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Information technology — Artificial intelligence (AI) — Use cases

*Technologies de l'information — Intelligence artificielle (IA) —
Cas pratiques*

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Contents

Page

Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviated terms	1
5 Applications	3
5.1 General	3
5.2 Application domains	3
5.3 Deployment models	4
5.4 Examples of AI applications	4
6 Use cases	8
6.1 General	8
6.2 Sources of use cases	8
6.3 Guidance for submitting use cases	8
6.4 Fields of the use case template	8
6.4.1 General	8
6.4.2 ID	9
6.4.3 Use case name	9
6.4.4 Application domain	9
6.4.5 Deployment model	9
6.4.6 Objective(s)	9
6.4.7 Narrative	9
6.4.8 Stakeholders and stakeholder perspectives	9
6.4.9 Data characteristics	10
6.4.10 Key performance indicators (KPIs)	10
6.4.11 Features of use case	10
6.4.12 Threats and vulnerabilities	11
6.4.13 Challenges and issues	11
6.4.14 Trustworthiness considerations	11
6.4.15 Use of standards; opportunities for future standardization	13
6.4.16 SDGs to be achieved	13
6.5 Basic statistics	13
6.5.1 Use cases by application domain	13
6.5.2 Use cases by task	14
6.5.3 Use cases by relevant SDGs	14
6.6 Societal concerns	15
7 Use cases summaries	15
7.1 General	15
7.2 Agriculture	21
7.2.1 Real-time segmentation and prediction of plant growth dynamics using low-power embedded systems equipped with AI (use case 126)	21
7.2.2 Smart agriculture (use case 156)	23
7.2.3 Forecasting of crop yield using decision support system (use case 173)	24
7.3 Digital marketing	26
7.3.1 Improving conversion rates and return on investment (RoI) with AI technologies (use case 53)	26
7.3.2 AI system for digital marketing in retail services (use case 185)	27
7.4 e-commerce/e-business	29
7.4.1 Emotion-sensitive AI customer service (use case 42)	29
7.4.2 Deep learning-based user intent recognition (use case 43)	31
7.4.3 AI virtual assistant for customer support and service (use case 106)	33

7.4.4	Customer relation management (CRM) (use case 157)	34
7.5	Education	36
7.5.1	A recommendation system for industrial training (use case 23)	36
7.5.2	An intelligent marking system (use case 83)	38
7.5.3	Intelligent educational robot (use case 84)	40
7.5.4	AI system to intelligent campus (use case 85)	41
7.5.5	AI adaptive learning platform for personalized learning (use case 102)	43
7.5.6	AI adaptive learning mobile app (use case 124)	45
7.6	Energy	46
7.6.1	Smart energy grid (use case 166)	46
7.7	Fintech	48
7.7.1	Detection of fraud based on collusion (use case 20)	48
7.7.2	Virtual bank assistant (use case 57)	49
7.7.3	Forecasting prices of commodities (use case 91)	51
7.7.4	Financial advice and asset management with AI (use case 114)	52
7.7.5	Loan in 7 minutes (use case 119)	54
7.7.6	Predictive risk intelligence (use case 164)	55
7.8	Healthcare	57
7.8.1	AI system to predict post-operative visual acuity for LASIK surgeries (use case 24)	57
7.8.2	AI system to quality control of electronic medical record (EMR) in real time (use case 50)	59
7.8.3	Discharge summary classifier (use case 79)	60
7.8.4	Generation of clinical pathways (use case 80)	62
7.8.5	Hospital management tools (use case 81)	63
7.8.6	Predicting relapse of a dialysis patient during treatment (use case 87)	64
7.8.7	Instant triaging of wounds (use case 89)	66
7.8.8	Detection of fraudulent medical claims (use case 90)	68
7.8.9	AI platform for chest CT-scan analysis (early stage lung cancer detection) (use case 105)	69
7.8.10	Neural network formation of 3D-models orthopaedic insoles (use case 121)	71
7.8.11	Search of undiagnosed patients (use case 127)	72
7.8.12	A clinical decision support system (use case 131)	73
7.8.13	Symptom assessment (hypothetical) (use case 134)	76
7.8.14	Making using evidence-based medicine and AI (use case 167)	77
7.8.15	AI-service for blood cells and bone marrow scans analysis (use case 168)	79
7.8.16	AI-service for chest X-ray and chest CT (use case 169)	81
7.8.17	Intelligent video analytics system (use case 170)	83
7.8.18	Retrospective analysis (use case 172)	84
7.8.19	Robotization of the federal hotlines on COVID-19 issues (use case 174)	85
7.8.20	Use of computer vision innovative technologies for analysis of medical images and further application (use case 175)	87
7.9	Home and service robotics	89
7.9.1	Device control using AI consisting of cloud computing and embedded system (use case 132)	89
7.10	ICT	91
7.10.1	AI system to help mobile phones to have better picture effect (use case 32)	91
7.10.2	Product failure prediction for critical IT infrastructure (use case 86)	93
7.10.3	AI-based optimized field dispatch (use case 151)	94
7.10.4	Wireless network failure prediction (use case 152)	96
7.10.5	AI performance evaluation of AI-powered messaging bots (use case 176)	97
7.11	Insurance	100
7.11.1	AI services for health insurance companies (use case 161)	100
7.12	Knowledge management	102
7.12.1	Water crystal mapping (use case 77)	102
7.12.2	AI system with a digital knowledge centre for utilizing the knowledge in the organization (use case 187)	104
7.13	Legal	106
7.13.1	AI contract management (use case 120)	106

