- **Open-weight AI** refers to foundation models (see below) with publicly available trained weights (i.e., numbers that determine the importance of any connection within a model's artificial neural network, which shapes the model's behaviour). These models can generate content and perform a variety of tasks across different applications. Examples include the recently launched DeepSeek R1, OpenAI's GPT-OSS, and Alibaba's Qwen (OECD, 2025c).

Other terms

- **Foundation models** are large-scale, pre-trained models that serve as the basis or foundation for developing more specialized AI applications or

models. These foundation models are typically trained on vast amounts of data using techniques such as unsupervised learning. Developers can fine-tune these pre-trained foundation models on specific datasets or tasks to create more specialized AI models tailored to particular applications or domains.

- **Source code** refers to the human-readable instructions written by programmers to define the behaviour, algorithms and models used in AI systems.
- **Natural language processing (NLP)** is a field of AI that focuses on enabling computers to understand, interpret, and generate human language, both written and spoken.
- **Artificial Intelligence of Things (AIoT)** refers to the integration of AI technologies with Internet of Things (IoT) devices and systems. AIoT combines the capabilities of AI algorithms with the vast amounts of data generated by IoT devices to create intelligent and autonomous systems.
- **Intelligent automation** combines AI technologies, such as machine learning, computer vision, natural language processing and robotics process automation, to automate and optimize processes, tasks and workflows in various domains and industries.

Annex C: Data and methodology for AI patent citation analysis

This annex documents the data construction procedures for analysing cross-border diffusion of AI-related knowledge using patent citations. It specifies sources, definitions and assumptions applied in assembling the analytical dataset.

Defining AI patents

The data are sourced from PATSTAT Online (Autumn 2024 edition),¹ a database of bibliographical and legal event patent data from a number of industrialized and developing economies provided by the European Patent Office. The unit of observation is the individual patent application, which is classified using the Cooperative Patent Classification (CPC) system.²

To identify AI-related patents, a two-step approach is used. First, the WIPO (2019) AI taxonomy is adopted as the baseline, which specifies CPC codes relevant to AI. Since CPC codes are updated twice a year, this baseline is extended by reviewing the 2024 CPC master headings for AI-related terms, using regular expressions based on the keyword list

in Table 2. These keywords are used only to identify potential new CPC headings, not to retrieve patents directly. All matches are manually checked to remove irrelevant entries.

Patent applications are classified as AI-related if they contain at least one CPC code listed in Table 1.

Identifying AI patent citation flows

To analyse AI knowledge diffusion, all patent citations received by AI-related patents are tracked, regardless of whether the citing patents are themselves AI-related. This approach captures how AI innovations influence other technological domains both within and beyond AI.

Patent citation data are drawn from PATSTAT (table TLS228_DOCDB_FAM_CITN), with self-citations within the same family excluded. A knowledge flow from country j to country i in year t is recorded when a patent with priority year t (priority country = i) cites an AI-related patent whose priority country is j (Thomas and Murdick, 2020).

The origin of an AI knowledge flow is determined by the filing of the cited patent by the country of priority, hence circumventing the problem of missing values

Table 1: AI patent classification codes

WIPO 2019 baseline G06N codes:

G06N-003, G06N-005/003:G06N-005/027, G06N-007/005:G06N-007/06, G06N-099/005, G06N-003/004:G06N-003/008, G06N-007/046

Extended CPC class list, defined as G06N codes that contain an AI-related keyword:

G06N 20/00, 20/10, 20/20; G06N 3/00, 3/02, 3/04, 3/042, 3/043, 3/044, 3/0442, 3/049, 3/0499, 3/06, 3/08, 3/084, 3/086, 3/088, 3/0895, 3/09, 3/091, 3/092, 3/094, 3/096, 3/098, 3/0985, 3/10, 3/12, 3/126; G06N 5/00, 5/02, 5/04, 5/043, 5/045, 5/048; G06N 7/00, 7/02.

Table 2: List of AI-related keywords

neural, learning, deep, fuzzy, inference, supervised, unsupervised, reinforcement, backpropagation, autoencoder, feedforward, recurrent, lstm [long short-term memory], gru [gated recurrent unit], embedding, representation, artificial intelligence, computational intelligence, neural network, bayesian network, chatbot, data mining, decision model, deep learning, genetic algorithm, inductive logic, machine learning, natural language, reinforcement learning, supervised learning, swarm intelligence, unsupervised learning, semi-supervised learning, expert system, fuzzy logic, transfer learning, support vector machine, random forest, decision tree, gradient tree boosting, xgboost [eXtreme Gradient Boosting], adaboost [Adaptive Boosting], rankboost, logistic regression, stochastic gradient descent, multilayer perceptron, latent semantic analysis, Latent Dirichlet Allocation, multi-agent system, hidden Markov model.

for inventor and applicant country of residence. According to Thomas and Murdick (2020), this simplified procedure accurately captures the first inventor country for AI-related patents in over 80 per cent of cases.

