



**Technical  
Specification**

**ISO/IEC TS 42112**

**Information technology — Artificial  
intelligence — Guidance on machine  
learning model training efficiency  
optimization**

*Technologies de l'information — Intelligence artificielle —  
Recommandations relatives à l'optimisation de l'efficacité de  
l'entraînement du modèle d'apprentissage automatique*

**First edition  
2026-06**



**COPYRIGHT PROTECTED DOCUMENT**

© ISO/IEC 2026

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](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>Introduction</b> .....	<b>v</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Abbreviated terms</b> .....	<b>3</b>
<b>5 Overview of ML model training</b> .....	<b>3</b>
5.1 Model training in ML pipeline.....	3
5.2 Stakeholders of model training.....	4
<b>6 ML model training efficiency</b> .....	<b>4</b>
<b>7 Characteristics impacting ML model training efficiency</b> .....	<b>4</b>
7.1 Training data.....	4
7.2 Model parameter management.....	4
7.3 Communication challenges.....	5
7.4 Failure detection in model training.....	5
7.5 Failure recovery in model training.....	5
7.6 Quality of the ML model.....	5
7.7 Management of computing resources.....	6
<b>8 Model training efficiency optimization methods</b> .....	<b>6</b>
8.1 Overview.....	6
8.2 Training data preparation and model optimization.....	6
8.2.1 General consideration.....	6
8.2.2 Training data quality optimization.....	7
8.2.3 Feature engineering.....	7
8.2.4 Feature selection.....	8
8.2.5 Feature scaling.....	8
8.2.6 Training algorithm selection.....	8
8.2.7 Training process optimization.....	9
8.2.8 Ensemble learning.....	9
8.3 Parallelism strategies.....	9
8.3.1 Data parallelism.....	9
8.3.2 Model parallelism.....	10
8.3.3 Hybrid parallelism.....	10
8.4 Communication optimization.....	10
8.4.1 Collective communication.....	10
8.4.2 Data compression.....	10
8.4.3 Asynchronous communication.....	11
8.4.4 Network topology-aware scheduling.....	11
8.5 Model checkpoint optimization.....	11
8.5.1 Hierarchical checkpoint saving.....	11
8.5.2 Overlapping model copy and computation.....	11
8.5.3 Network-aware asynchronous storage.....	11
8.6 Resource management for model training.....	12
8.7 Failure detection optimization.....	12
8.8 Continuous monitoring and anomaly detection.....	13
8.9 Environment and infrastructure assessment.....	13
<b>Annex A (informative) Use case: Deep learning recommendation system for an e-commerce platform</b> .....	<b>14</b>
<b>Bibliography</b> .....	<b>17</b>

## 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](http://www.iso.org/directives) or [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs)).

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents) and <https://patents.iec.ch>. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

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](http://www.iso.org/iso/foreword.html). In the IEC, see [www.iec.ch/understanding-standards](http://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](http://www.iso.org/members.html) and [www.iec.ch/national-committees](http://www.iec.ch/national-committees).

## Introduction

Machine learning (ML) is a key branch of artificial intelligence (AI). To apply ML across diverse domains, ML models are trained, validated and deployed in production environments. As model complexity and dataset size continue to grow, the time, hardware resources, human effort and financial costs associated with ML model training are escalating.

ML platforms, services and products are now widely available and adopted. Both AI providers (who offer ML platforms, services or products) and AI producers (who build ML-based solutions) seek to optimize training efficiency to minimize resource consumption and cost, without compromising model or dataset scale. For instance, AI providers aim to reduce hardware usage per training task to support more customers and improve resource utilization. AI producers prioritize faster training cycles to accelerate deployment of validated models.

This document provides guidance to help AI providers and producers achieve faster training and reduced resource consumption, given specific models, dataset and infrastructure.



# Information technology — Artificial intelligence — Guidance on machine learning model training efficiency optimization

## 1 Scope

This document outlines key factors affecting machine learning model training efficiency and presents corresponding optimization approaches.

It provides guidance for AI providers and producers through a structured set of characteristics and related optimizations to improve training efficiency. This information can support the evaluation and comparison of various ML training strategies.

This document does not specify any training accelerating mechanisms provided and implemented within machine learning computing device described in ISO/IEC TR 17903.

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

ISO/IEC TR 17903:2024, *Information technology — Artificial intelligence — Overview of machine learning computing devices*

ISO/IEC TS 4213, *Information technology — Artificial intelligence — Assessment of machine learning classification performance*

## Bibliography

- [1] ISO/IEC 20944-1:2013, *Information technology — Metadata Registries Interoperability and Bindings (MDR-IB) — Part 1: Framework, common vocabulary, and common provisions for conformance*
- [2] ISO/IEC TS 12791:2024, *Information technology — Artificial intelligence — Treatment of unwanted bias in classification and regression machine learning tasks*
- [3] ISO 18115-1:2023, *Surface chemical analysis — Vocabulary — Part 1: General terms and terms used in spectroscopy*
- [4] ISO/IEC 25059, *Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality model for AI systems*
- [5] ISO/IEC 25010:2023, *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Product quality model*
- [6] ISO/IEC 5259-2:2024, *Artificial intelligence — Data quality for analytics and machine learning (ML) — Part 2: Data quality measures*
- [7] ISO/IEC 5259-4:2024, *Artificial intelligence — Data quality for analytics and machine learning (ML) — Part 4: Data quality process framework*
- [8] ISO/IEC TR 24372:2021, *Information technology — Artificial intelligence (AI) — Overview of computational approaches for AI systems*
- [9] ALIBABA CLOUD PLATFORM FOR AI. *SDK Reference [online]*, [viewed 20 August 2024]. Available from: <https://www.alibabacloud.com/help/en/pai/user-guide/sdk-reference/?spm=a2c63.p38356.0.0.67e53721Pt0SIk>
- [10] PYTORCH DOCUMENTATION. PyTorch Foundation, *The Linux Foundation PyTorch Foundation [online]*, [viewed 20 August 2024]. Available from: <https://pytorch.org/docs/stable/index.html>
- [11] TensorFlow tutorials for beginners, TensorFlow Core, [viewed 20 August 2024]. Available from: <https://www.tensorflow.org/tutorials>
- [12] Sasse, L., Nicolaisen-Sobesky, E., Dukart, J. et al. Overview of leakage scenarios in supervised machine learning. *J Big Data* 12, 135 (2025). <https://doi.org/10.1186/s40537-025-01193-8>