7.14	Manufacturing.....	108
7.14.1	Quality assurance solution based on AI, to detect defects on wind turbines blades (use case 4)	108
7.14.2	Generative design of mechanical parts (use case 15).....	110
7.14.3	Powering remote drilling command centre (use case 36).....	111
7.14.4	Quality improvement of adhesive products, based on AI (use case 37).....	113
7.14.5	Empowering autonomous flow meter control- reducing time taken to “proving of meters” (use case 40).....	114
7.14.6	Improvement of productivity of semiconductor manufacturing (use case 82).....	116
7.14.7	AI decryption of magnetograms (use case 104).....	119
7.14.8	Analysing and predicting acid treatment effectiveness of bottom hole zone (use case 110).....	120
7.14.9	Automatic classification tool for full size core (use case 112).....	122
7.14.10	Collaborative AI to assist workers with production and assembly in factories (use case 179).....	124
7.15	Media and entertainment.....	126
7.15.1	Video on demand publishing intelligence platform (use case 58).....	126
7.15.2	AI system for promoting DX in customer attraction services at a museum (use case 178).....	128
7.16	Public sector.....	129
7.16.1	AI ideally matches children to daycare centres (use case 7).....	129
7.16.2	Open spatial data set for developing AI algorithms based on remote sensing (satellite, drone, aerial imagery) data (use case 122).....	131
7.16.3	Smart city (use case 165).....	133
7.16.4	AI tool for species categorization for wildlife population monitoring (use case 177).....	135
7.17	Security.....	137
7.17.1	Non-intrusive detection of malware (use case 93).....	137
7.17.2	Detect pickpockets in a crowd - training with privacy-sensitive data (use case 181).....	138
7.18	Transportation.....	140
7.18.1	Enhancing traffic management efficiency and infraction detection accuracy with AI technologies (use case 29).....	140
7.18.2	AI system for traffic signal optimization based on multi-source data fusion (use case 49).....	142
7.18.3	Dynamic routing software as a service (SaaS) based on artificial intelligence (use case 92).....	144
7.18.4	Misbehaviour detection (MBD) for V2X (use case 182).....	145
7.18.5	AI system to estimate or predict congestion length for traffic signal control (use case 183).....	147
7.18.6	Traffic signal control using artificial intelligence (use case 184).....	148
7.18.7	AI system for predicting rivers’ water levels during flooding (use case 186).....	149
7.19	Work and life.....	152
7.19.1	Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain (use case 28).....	152
7.19.2	Improving the quality of online interaction (use case 88).....	153
7.19.3	Business use of IoT for surveillance (use case 162).....	155
7.19.4	Video surveillance (use case 180).....	157
Annex A (informative) Use case template.....		159
Annex B (informative) Use cases list of ISO/IEC TR 24030:2021 and ISO/IEC TR 24030:—.....		162
Bibliography.....		168

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).

