INTERNATIONAL STANDARD

ISO/IEC 22989

First edition
2022-07

Information technology — Artificial intelligence — Artificial intelligence concepts and terminology

Technologies de l'information — Intelligence artificielle — Concepts et terminologie relatifs à l'intelligence artificielle

Reference number
ISO/IEC 22989:2022(E)

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Published in Switzerland

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 42, *Artificial Intelligence*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

Advancements in computing capacity, reduction of costs of computation, availability of large amounts of data from many sources, inexpensive online learning curricula and algorithms capable of meeting or exceeding human level performance in particular tasks for speed and accuracy have enabled practical applications of AI, making it an increasingly important branch of information technology.

AI is a highly interdisciplinary field broadly based on computer science, data science, natural sciences, humanities, mathematics, social sciences and others. Terms such as “intelligent”, “intelligence”, “understanding”, “knowledge”, “learning”, “decisions”, “skills”, etc. are used throughout this document. However, it is not the intention to anthropomorphize AI systems, but to describe the fact that some AI systems can rudimentarily simulate such characteristics.

There are many areas of AI technology. These areas are intricately linked and developing rapidly so it is difficult to fit the relevance of all technical fields into a single map. Research of AI includes aspects such as aspects including “learning, recognition and prediction”, “inference, knowledge and language” and “discovery, search and creation”. Research also addresses interdependencies among these aspects[23].

The concept of AI as an input and output process flow is shared by many AI researchers, and research on each step of this process is ongoing. Standardized concepts and terminology are needed by stakeholders of the technology to be better understood and adopted by a broader audience. Furthermore, concepts and categories of AI allow for a comparison and classification of different solutions with respect to properties like trustworthiness, robustness, resilience, reliability, accuracy, safety, security and privacy. This enables stakeholders to select appropriate solutions for their applications and to compare the quality of available solutions on the market.

As this document does provide a definition for the term AI in the sense of a discipline only, the context for its usage can be described as follows: AI is a technical and scientific field devoted to the engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives.

This document provides standardized concepts and terminology to help AI technology to be better understood and used by a broader set of stakeholders. It is intended for a wide audience including experts and non-practitioners. The reading of some specific clauses can however be easier with a stronger background in computer science. These concerns are described primarily Clauses 5.10, 5.11 and 8, which are more technical than the rest of the document.

Information technology — Artificial intelligence — Artificial intelligence concepts and terminology

1 Scope

This document establishes terminology for AI and describes concepts in the field of AI.

This document can be used in the development of other standards and in support of communications among diverse, interested parties or stakeholders.

This document is applicable to all types of organizations (e.g. commercial enterprises, government agencies, not-for-profit organizations).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms related to AI

3.1.1
AI agent
automated (3.1.7) entity that senses and responds to its environment and takes actions to achieve its goals

3.1.2
AI component
functional element that constructs an *AI system* (3.1.4)

3.1.3
artificial intelligence
AI
<discipline> research and development of mechanisms and applications of *AI systems* (3.1.4)

Note 1 to entry: Research and development can take place across any number of fields such as computer science, data science, humanities, mathematics and natural sciences.

3.1.4
artificial intelligence system
AI system
engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives

Note 1 to entry: The engineered system can use various techniques and approaches related to *artificial intelligence* (3.1.3) to develop a *model* (3.1.23) to represent data, *knowledge* (3.1.21), processes, etc. which can be used to conduct *tasks* (3.1.35).

Note 2 to entry: AI systems are designed to operate with varying levels of *automation* (3.1.7).

3.1.5
autonomy
autonomous
characteristic of a system that is capable of modifying its intended domain of use or goal without external intervention, control or oversight

3.1.6
application specific integrated circuit
ASIC
integrated circuit customized for a particular use

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.193, modified — Acronym has been moved to separate line.]

3.1.7
automatic
automation
automated
pertaining to a process or system that, under specified conditions, functions without human intervention

[SOURCE: ISO/IEC 2382:2015, 2121282, modified — In the definition, "a process or equipment" has been replaced by "a process or system" and preferred terms of "automated and automation" are added.]

3.1.8
cognitive computing
category of *AI systems* (3.1.4) that enables people and machines to interact more naturally

Note 1 to entry: Cognitive computing tasks are associated with *machine learning* (3.3.5), speech processing, *natural language processing* (3.6.9), *computer vision* (3.7.1) and human-machine interfaces.

3.1.9
continuous learning
continual learning
lifelong learning
incremental training of an *AI system* (3.1.4) that takes place on an ongoing basis during the operation phase of the AI system life cycle

3.1.10
connectionism
connectionist paradigm
connectionist model
connectionist approach
form of cognitive modelling that uses a network of interconnected units that generally are simple computational units

3.1.11
data mining
computational process that extracts patterns by analysing quantitative data from different perspectives and dimensions, categorizing them, and summarizing potential relationships and impacts

[SOURCE: ISO 16439:2014, 3.13, modified — replace "categorizing it" with "categorizing them" because data is plural.]

