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Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality models for AI systems

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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*.

This second edition cancels and replaces the first edition (ISO/IEC 25059:2023), which has been technically revised.

The main changes are as follows:

— alignment with the revised version of ISO/IEC 25010:2023;

— alignment with the revised version of ISO/IEC 25019:2023;

— addition of an AI service quality model based on ISO/IEC TS 25011:2017;

— addition of “Environmental sustainability” as a sub-characteristic of “Performance efficiency” in the product quality model.

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.

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Introduction

High-quality software products and computer systems are crucial to stakeholders. Quality models, quality requirements, quality measurement, and quality evaluation are standardized within the International Standards on SQuaRE, see Annex A for further information.

AI systems require additional properties and characteristics of systems to be considered, and stakeholders have varied needs. AI systems have different properties and characteristics. For example, AI systems can:

— replace human decision-making;

— be based on noisy, or incomplete data;

— be probabilistic;

— adapt during operation.

The concept of trustworthiness is addressed through a holistic ecosystem of standards. It is understood both as an ongoing organizational process, guided by standards like ISO/IEC 42001 and as a set of non-functional requirements specifying emergent properties of a system as described in ISO/IEC TR 24028. [2] These requirements — which are a set of inherent characteristics with their attributes — within the context of quality of use as indicated in ISO/IEC 25010 (product quality model), ISO/IEC 25019 (quality-in-use model) and ISO/IEC TS 25011 (service quality models).

A key consideration in the field is the applicability of standards developed for conventional software to AI systems. It is widely recognized that existing frameworks do not sufficiently address the data-driven and unpredictable nature of AI systems. While considering the existing body of work, experts have identified the need to develop new international standards for AI systems that can go beyond the characteristics and requirements of conventional software development.

A related discussion concerns different approaches to the testing and evaluation of AI systems. The prevailing view is that for the testing of an AI system, modified versions of existing software and hardware verification and validation techniques are needed. Due to several conceptual differences between many AI systems and conventional systems, it has been concluded that “the ability of the [AI] system to achieve the planned and desired result … [cannot] always be measurable by conventional approaches to software testing”. Testing of AI systems is addressed in ISO/IEC 42119 series (42119-2 and DTS 42119-3).

This document outlines an application-specific AI system extension to the SQuaRE quality models specified in ISO/IEC 25010, ISO/IEC 25019 and ISO/IEC TS 25011.

The AI system quality is considered from two perspectives (quality models), product quality as described in Clause 5 and quality-in-use in Clause 6. The relevance of these terms is explained, and links to other standardization deliverables (e.g. the ISO/IEC 24029 series) are highlighted.

AI service quality is also part of this document as users and organizations need high-quality support for their AI systems. AI service quality is described in Clause 7.

Cybersecurity is also an important aspect that is captured in these SQuaRE models. For example, security, confidentiality, compliance, authenticity, resistance and recoverability are characteristics or sub-characteristics described in this document.

ISO/IEC 25012 contains a model for data quality that is complementary to the model defined in this document. ISO/IEC 25012:2008 is being extended for AI systems by the ISO/IEC 5259 series.

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Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality models for AI systems

1 Scope

This document outlines quality models for AI systems and services and is an application specific extension to the standards on SQuaRE. The characteristics and sub-characteristics detailed in the models provide consistent terminology for specifying, measuring and evaluating AI system and service quality. The characteristics and sub-characteristics detailed in the models also provide a set of quality characteristics against which stated quality requirements can be compared for completeness.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 25010:2023, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Product quality model*

ISO/IEC 25019:2023, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality-in-use model*

ISO/IEC 22989:2022, *Information technology — Artificial intelligence — Artificial intelligence concepts and terminology*

ISO/IEC 23053:2022, *Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 22989:2022, ISO/IEC 23053:2022 and the following 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 General

3.1.1
measure,noun
variable to which a value is assigned as the result of measurement

Note 1 to entry: The term “measure” is used to refer collectively to base measures, derived measures, and indicators.

[SOURCE: ISO/IEC/IEEE 15939:2017, 3.15]

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3.1.2
measure,verb
make a measurement

[SOURCE: ISO/IEC/IEEE 15939:2017, 3.16]

3.1.3
software quality measure
measure of internal software quality, external software quality or software quality in use

Note 1 to entry: Internal measure of software quality, external measure of software quality or software quality in use measure are described in the quality model in ISO/IEC 25010.

[SOURCE: ISO/IEC 25040:2024, 4.61]

3.1.4
risk treatment measure
protective measure
action or means to eliminate hazards or reduce risks

[SOURCE: ISO/IEC Guide 51:2014, 3.13, modified — change reduction to treatment.]

3.1.5
transparency
degree to which appropriate information about the AI system is communicated to relevant stakeholders

Note 1 to entry: Appropriate information for AI system transparency can include aspects such as features, components, procedures, measures, design goals, design choices and assumptions.