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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 TR 24030:2021), which has been technically revised.

The main changes are as follows:

- selection of 51 “in operation” use cases from Annex A (informative), Collected use cases of ISO/IEC TR 24030:2021;
- collection and selection of 30 additional use cases;
- enhanced the use case submission form and the structure of use case description in [Clause 7](#) to describe the desirable information of use cases;
- updated the statistics in [6.5](#) to reflect the use cases in this document;
- removed the subclauses that are no longer suitable for the use cases in this document (e.g. 6.6.3, Annex A and Annex C in the first edition);
- removed most of the terms from [Clause 3](#) to leave two definitions in this document.

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.

Introduction

This document provides a collection of artificial intelligence (AI) use cases in a variety of domains.

In total, 187 AI use cases were submitted by experts between July 2018 and the end of June 2022. In this document, the term “use cases” means “use cases selected from those submitted”. This document selected 81 in-operation use cases from all submissions.

The rationale for this document is as follows:

- illustrating the applicability of the AI standardization work across a variety of application domains;
- input to and reference for AI standardization work;
- sharing the collected use cases in support of AI standardization work with external organizations and internal entities to foster collaboration;
- reach out to new stakeholders interested in AI applicability;
- liaising with organizations to collect requirements for AI through use cases;
- by investigating use cases, it is possible to find new technical requirements (standardized demands) in the market, which can accelerate the pace of transformation of scientific and technological achievements.

While a bottom-up approach was used to collect use cases, a top-down approach is used in this document to identify AI applications, their deployment models and their application domains, as shown in [5.2](#)

The first step taken to collect use cases was to identify application domains of AI systems (described in [Clause 5](#)) and to provide a use case template (described in [6.4](#) and [Annex A](#)). Contributors were requested to submit use cases using the provided template.

To improve the quality of use cases, guidance has been provided to contributors. This guidance includes acceptable sources (described in [6.3](#)) and the characteristics of the AI systems (described in [6.4](#)) that are used to develop use cases.

In this document, [6.5](#) includes basic statistics of use cases. [Subclause 6.6](#) introduces societal concerns that affect many use cases.

The use cases were grouped and categorized according to the identified application domains. In this document, use cases are grouped, categorized and summarized according to the identified application domains in [Clause 7](#). Use cases of specific application domains and their original submissions can be found at <https://standards.iso.org/iso-iec/tr/24030/ed-2/en>.

The perspectives of security and privacy in the AI use cases can be found in ISO/IEC TR 27563^[6]. ISO/IEC TR 27563^[6] includes a security and privacy analysis of the use cases in ISO/IEC TR 24030:2021. It is mentioned that the analysis was carried out independently from the use cases in ISO/IEC TR 24030:2021 contributors and therefore that it does not necessarily reflect their views.

AI is an emerging field with use cases and solutions with a wide range of maturity and success. The descriptions are given for the convenience of users of this document and does not constitute an endorsement by ISO.

Information technology — Artificial intelligence (AI) — Use cases

1 Scope

This document provides a collection of representative use cases of AI applications in a variety of domains.

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 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 artificial intelligence

AI

<discipline> research and development of mechanisms and applications of *AI systems* (3.2)

Note 1 to entry: Research and development can take place across any number of fields such as computer science, data science, natural sciences, humanities, mathematics and natural sciences.

[SOURCE: ISO/IEC 22989:2022, 3.1.3]

3.2 artificial intelligence system

AI system

engineered system that generates outputs such as content, forecasts, recommendations or decisions for a given set of human-defined objectives

Note 1 to entry: The engineered system can use various techniques and approaches related to artificial intelligence to develop a model to represent data, knowledge, processes, etc. which can be used to conduct tasks.

Note 2 to entry: AI systems are designed to operate with varying levels of automation.

[SOURCE: ISO/IEC 22989:2022, 3.1.4]

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply. The abbreviated terms are extracted from use cases.