3.1.12
declarative knowledge
knowledge represented by facts, rules and theorems

Note 1 to entry: Usually, declarative knowledge cannot be processed without first being translated into *procedural knowledge* (3.1.28).

[SOURCE: ISO/IEC 2382-28:1995, 28.02.22, modified — Remove comma after “rules” in the definition.]

3.1.13
expert system
AI system (3.1.4) that accumulates, combines and encapsulates *knowledge* (3.1.21) provided by a human expert or experts in a specific domain to infer solutions to problems

3.1.14
general AI
AGI
artificial general intelligence
type of *AI system* (3.1.4) that addresses a broad range of *tasks* (3.1.35) with a satisfactory level of performance

Note 1 to entry: Compared to *narrow AI* (3.1.24).

Note 2 to entry: AGI is often used in a stronger sense, meaning systems that not only can perform a wide variety of tasks, but all tasks that a human can perform.

3.1.15
genetic algorithm
GA
algorithm which simulates natural selection by creating and evolving a population of individuals (solutions) for optimization problems

3.1.16
heteronomy
heteronomous
characteristic of a system operating under the constraint of external intervention, control or oversight

3.1.17
inference
reasoning by which conclusions are derived from known premises

Note 1 to entry: In AI, a premise is either a fact, a rule, a model, a feature or raw data.

Note 2 to entry: The term "inference" refers both to the process and its result.

[SOURCE: ISO/IEC 2382:2015, 2123830, modified – Model, feature and raw data have been added. Remove “Note 4 to entry: 28.03.01 (2382)”. Remove “Note 3 to entry: inference: term and definition standardized by ISO/IEC 2382-28:1995”.]

3.1.18
internet of things
IoT
infrastructure of interconnected entities, people, systems and information resources together with services that process and react to information from the physical world and virtual world

[SOURCE: ISO/IEC 20924:2021, 3.2.4, modified – “…services which processes and reacts to…” has been replaced with “…services that process and react to…” and acronym has been moved to separate line.]

3.1.19
IoT device
entity of an *IoT system* (3.1.20) that interacts and communicates with the physical world through sensing or actuating

Note 1 to entry: An IoT device can be a sensor or an actuator.

[SOURCE: ISO/IEC 20924:2021, 3.2.6]

3.1.20
IoT system
system providing functionalities of *IoT* (3.1.18)

Note 1 to entry: An IoT system can include, but not be limited to, IoT devices, IoT gateways, sensors and actuators.

[SOURCE: ISO/IEC 20924:2021, 3.2.9]

3.1.21
knowledge
<artificial intelligence> abstracted information about objects, events, concepts or rules, their relationships and properties, organized for goal-oriented systematic use

Note 1 to entry: Knowledge in the AI domain does not imply a cognitive capability, contrary to usage of the term in some other domains. In particular, knowledge does not imply the cognitive act of understanding.

Note 2 to entry: Information can exist in numeric or symbolic form.

Note 3 to entry: Information is data that has been contextualized, so that it is interpretable. Data is created through abstraction or measurement from the world.

3.1.22
life cycle
evolution of a system, product, service, project or other human-made entity, from conception through retirement

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.23]

3.1.23
model
physical, mathematical or otherwise logical representation of a system, entity, phenomenon, process or data

[SOURCE: ISO/IEC 18023-1:2006, 3.1.11, modified – Remove comma after “mathematical” in the definition. "or data" is added at the end.]

3.1.24
narrow AI
type of *AI system* (3.1.4) that is focused on defined *tasks* (3.1.35) to address a specific problem

Note 1 to entry: Compared to *general AI* (3.1.14).

3.1.25
performance
measurable result

Note 1 to entry: Performance can relate either to quantitative or qualitative findings.

Note 2 to entry: Performance can relate to managing activities, processes, products (including services), systems or organizations.

3.1.26
planning
<artificial intelligence> computational processes that compose a workflow out of a set of actions, aiming at reaching a specified goal

Note 1 to entry: The meaning of the “planning” used in AI life cycle or AI management standards can be also actions taken by human beings.

3.1.27
prediction
primary output of an *AI system* (3.1.4) when provided with *input data* (3.2.9) or information

Note 1 to entry: Predictions can be followed by additional outputs, such as recommendations, decisions and actions.

Note 2 to entry: Prediction does not necessarily refer to predicting something in the future.

Note 3 to entry: Predictions can refer to various kinds of data analysis or production applied to new data or historical data (including translating text, creating synthetic images or diagnosing a previous power failure).

3.1.28
procedural knowledge
knowledge which explicitly indicates the steps to be taken in order to solve a problem or to reach a goal

[SOURCE: ISO/IEC 2382-28:1995, 28.02.23]

3.1.29
robot
automation system with actuators that performs intended *tasks* (3.1.35) in the physical world, by means of sensing its environment and a software control system

Note 1 to entry: A robot includes the control system and interface of a control system.

