TECHNICAL REPORT

ISO/TR 24291

First edition

Health informatics - Applications of machine learning technologies in imaging and other medical applications

Informatique de santé — Applications de technologies d'apprentissage automatique en imagerie et autres applications médicales

PROOF/ÉPREUVE

Reference number
ISO/TR 24291:2021(E)

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

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 ISO documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO 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).

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.

This document was prepared by Technical Committee ISO/TC 215, *Health informatics*.

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.

Introduction

Due to the rapid advancement of artificial intelligence, especially machine learning and deep learning, defining categories of use cases in the clinical setting have started to be adopted to enhance healthcare system and patients' outputs. Therefore, it is crucial to define the categories of use cases for artificial intelligence in the clinical setting to focus on application of artificial intelligence in medicine.

This document proposes categories of use cases of machine learning technologies for artificial intelligence in medicine considering the property of artificial intelligence technology including machine learning and deep learning and clinical settings especially requiring repeated detection and/or diagnosis, real-time monitoring, and treatment prediction with images and continuous signals, etc. This document will assist the health IT companies by reviewing the current status of machine learning technologies for artificial intelligence in medicine and then by proposing a gap for a new application. This document can be used to further develop the applications or the necessary standards of machine learning technologies for artificial intelligence in medicine.

Health informatics - Applications of machine learning technologies in imaging and other medical applications

1 Scope

This document lists examples of and defines categories of use cases for machine learning in medicine for clinical practice.

The developments and applications of machine learning technologies for artificial intelligence consist of 1) data collection and curation, 2) pre-processing, 3) model training and validation, and 4) medicine depending on various kinds of specialty including radiology, pathology, emergency medicine, dermatology, ophthalmology, anaesthesia, surgery, etc., and clinical settings including repeated detection and/or diagnosis, real-time monitoring, and treatment prediction.

This document covers categories applications of medicine in (4). It also defines the clinical usages and necessities of the artificial intelligence in medicine.

(1) to (3) are not the scope of this document

This document also excludes

— basic research and other scientific areas,

— use cases related to artificial intelligence methods other than machine learning (for example, symbolic artificial intelligence, expert systems), and

— non-human results such as veterinary medicine.

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 terminological databases for use in standardization at the following addresses:

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

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

3.1
artificial intelligence
AI
branch of computer science devoted to developing data processing systems that perform functions normally associated with human intelligence, such as reasoning, learning, and self-improvement

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.234]

3.2
big data
extensive datasets — primarily in the data characteristics of volume, variety, velocity, and/or variability — that require a scalable technology for efficient storage, manipulation, management, and analysis

Note 1 to entry: Big data is commonly used in many different ways, for example as the name of the scalable technology used to handle big data extensive datasets.

[SOURCE: ISO/IEC 20546:2019, 3.1.2]

3.3
electronic medical records
EMR
electronic record derived from a computerized system used primarily for delivering patient care in a clinical setting

3.4
clinical decision support
CDS
type of service that assists healthcare providers in making medical decisions, which typically requires input of patient-specific clinical variables and provide patient-specific recommendations

[SOURCE: ISO/TS 22756:2020, 3.1]

3.5
clinical decision support system
CDSS
software designed to be a direct aid to clinical decision-making, in which the characteristics of an individual patient are matched to a computerized clinical knowledge base, whereafter patient-specific assessments or recommendations are presented to the clinician or the patient to aid in the process of making evidence based clinical decisions

[SOURCE: ISO/TS 22756:2020, 3.2]

3.6
computer aided detection
CADe
health information technology system to provide physicians and other health professionals with automated detection in medical records (i.e., images), that is, assistance with clinical diagnosis tasks

3.7
computer aided diagnosis
CADx
health information technology system to provide physicians and other health professionals with automated diagnosis by using medical records including images, and EMR, that is, assistance with clinical diagnosis tasks

3.8
computer aided differential diagnosis
CADD
health information technology system to provide physicians and other health professionals with automated differential diagnosis by using medical records including images, and EMR

3.9
computed tomography
CT
radiographic scanning technique that uses a number of CT projections of an object at different angles in order to allow calculation of a CT image

[SOURCE: ISO 15708-1:2017, 3.7]

3.10
deep learning
approach to creating rich hierarchical representations through the training of *neural networks* (3.16) with many hidden layers

Note 1 to entry: Deep learning is also known as deep neural network learning

[SOURCE: ISO/IEC TR 29119-11:2020, 3.1.26, modified — Note 1 has been modified.]

3.12
image processing
<computer graphics> process of applying any operation to a pictorial representation of objects or data for a given purpose

Note 1 to entry: Examples of operations include scene analysis, image compression, image restoration, image enhancement, preprocessing, quantizing, spatial filtering, and construction of two- and three-dimensional models of objects.

[SOURCE: ISO/IEC 2382:2015, 2125939, modified — Admitted term and Note 3 to entry deleted.]