AUC	area under the curve
BERT	bidirectional encoder representations from transformers
CNN	convolutional neural network
COBIT	control objective for information and related technology
CRISP-DM	cross-industry standard process for data mining
CRM	customer relations management
CSV	comma separated values
CT	computed tomography
CV	computer vision
DICOM	digital imaging and communications in medicine
DL	deep learning
EHR	electronic health record
GDPR	general data protection regulation
GPU	graphics processing unit
ICT	information and communication technology
ISP	internet service provider
ITIL	information technology infrastructure library
KPIs	key performance indicators
LSTM	long-short-term memory network
ML	machine learning
NLP	natural language processing
NLU	natural language understanding
PACS	picture archiving and communication system
RMSE	root mean square error
RNN	recurrent neural network
ROC	receiver operating characteristic
SaaS	software as a service
SIS	smart information systems
SVM	support vector machine
UT	ultrasonic testing
XGBoost	extreme gradient boosting

5 Applications

5.1 General

This clause identifies AI applications from the perspectives of their application domains and deployment models.

5.2 Application domains

Eighteen application domains were considered as target domains for the use cases. The classifications of the application domains are based on the categories in References [16] and [17].

- agriculture: this domain refers to the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food or other products (see ISO 20670:2018, 3.2[7]);
- digital marketing: this domain refers to the applications of marketing that uses the Internet and online based digital technologies such as desktop computers, mobile phones and other digital media and platforms to promote products and services;
- e-commerce/e-business (electronic commerce / electronic business): this domain is a category of business transactions, involving two or more Persons, enacted through electronic data interchange, based on a monetary and for-profit basis. Persons can be individuals, organizations or public administrations. The underlying principles and characteristics of e-commerce and e-business include: 1) being business transaction based (of both a financial and non-financial nature); 2) using information technology (computers and telecommunications); 3) interchanging electronic data involving establishment of commitments among persons;
- education: this domain refers to the applications that can provide processes by which an individual or group of people conveys, transfers or obtains knowledge about a subject or concept (see ISO 30422:2022, 3.9[8]);
- energy: this domain refers to the industry that is the totality of all of the industries involved in the production and sale of energy, including fuel extraction, manufacturing, refining and distribution;
- fintech: this domain refers to the companies whose line of business combines software and technology to deliver financial services. the emergence of fintech companies can reshape and improve finance by cutting costs and expanding access to financial services[20];
- healthcare: this domain refers to the applications that provide activities, services, or supplies related to the health of an individual (see ISO/TR 14639-2:2014, 2.31[9]);
- home and service robotics: this domain refers to the science and practice of designing, manufacturing and applying robots that performs useful tasks for humans or equipment excluding industrial automation applications (see ISO 8373:2021, 3.7, 3.10[10]);
- ICT (Information and Communications Technology): this domain refers to group of applications using information and communications (telecommunications) technologies for gathering, storing, retrieving, processing, analysing and transmitting information (see ISO/IEC TR 24704:2004, 3.1.5[11] and ISO/IEC 29138-1:2018, 3.3[12]);
- insurance: this domain provides an effective mechanism for protection and risk management and limits or relieves the financial burden on the insured by mitigating the effects of unpredictable events such as illness, accident, death and natural disasters. Insurance companies pool different types of risk and use statistical analysis to project losses within a given class;
- knowledge management: this domain refers to the applications that provide combination of processes, actions, methodologies, and solutions that enable the creation, maintenance, distribution and access to knowledge (see ISO/IEC 30145-2:2020, 3.7[13]);

- legal: this domain refers to the applications that are used in the legal services industry provide expert advice in all aspects of the law, including contract, corporate, criminal, family and estate, tax and tort law^[21];
- manufacturing: this domain refers to the industry that is industries transforming goods, that is, mainly manufacturing industries in their own right, but they also concern the repair and installation of industrial equipment and subcontracting operations for third parties^[22];
- media and entertainment: this domain comprises businesses that produce, distribute and offer ancillary digital services and products for motion pictures, television programs and commercials along with streaming content, music, video and audio recordings, broadcast, radio, text and book publishing, eSports and video games sectors^[23];
- public sector: this domain refers to businesses and industries that are owned or controlled by the government;
- security: this domain refers to the industry that is made up of companies that manufacture and sell security products. The industry also includes licensed security agents, as well as associations that regulate security agencies, services and products^[24];
- transportation: this domain encompasses the movement of humans, animals and goods from one place to another. “Transportation” can be subdivided into “transportation infrastructure”, “transportation vehicles” and “transportation operations”;
- work and life: this domain refers to the industries in which digital technologies have had profound impacts, good and bad, and other sectors in which automation will likely experience major changes in the near future. Many of these changes have been driven strongly by “routine” digital technologies, including enterprise resource planning, networking, information processing and search^[17].

