Technical Specification

ISO/IEC TS 8200

First edition
2024-04

Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems

Technologies de l'information — Intelligence artificielle — Contrôlabilité des systèmes d'intelligence artificiels automatisés

Reference number
ISO/IEC TS 8200:2024(en)

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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*.

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Introduction

Artificial intelligence (AI) techniques have been applied in domains and markets such as health care, education, clean energy and sustainable living. Despite being used to enable systems to perform automated predictions, recommendations or decisions, AI systems have raised a wide range of concerns. Some characteristics of AI systems can introduce uncertainty in predictability of AI system behaviour. This can bring risks to users and other persons. For this reason, controllability of AI systems is very important. This document is primarily intended as a guidance for AI system design and use in terms of controllability realization and enhancement.

Controllability characteristics (see Clause 6) and principles of AI systems are identified in this document. This document describes the needs of controllability in a domain-specific context and strengthens the understanding of an AI system's controllability. Controllability is an important fundamental characteristic supporting AI systems' safety for users and other persons.

Automated systems as described in ISO/IEC 22989:2022, Table 1 can potentially use AI. The degree of external control or controllability is an important characteristic of automated systems. Heteronomous systems range over a spectrum from no external control to direct control. The degree of external control or controllability can be used to guide or manipulate systems at various levels of automation. This can be satisfied by the use of controllability features (see Clause 7) or by taking specific preventive actions within each stage of the AI system life cycle as defined in ISO/IEC 22989:2022, Clause 6. This document refers to the controllability by a controller, that is a human or another external agent. It describes controllability features (what and how), but does not presuppose who or what is in charge of the controlling.

Unwanted consequences are possible if an AI system is permitted to make decisions or take actions without any external intervention, control or oversight. To realize controllability (see Clause 8), key points of system state observation and state transition are identified. The exact points where transfer of control is enabled can be considered during the design and implementation of an AI system.

Ideally, the transfer of control for an intervention occurs within reasonable time, space, energy and complexity limits, with minimal interruption to the AI system and the external agent. Stakeholders can consider the cost of control transfer (see 6.9) of automated AI systems. Uncertainty during control transfer can exist on the AI system and the external agent sides. Thus, it is important to carefully design the control transfer processes to remove, minimize, or mitigate uncertainty (see 6.8) and other undesired consequences.

The effectiveness of control can be tested. Such testing takes into account the design and development of the control transfer. This calls for principles and approaches for validation and verification of AI systems' controllability (see Clause 9).

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1 Scope

This document specifies a basic framework with principles, characteristics and approaches for the realization and enhancement for automated artificial intelligence (AI) systems' controllability.

The following areas are covered:

— state observability and state transition;

— control transfer process and cost;

— reaction to uncertainty during control transfer;

— verification and validation approaches.

This document is applicable to all types of organizations (e.g. commercial enterprises, government agencies, not-for-profit organizations) developing and using AI systems during their whole life cycle.

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

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