TECHNICAL REPORT

ISO/IEC TR 24372

First edition
2021-12

Information technology — Artificial intelligence (AI) — Overview of computational approaches for AI systems

This document is a preview generated by EVS

Reference number
ISO/IEC TR 24372:2021(E)

© ISO/IEC 2021

This document is a preview generated by EVS



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO/IEC 2021 – All rights reserved

Contents

Page

Foreword ..... **v**
Introduction ..... **vi**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Abbreviated terms **2**
5 General **3**
6 Main characteristics of AI systems **5**
6.1 General 5
6.2 Typical characteristics of AI systems 6
6.2.1 Adaptable 6
6.2.2 Constructive 6
6.2.3 Coordinated 6
6.2.4 Dynamic 6
6.2.5 Explainable 6
6.2.6 Discriminative or generative 6
6.2.7 Introspective 6
6.2.8 Trained or trainable 7
6.2.9 Accommodating various data 7
6.3 Computational characteristics of AI systems 7
6.3.1 Data-based or knowledge-based 7
6.3.2 Infrastructure-based 7
6.3.3 Algorithm-dependent 8
6.3.4 Multi-step or end-to-end learning-based 9
7 Types of AI computational approaches **9**
7.1 General 9
7.2 Knowledge-driven approaches 10
7.3 Data-driven approaches 10
8 Selected algorithms and approaches used in AI systems **11**
8.1 General 11
8.2 Knowledge engineering and representation 11
8.2.1 General 11
8.2.2 Ontology 12
8.2.3 Knowledge graph 12
8.2.4 Semantic web 14
8.3 Logic and reasoning 14
8.3.1 General 14
8.3.2 Inductive reasoning 15
8.3.3 Deductive inference 15
8.3.4 Hypothetical reasoning 16
8.3.5 Bayesian inference 17
8.4 Machine learning 18
8.4.1 General 18
8.4.2 Decision tree 18
8.4.3 Random forest 19
8.4.4 Linear regression 20
8.4.5 Logistic regression 21
8.4.6 K-nearest neighbour 21
8.4.7 Naïve Bayes 22
8.4.8 Feedforward neural network 22
8.4.9 Recurrent neural network 23

This document is a preview generated by EVS

© ISO/IEC 2021 – All rights reserved

8.4.10 Long short-term memory network 24
8.4.11 Convolutional neural network 25
8.4.12 Generative adversarial network 26
8.4.13 Transfer learning 27
8.4.14 Bidirectional encoder representations from transformers 27
8.4.15 XLNet 28
8.5 Metaheuristics 29
8.5.1 General 29
8.5.2 Genetic algorithms 29
Bibliography **31**

This document is a preview generated by EVS

© ISO/IEC 2021 – All rights reserved

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see https://patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

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.

This document is a preview generated by EVS

© ISO/IEC 2021 – All rights reserved

Introduction

Artificial intelligence (AI)-related products, systems and solutions have become more common in recent years thanks to rapid software and hardware improvements that boost computational performance, data storage capabilities and network bandwidth. The intent of this document is to look at computational methods and approaches within AI systems. Based on ISO/IEC 22989[1)], ISO/IEC 23053[2)] and ISO/IEC TR 24030, this document provides a description of the characteristics of an AI system and its computational approaches. The illustration of computational approaches in AI systems includes both machine learning and non-machine learning methods. To reflect state-of-the-art methods used in AI, this document is structured as follows:

— Clause 5 provides an overall description of computational approaches in AI systems;

— Clause 6 discusses the main characteristics of AI systems;

— Clause 7 provides a general taxonomy of computational approaches, including knowledge-driven and data-driven approaches;

— Clause 8 discusses selected algorithms used in AI systems, including basic theories and techniques, main characteristics and typical applications.

By giving an overview of different technologies used by AI systems, this document is intended to help users understand computational characteristics and approaches used in AI.

This document is a preview generated by EVS

1) Under preparation. Stage at the time of publication: ISO/IEC DIS 22989:2021.

2) Under preparation. Stage at the time of publication: ISO/IEC DIS 23053:2021.

© ISO/IEC 2021 – All rights reserved

Information technology — Artificial intelligence (AI) — Overview of computational approaches for AI systems

This document is a preview generated by EVS

1 Scope

This document provides an overview of the state of the art of computational approaches for AI systems, by describing: a) main computational characteristics of AI systems; b) main algorithms and approaches used in AI systems, referencing use cases contained in ISO/IEC TR 24030.

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, *Information technology — Artificial intelligence — Artificial intelligence concepts and terminology*

ISO/IEC 23053, *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 and ISO/IEC 23053 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
heuristic search
search, based on experience and judgment, used to obtain acceptable results without guarantee of success

[SOURCE: ISO/IEC 2382:2015, 2123854, modified — Notes to entry removed.]

3.2
fuzzy logic
fuzzy-set logic
nonclassical logic in which facts, inference rules and quantifiers are given certainty factors

[SOURCE: ISO/IEC 2382:2015, 2123795, modified — Notes to entry removed.]

3.3
generator
neural network that produces samples usually to be classified by a discriminator

Note 1 to entry: Generators primarily appear in the context of generative adversarial networks.

© ISO/IEC 2021 – All rights reserved