5.3 Deployment models

This document considers the use of AI applications and lists the following possible deployment models of AI applications.

- cloud services;
- cyber-physical systems;
- embedded systems;
- hybrid (embedded systems and cloud services, or on-premise systems and cloud services);
- on-premise systems;
- social networks.

5.4 Examples of AI applications

Examples of AI applications are listed in [Table 1](#). These application examples were derived from the “Artificial Intelligence White Paper”^[16]. Each example in [Table 1](#) has an application domain, deployment mode and short description.

The applications in [Table 1](#) are the result of a top-down approach and can be considered to be indicative for collecting use cases. Not all the applications are necessarily addressed by the collected use cases.

Table 1 — Examples of AI applications

Application domain	Application	Deployment model	Short description
Agriculture	Agricultural automation	Cloud services	Monitor and manage field conditions.
		On-premise systems	Accumulate weed or insect patterns and eliminate them.

Table 1 (continued)

Application domain	Application	Deployment model	Short description
Agriculture	Craftsmanship skill transfer	Cloud services	Learn about the best practices from craftsmen and provide feedback to others.
Agriculture	Cultivation management	On-premise systems	Monitor the field condition and manage the irrigation condition.
Manufacturing	Construction planning	Cloud services	Learn about the best practices and apply them to future planning.
Manufacturing	Robot construction	Cloud services	Provide autonomous construction robots to construction sites.
		On-premise systems	
Manufacturing	Abnormality or malfunction prediction	Cloud services	Accumulate normal signal patterns to learn normal signals.
		On-premise systems	Find out abnormal signal patterns on the premises.
Security	Cyber security	Cloud services	Monitor cyber transactions against important defence assets and find out attack patterns and prevent their intrusion.
Security	Electronic warfare	Cloud services	Autonomous pilot with cloud support to enable electronic warfare.
		Embedded systems	
		On-premise systems	
Digital marketing	Online campaign performance optimization	Cloud services	Targeted advertising through data analysis.
Education	Adaptive learning	On-premise systems	Provide personalized learning materials via a learning model to achieve efficient learning results.
Education	Scoring	On-premise systems	Provide the most effective feedback to learners via the cognitive learning model to achieve the most effective learning results.
Fintech	Asset management	Cloud services	Accumulate and learn about the best practices and apply them to realize customer satisfaction.
Fintech	Fraud identification	Cloud services	Identify fraud transactions and warn managers.
Fintech	Loan screening	Cloud services	Learn about customers' backgrounds to find out abnormal loan patterns.
Fintech	Security assurance against cyber attacks	Cloud services	Learn and detect known fraud patterns or discover unknown fraud patterns.
Fintech	Stock exchange and trading	Cloud services	Accumulate the best practices and enable 24/7 trading.
Healthcare	Diagnosis support	Cloud services	Provide diagnostic or treatment information and find out abnormal condition compared with normal condition.
		On-premise systems	
Healthcare	Electronic health record system	Cloud services	Accumulate and disseminate learning disease patterns and healthy patterns, and assistants as an integrated medical support system.
		Embedded systems	
		Hybrid	
		On-premise systems	

Table 1 (continued)