3.1.6
environment
surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans and their interrelationships

Note 1 to entry: Surroundings in this context extend from within an organization to the global system.

[SOURCE: ISO 14001:2015, 3.2.1, modified — Note 1 to entry was modified and Note 2 to entry was removed.]

3.1.7
sustainability aspect
element of an organization's activities or products or services that can interact with the *environment* (3.1.6)

[SOURCE: ISO 14001:2015, 3.2.2, modified — The notes to entry were removed and new note 1 to entry was added.]

3.1.8
environmental impact
any change to the *environment* (3.1.6), whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects (3.1.7)

[SOURCE: ISO 14001:2015, 3.2.3, modified]

3.1.9
life cycle assessment
LCA
systematic evaluation of the *environmental impact* (3.1.8) product(s) that include all stages of its life cycle

EXAMPLE Period from installation to uninstalling an AI system.

[SOURCE: ISO 17889-1:2021, 3.1.4, modified — updated EXAMPLE to refer to an AI system.]

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3.1.10
economic sustainability
ability to provide sustainable, successful places in an economic context

Note 1 to entry: Economic considerations include employment, competitiveness, wealth and distribution, welfare, accounting and regulation.

[SOURCE: ISO 17889-1:2021, 3.1.2]

3.1.11
social sustainability
ability to provide sustainable, successful places in a social context

Note 1 to entry: Social sustainability combines design of the physical realm with design of the world, infrastructure to support social and cultural life, provides social amenities, systems for citizen engagement and spaces for people and places to evolve.

[SOURCE: ISO 17889-1:2021, 3.1.3]

3.1.12
control,verb
<controllability>in engineering, the monitoring of system output to compare with expected output and taking corrective action when the actual output does not match the expected output

Note 1 to entry: Social sustainability combines design of the physical realm with design of the world, infrastructure to support social and cultural life, provides social amenities, systems for citizen engagement and spaces for people and places to evolve.

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.846.1]

3.1.13
controller
authorized human or another external agent that performs a control

Note 1 to entry: A controller interacts with the control points of an AI system.

3.1.14
engagement of control
control engagement
process where a *controller* (3.1.13) takes over a set of *control points* (3.1.15)

Note 1 to entry: Besides taking over a set of control points, an engagement of control can also include a confirmation about the transfer of control to a controller.

3.1.15
control point
part of the interface of a system where controls can be applied

Note 1 to entry: A control point can be a function, physical facility (such as a switch) or a signal receiving subsystem.

3.1.16
selection bias
type of data bias that can occur when a dataset's samples are not collected in a way that is representative of their real-world distribution

[SOURCE: ISO/IEC TS 12791:2024, 3.3.8]

3.2 Product quality

3.2.1
user controllability
degree to which a user can appropriately intervene in an AI system's functioning in a timely manner

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3.2.2
functional adaptability
degree to which an AI system can accurately acquire information from data, or the result of previous actions, and use that information in future predictions

3.2.3
functional correctness
degree to which a product or system provides the correct results with the needed degree of precision

Note 1 to entry: AI systems, and particularly those using machine learning models, do not usually provide functional correctness in all observed circumstances.

[SOURCE: ISO/IEC 25010:2023, 4.2.1.2, modified — Note to entry replaced.]

3.2.4
intervenability
degree to which an operator can intervene in an AI system's functioning in a timely manner to prevent harm or hazard

3.2.5
robustness
degree to which an AI system can maintain its level of functional correctness under any circumstances

3.2.6
environmental sustainability
state in which the ecosystem and its functions are maintained for the present and future generations

[SOURCE: ISO 17889-1:2021, 3.1.1, modified — generation made plural.]

3.3 Quality-in-use

3.3.1
environmental risk mitigation
degree to which a product or system mitigates the potential risk to the environment in the intended contexts of use

Note 1 to entry: environmental risk mitigation includes the mitigation of risks that could harm the environment, such as pollution, waste, and resource depletion. Additionally, it involves the product or system's role in sustainability through the efficient utilization of resources, reduction of waste, and facilitation of recycling and reuse processes.

3.3.2
societal and ethical risk mitigation
degree to which a product or system mitigates the potential societal or ethical risks

Note 1 to entry: Societal and ethical risk mitigation includes accountability, fairness, transparency and explainability, professional responsibility, promotion of human value, privacy, human control of technology, community involvement and development, respect for the rule of law, respect for international norms of behaviour and labour practices.

3.4 AI service quality

3.4.1
traceability
degree to which the AI service outcomes can be traced to or from the user needs

3.4.2
service adaptability
degree to which a service can be adapted based on factors such as functions, responsibility, skill of employees, communication style with users or instruments available

3.4.3
customizability
degree to which the AI service can be customized at the request of users

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