Note 2 to entry: The classification of a robot as industrial robot or service robot is done according to its intended application.

Note 3 to entry: In order to properly perform its *tasks* (3.1.35), a robot makes use of different kinds of sensors to confirm its current state and perceive the elements composing the environment in which it operates.

3.1.30
robotics
science and practice of designing, manufacturing and applying robots

[SOURCE: ISO 8373:2012, 2.16]

3.1.31
semantic computing
field of computing that aims to identify the meanings of computational content and user intentions and to express them in a machine-processable form

3.1.32
soft computing
field of computing that is tolerant of and exploits imprecision, uncertainty and partial truth to make problem-solving more tractable and robust

Note 1 to entry: Soft computing encompasses various techniques such as fuzzy logic, machine learning and probabilistic reasoning.

3.1.33
symbolic AI
AI (3.1.3) based on techniques and *models* (3.1.23) that manipulate symbols and structures according to explicitly defined rules to obtain inferences

Note 1 to entry: Compared to *subsymbolic AI* (3.1.34), symbolic AI produces declarative outputs, whereas subsymbolic AI is based on statistical approaches and produces outputs with a given probability of error.

3.1.34
subsymbolic AI
AI (3.1.3) based on techniques and *models* (3.1.23) that use an implicit encoding of information, that can be derived from experience or raw data.

Note 1 to entry: Compared to *symbolic AI* (3.1.33). Whereas symbolic AI produces declarative outputs, subsymbolic AI is based on statistical approaches and produces outputs with a given probability of error.

3.1.35
task
<artificial intelligence>action required to achieve a specific goal

Note 1 to entry: Actions can be physical or cognitive. For instance, computing or creation of *predictions* (3.1.27), translations, synthetic data or artefacts or navigating through a physical space.

Note 2 to entry: Examples of tasks include classification, regression, ranking, clustering and dimensionality reduction.

3.2 Terms related to data

3.2.1
data annotation
process of attaching a set of descriptive information to data without any change to that data

Note 1 to entry: The descriptive information can take the form of metadata, labels and anchors.

3.2.2
data quality checking
process in which data is examined for completeness, bias and other factors which affect its usefulness for an *AI system* (3.1.4)

3.2.3
data augmentation
process of creating synthetic samples by modifying or utilizing the existing data

3.2.4
data sampling
process to select a subset of data samples intended to present patterns and trends similar to that of the larger *dataset* (3.2.5) being analysed

Note 1 to entry: Ideally, the subset of data samples will be representative of the larger *dataset* (3.2.5).

3.2.5
dataset
collection of data with a shared format

EXAMPLE 1 Micro-blogging posts from June 2020 associated with hashtags #rugby and #football.

EXAMPLE 2 Macro photographs of flowers in 256x256 pixels.

Note 1 to entry: Datasets can be used for validating or testing an AI *model* (3.1.23). In a *machine learning* (3.3.5) context, datasets can also be used to train a *machine learning algorithm* (3.3.6).

3.2.6
exploratory data analysis
EDA
initial examination of data to determine its salient characteristics and assess its quality

Note 1 to entry: EDA can include identification of missing values, outliers, representativeness for the task at hand – see *data quality checking* (3.2.2).

3.2.7
ground truth
value of the target variable for a particular item of labelled input data

Note 1 to entry: The term ground truth does not imply that the labelled input data consistently corresponds to the real-world value of the target variables.

3.2.8
imputation
procedure where missing data are replaced by estimated or modelled data

[SOURCE: ISO 20252:2019, 3.45]

3.2.9
input data
data for which an *AI system* (3.1.4) calculates a predicted output or inference

3.2.10
label
target variable assigned to a sample

3.2.11
personally identifiable information
PII
personal data
any information that (a) can be used to establish a link between the information and the natural person to whom such information relates, or (b) is or can be directly or indirectly linked to a natural person

Note 1 to entry: The "natural person" in the definition is the PII principal. To determine whether a PII principal is identifiable, account should be taken of all the means which can reasonably be used by the privacy stakeholder holding the data, or by any other party, to establish the link between the set of PII and the natural person.

Note 2 to entry: This definition is included to define the term PII as used in this document. A public cloud PII processor is typically not in a position to know explicitly whether information it processes falls into any specified category unless this is made transparent by the cloud service customer.

[SOURCE: ISO/IEC 29100:2011/Amd1:2018, 2.9]

3.2.12
production data
data acquired during the operation phase of an *AI system* (3.1.4), for which a deployed *AI system* (3.1.4) calculates a predicted output or *inference* (3.1.17)

3.2.13
sample
atomic data element processed in quantities by a *machine learning algorithm* (3.3.6) or an *AI system* (3.1.4)

3.2.14
test data
evaluation data
data used to assess the performance of a final *model* (3.1.23)

Note 1 to entry: Test data is disjoint from *training data* (3.3.16) and *validation data* (3.2.15).