Gravity model specification

The sample covers patent citations from 2010 to 2022, with subsequent citations left out of the sample to avoid a potential truncation bias. The resulting dataset is an 84-country balanced dyad-year panel with annual flows, retaining zero-citation pairs for Poisson Pseudo-Maximum Likelihood estimation. Domestic flows are excluded.

Bilateral AI knowledge flows were estimated using a Poisson Pseudo-Maximum Likelihood model, following the approach of Silva and Tenreyro (2006), which is robust to heteroskedasticity and the presence of zero flows:

$$Citation\ Flow_{ijt} = \exp(\beta_1 \log(Trade_{ijt}) + \beta_2 RTA_{ijt} + \gamma_{it} + \delta_{jt} + \Phi_{ij} + \varepsilon_{ijt})$$

where $Citation\ Flow_{ijt}$ represents citations from country i to AI patents originating in country j during year t .

Origin-year fixed effects γ_{it} and destination-year fixed effects δ_{jt} are included to control for multilateral resistance and other time-varying country-specific

factors affecting citation intensity, as well as directional country-pair fixed effects Φ_{ij} to account for potentially asymmetric knowledge flow frictions between country i and j . Only cross-border flows ($i \neq j$) are included when trade variables are used as regressors. Standard errors are clustered at country-pair level.

Five alternative trade specifications are tested:

1. Digitally deliverable services trade only
2. Other services trade (total services minus digitally deliverable services)
3. Goods trade only
4. Digital services + goods trade
5. All trade (digital + other services + goods).

Data on goods trade are taken from the International Trade and Production Database (ITPD-Ev2024), expressed in current US dollars, with zero trade flows retained. Services trade data are sourced from the OECD-WTO Balanced Trade in Services dataset (OECD-WTO BaTIS, 2023 release). Measures of bilateral distance and regional trade agreement (RTA) coverage are taken from the Centre d'Études Prospectives et d'Informations Internationales (CEPII), with distance calculated as population-weighted and all values corresponding to the 2023 release.

Annex D: WTO AI Trade Policy Openness Index (AI-TPOI): methodology

1. Introduction

This annex documents the construction of the AI Trade Policy Openness Index (AI-TPOI), a composite indicator designed to summarize how trade policies and regulatory frictions shape an economy's AI readiness and integration into the global AI ecosystem. The index captures the degree of policy openness across three key dimensions: services trade, goods trade and cross-border data flows. Together, these components reflect policy instruments that influence economies' ability to access, develop and diffuse AI and AI-related goods and services. The composite index aggregates these elements to provide a standardized measure of AI-related trade policy openness.

The AI-TPOI covers 108 economies and is reported on a 0–1 scale, where higher values denote less openness, and therefore greater restrictiveness and potential barriers to AI-related trade.

2. Conceptual framework

The AI-TPOI is structured around three pillars, each reflecting a policy domain relevant to AI diffusion: (i) services trade restrictiveness in AI-salient sectors; (ii) trade measures on AI-related goods; and (iii) cross-border data flow restrictions. The index assigns equal weight to these dimensions, reflecting the view that services, goods and data flows are complementary enablers of AI development, deployment and scaling.

Formally, the index for economy i is computed as:

$$AI-TPOI_i = \frac{1}{3} \cdot STRI_i + \frac{1}{3} \cdot TRM_i + \frac{1}{3} \cdot CBP_i$$

where:

$STRI_i$: restrictiveness in AI-salient services;

TRM_i : trade measures on AI-related goods;

CBP_i : restrictiveness of cross-border data policies.

Each component is normalized to the [0,1] interval, with higher values indicating more restrictive policy regimes and, thus, lower openness to AI and AI-related trade.

i. Services trade restrictions

The services component is based on the World Bank–WTO Services Trade Restrictiveness Index (STRI),³ which classifies measures affecting foreign service suppliers on a 0–1 scale, where 0 indicates full openness and 1 indicates a complete restriction.

Given the focus on AI preparedness, the index includes services subsectors particularly salient for AI development and deployment. These comprise telecommunications (fixed-line, mobile and internet), audio-visual services, computer and related services (including data processing and database services) and professional services highly complementary to AI deployment, such as engineering and research and development (R&D) services. These sectors are selected because they either directly provide AI services, supply critical inputs to AI development, or represent key areas of application for AI technologies. This targeted approach ensures that the index captures the most relevant policy barriers while maintaining parsimony.