Application domain	Application	Deployment model	Short description
Healthcare	New drug development	Cloud services	Curation: Find out the correlation among submitted papers.
			Molecular pattern: Find out the effective coordination of target molecule.
Legal	Early case assessment	Cloud services	AI support of work that preps had been doing.
Legal	Judicial recommendation	Cloud services	Judge support by using previous judicial judgment cases.
Transportation	Logistics in the base	Cloud services	Coordinate the best logistic move in the local procurement base warehouse.
		On-premise systems	
Transportation	Procurement logistics	Cloud services	Analyse the procurement context and propose the best procurement actions.
		On-premise systems	
Transportation	Sales logistics	Cloud services	Analyse and learn about the best practices of sales logistics and provide the most effective routes to move sales.
		On-premise systems	
Transportation	Automatic cruise control	Cloud services	Update cruise control software dynamically. Accumulate road condition data and disseminate them to autonomous agents. Mainly enabled on wheelchairs, ships and autonomous robots.
		Embedded systems	Enable autonomous driving without any help from connected devices. Mainly enabled on wheelchairs, ships and autonomous robots.
Transportation	Autonomous driving	Cloud services	Update cruise control software dynamically. Accumulate road condition data and disseminate them to autonomous agents. This application is mainly implemented on vehicles.
		Embedded systems	Enable autonomous driving without any help from connected devices. This application is mainly implemented on vehicles.
Transportation	City-wide traffic control	Cyber-physical systems	Optimize city-wide traffic flow by inspecting real-time traffic images and controlling traffic signals.
Transportation	Dynamic map for autonomous cruise control	Cloud services	Create, maintain, and disseminate map information with semantic tags with real-time communication with mobile agents such as cars, wheelchairs, robots, and human beings.
		On-premise systems	Accumulate actual road situation data and recognize objects that are not on the shared map.

Table 1 (continued)

Application domain	Application	Deployment model	Short description
Transportation	Robot taxi	Cloud services	Pick-up arrangement system controls robot taxis effectively.
		Embedded systems	Autonomously drive on the road with dynamic control of steering, acceleration and braking.
		On-premise systems	Autonomously drive on the road using a road map.
Manufacturing	Development design	Cloud services	Accumulate design patterns to help designers.
		On-premise systems	Check design patterns under real constraints on the premises.
Manufacturing	Product quality inspection	On-premise systems	Inspect products by image recognition.
Manufacturing	Production process	Cloud services	Accumulate production quality actuation patterns and estimate quality performance.
Manufacturing	Production process	On-premise systems	Accumulate production throughput-related parameters and estimate the output throughput.
Public sector	Online service support	Cloud services	Provide residents with support for online services.
		Social networks	
Public sector	Public service matching	Cloud services	Optimize matching between residents and public services.
		On-premise systems	
Digital marketing	Autonomous driving store	On-premise systems	Provide autonomous driving sales robots.
Digital marketing	Register-less store	On-premise systems	Monitor all customer movements to realize cash register-less retail shops.
Security	Cyber security	Cloud services	Monitor transactions in cyber space and find out attacks through finding abnormal transaction patterns.
Security	Personal information management	Cloud services	Monitor operations for GDPR conformance assurance.
Security	Video surveillance and crime risk prediction	Cloud services	Monitor behavioural patterns in urban areas, predict crime risk and find out criminal patterns.
Public sector	Equipment operation	Cloud services	Accumulate operational parameters and learn normal operations.
		On-premise systems	Monitor operations and find out abnormal operation patterns.
Public sector	Improvement of operational efficiency	Cloud services	Learn about the correlation among significant parameters and realize the most efficient operations. Traffic control, electricity supply control, etc.
Public sector	Landslide, flood prediction	Cloud services	Monitor weather and ground conditions in real time and predict disasters such as landslides, floods, etc.
		On-premise systems	
Energy	Power demand forecasting	Cloud services	Learn about demand patterns with other significant parameters and forecast future demand.

Table 1 (continued)

Application domain	Application	Deployment model	Short description
Work and life	Smart home appliances	Embedded systems	Equip robot vacuums, refrigerators and air conditioners with sophisticated control.
Work and life	Smart personal agent	Social networks	Smart agents assist individual users.