3.13
machine learning
process using computational techniques to enable systems to learn from data or experience

[SOURCE: ISO/IEC TR 29119-11:2020, 3.1.43]

3.14
magnetic resonance imaging
MRI
imaging technique that uses static and time varying magnetic fields to provide images of tissue by the magnetic resonance of nuclei

[SOURCE: ISO 14630:2012, 3.5]

3.15
natural language processing
NLP
technology used to determine and identify key words and phrases within processing audio data (e.g. call centres) and free-form text (e.g. the body of an email)

Note 1 to entry: This technology is able to reduce words to their base constructs and perform other actions, such as stemming, along with locating similar words or phrases without user intervention. This technology also varies greatly from standard IDR technology due to the ability to automatically update rules as determined by the users without the need for technical intervention. This technology is best suited for unstructured documents.

[SOURCE: ISO/TR 22957:2018, 3.7]

3.16
artificial neural network
neural network
neural net
ANN
network of primitive processing elements connected by weighted links with adjustable weights, in which each element produces a value by applying a nonlinear function to its input values, and transmits it to other elements or presents it as an output value

Note 1 to entry: Whereas some neural networks are intended to simulate the functioning of neurons in the nervous system, most neural networks are used in artificial intelligence as realizations of the connectionist model.

Note 2 to entry: Examples of nonlinear functions are a threshold function, a sigmoid function, and a polynomial function.

[SOURCE: ISO/IEC 2382:2015, 2120625, modified — Notes to entry 3 to 5 deleted.]

3.17
prediction
output of an algorithm after it has been trained on a historical dataset and applied to new data when forecasting the likelihood of a particular outcome

3.18
robotics
techniques involved in designing, building, and using robots

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3554]

3.19
speech recognition
automatic speech recognition
conversion, by a functional unit, of a speech signal to a representation of the content of the speech

Note 1 to entry: The content to be recognized can be expressed as a proper sequence of words or phonemes.

[SOURCE: ISO/IEC 19794-13:2018, 3.22]

4 Abbreviated terms

CBIR	Content-based case retrieval
CNN	Convolutional Neural Net
DB	Database
EMR	Electronic Medical Records
ICU	Intensive Care Unit
IDR	Intelligent Document Recognition
IoT	Internet of Things
OR	Operation Room

5 Categories for defining use cases of machine learning in medicine

5.1 Categories based on technology

5.1.1 General

AI techniques used in medicine can be summarized as in Table 1.

Table 1 — Technology based categories of artificial intelligence and their purposes

Technology	Purpose
Robotics	Providing high quality treatments by increasing the precision and accuracy of the surgical process.
Continuous monitoring	Within golden time, proper treatment could be performed by continuously monitoring of patient condition and alerting nurses.
Machine learning	Predict response by analyzing data affecting treatment outcomes.
Deep learning	Self-learning ability to process large amounts of medical imaging records, reducing uncertainty in medical treatment decisions.

Table 1 *(continued)*

Technology	Purpose
Image processing	Process large-scale medical images and apply them to detect diseases, diagnosis, etc.
Natural language processing	Translate long descriptive character sets such as electric medical records to be interpreted.
Audio recognition	By recognizing voice and language of patient, dictate important information in electric medical records.
Bigdata analysis	Process vast patient health records held by healthcare organizations and provide tailored recommendations to patients and providers.
Prediction modeling	Apply AI models to predict outcomes such as predicting risk disorders.

5.1.2 Robotics

In robotics, AI can provide high quality treatments by increasing the precision and accuracy of the surgical process. For example, it can control the trajectory, depth, and speed of the robot movements with high precision and can go where traditional tools cannot. It can also reduce the burdens of the surgeons during surgery by providing the same, repetitive movements without fatigue.

5.1.3 Continuous monitoring

Proper treatment within golden time could be performed by continuously monitoring of patient condition and alerting nurses by AI. AI model with continuous monitoring data also can alert the clinicians before onset.

5.1.4 Machine learning

By using traditional machine learning methods, AI can be used to predict response by analysing data affecting treatment outcomes.

5.1.5 Deep learning

By using deep learning, self-learning ability to process large amounts of imaging and audios records in medicine, reducing uncertainty in medical treatment decisions including computer aided detection, computer aided diagnosis, computer aided differential diagnosis, and clinical decision support system. Deep learning can handle multiple different types of clinical data such as images, texts, and signals at the same time.

5.1.6 Image processing

In image processing, AI can be used to process large-scale medical images and apply them to detect diseases, diagnosis, etc. AI for clinical image handling has demonstrated its performance in clinical settings.

5.1.7 Natural language processing

In NLP, AI can be used to translate long descriptive character sets such as electric medical records to be interpreted, i.e. extracting the information from unstructured electronic medical records.

5.1.8 Audio recognition

In audio recognition, by recognizing voice and language of patient, AI can automatically dictate important information in electric medical records.