The STRI for each economy is calculated as a weighted average, using as weights sectoral value-added shares (or regional averages if unavailable).

$$STRI_i = \sum_s w_{i,s} \cdot STRI_{i,s}$$

The underlying STRI aggregation follows a CES (constant elasticity of substitution) functional form, capturing the imperfect substitutability between different types of regulatory barriers. This approach recognizes that overall restrictiveness depends not only on individual measures, but also on their interaction effects.

ii. Trade-related measures on AI goods

While AI is a digital technology, it depends heavily on physical infrastructure, including servers, computing hardware and telecommunications equipment. Trade policies affecting access to these goods can significantly hinder AI trade and development.

The index combines three types of trade barriers – tariffs, quantitative restrictions (QRs) and trade remedies – each weighted according to its expected impact on AI-related trade flows.

$$TRM_i = 0.5 \cdot Tariff_i + 0.4 \cdot QRs_i + 0.1 \cdot TRs_i$$

Tariffs:

Based on simple average applied tariff rates on AI-related products from the WTO Tariff & Trade

Data (TTD),⁴ averaged over 2019-23 and normalized to [0,1] using min-max scaling. Covered AI-related products include computers and processing units, telecommunications equipment, scientific instruments and other ICT hardware identified through HS codes.

Quantitative restrictions (QRs):

This component is drawn from the Digital Trade Integration (DTI) database (Ferracane, González Ugarte and Rogaler, 2025),⁵ averaging indicators 10.1 through 10.4, which capture import and export restrictions on ICT hardware, including licensing requirements and local content requirements for ICT systems. The DTI is used instead of the WTO QRs database⁶ because it offers slightly broader data coverage and a structure more conducive to index construction.

Trade remedies:

This covers contingent protection measures – such as anti-dumping, countervailing duties and safeguards measures – applied to ICT-related products as reported in the DTI database. Though these measures may address legitimate trade concerns, they can increase trade uncertainty and raise costs for AI technology importers.

iii. Cross-border data policy

Data are a fundamental input for AI development and deployment. Restrictions on cross-border data flows

can significantly fragment digital ecosystems and constrain AI innovation and trade.

The cross-border data policy is calculated as a simple average of five regulatory indicators from the DTI database (items 6.1 to 6.5). These comprehensively cover data localization requirements, restrictions on cross-border data transfers, mandates for local processing, conditional flow regimes and local storage requirements, and commitments in RTAs on data governance.

$$CBP_i = \frac{1}{5} \sum_{k=1}^5 DTI_{i,k}$$

All sub-components are scaled so that higher values indicate more restrictive regimes.

3. Normalization and robustness

All sub-indicators are normalized to [0,1], and thus higher values always indicate greater restrictiveness. The STRI and DTI databases already follow this convention by design. Tariff data are min-max normalized across the full sample of 108 economies.

Where time-series data are available, multi-year averages are used to smooth possible short-term fluctuations. Tariff data are averaged over a five-year period (2019-23). Services and data policies, which typically change less frequently, are measured at the most recent available year.

Endnote

- 1 See <https://www.epo.org/en/searching-for-patents/business/patstat>.
- 2 See <https://www.cooperativepatentclassification.org/home>.
- 3 See <https://itip-services-worldbank.wto.org/>.

- 4 See <https://ttd.wto.org/en>.
- 5 The Digital Trade Integration (DTI) index is still under development. Some values may change in the final version, which will be released on the DTI website: <https://dti.eui.eu/>.
- 6 See <https://qr.wto.org/en>.

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Note

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World Trade Report 2025

Artificial intelligence (AI) has the potential to lead to a new era of growth. By transforming how goods and services are produced, exchanged and consumed, AI can bring about substantial changes in the global economy. Yet the future trajectory of AI remains uncertain, raising critical questions about trade and inclusive growth.

The *World Trade Report 2025* explores the complex and fast-evolving relationship between AI and international trade and how this relationship can shape inclusive growth. AI offers new opportunities to reduce trade costs, boost productivity and expand access to global markets. In addition, trade can help to render AI more accessible by spreading knowledge, fostering innovation and promoting participation in AI value chains. However, unequal access across the world to digital infrastructure, appropriate skills and capabilities could increase the digital divide. Also, the impact of AI on the labour market presents additional challenges.

Whether AI-enabled trade translates into broad-based, inclusive growth will depend on the design and implementation of trade and trade-related policies. WTO rules on trade in goods, services, data, intellectual property and public procurement can shape the availability, affordability and diffusion of AI. Complementary policies regulating competition, data infrastructure, energy, education and government support can also help to determine whether and how economies benefit from AI-enabled trade. The WTO can play a central role in ensuring that AI supports more inclusive trade-led growth by administering WTO rules, by fostering dialogue, transparency and capacity-building, and by deepening collaboration on AI and digital trade with other international organizations.