6 Use cases

6.1 General

This document is based on a collection of use cases available at <https://standards.iso.org/iso-iec/tr/24030/ed-2/en>. Use cases from the first edition of ISO/IEC TR 24030 were included only when they were updated to meet the selection criteria for the second editions. New submissions to the second edition that did not meet the selection criteria (in-operation and of sufficient quality) are omitted from the electronic attachment. This document contains 81 “in-operation” use cases that were selected from those submitted. [Annex B](#) gives the use case titles and the subclause numbers in the first edition and this document. Some use cases refer to trademarks or trade names such as company names, product names or service names. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products or services.

The terms of the template used for the collection of use cases, which is given in [Annex A](#), are defined in [6.4](#). [Clause A.1](#) describes a blank template and [Clause A.2](#) describes the comparison of the use case templates between ISO/IEC TR 24030:2021 and this document. [Subclause 6.2](#) provides sources of use cases. [Subclause 6.3](#) provides guidance for the submission of use cases. [Subclause 6.5](#) presents basic statistics on the selected use cases. Societal concerns relating to the use cases are described in [6.6](#).

6.2 Sources of use cases

To improve the quality of use case descriptions, potential sources are:

- peer-reviewed scientific or technical publications on AI applications;
- patent documents describing AI systems;
- technical reports or conference presentations;
- high quality company whitepapers and presentations;
- publicly accessible sources in sufficient detail.

6.3 Guidance for submitting use cases

Use case submissions were considered for inclusion in this document based on the following factors:

- diversity and representativeness: this document is meant to represent a range of AI use cases in terms of application domain, deployment model, objectives, stakeholders, autonomy, data characteristics, architecture and other factors;
- amount of information: to populate as many fields as possible;
- positive impact: demonstration of positive outcomes for society, the environment and stakeholders.

6.4 Fields of the use case template

6.4.1 General

The terms in the template used for the collection of use cases are defined in [6.4.2](#) to [6.4.16](#).

6.4.2 ID

The unique number that identifies the use cases in ISO/IEC TR 24030:2021^[4] and in this document.

6.4.3 Use case name

Generally, the name of the use case provided by the use case contributor. However, some use cases were renamed for clarity.

6.4.4 Application domain

Generally, the application domain selected by the use case contributor from the list in [5.2](#). However, the classification of some use cases was changed for consistency reasons.

6.4.5 Deployment model

Deployment model selected by the use case contributor from the list in [5.3](#).

6.4.6 Objective(s)

Generally, the objectives of the AI system defined by the use case contributor, including the following:

- what is to be accomplished;
- intended beneficiaries of the AI system;
- scope, boundaries and limitations.

The objectives of some use cases were amended to improve their readability.

6.4.7 Narrative

This field asks the contributor to provide description of optimization or inferences being made with the AI model and what decisions, predictions, recommendations are being applied; capabilities and features that are unique to the domain, decision environment; whose decision is being augmented? the dynamics of the decision environment, etc.

6.4.8 Stakeholders and stakeholder perspectives

ISO/IEC 22989^[1] defines a stakeholder as any individual, group, or organization that can affect, be affected by, or perceive itself to be affected by a decision or activity. This can include organizations, customers, third parties, end users, the community, the environment, developers and other entities. The use case can describe AI system stakeholders and how their perspectives are taken into consideration. Stakeholder perspectives include stakeholder assets, values and effects.

AI stakeholder roles includes:

- AI provider: provides products or services that use the AI system;
- AI producer: designs, develops, tests and deploys products or services that use the AI system;
- AI Customer: uses an AI product or service either directly or by its provision to AI users;
- AI partner: provides services in the context of AI;
- AI subject: impacted by an AI system, service, or product.

Details of AI stakeholder roles can be found in ISO/IEC 22989:2022, 5.19^[1].

6.4.9 Data characteristics

6.4.9.1 General

This field describes the data characteristics that are defined in [6.4.9.2](#) to [6.4.9.7](#).

6.4.9.2 Source

Origin of data processed by the AI system, e.g. customers, instruments, IoT, web, surveys, commercial activity, simulations or other sources.

6.4.9.3 Variety

Types of data processed by the AI system, e.g. structured or unstructured text, images, voices, gene sequences, numbers, composite: time-series, graph-structures. This field can also briefly discuss formats, logical models, timescales and semantics.

6.4.9.4 Velocity

The rate of flow at which the data in the AI system is created, stored, analysed or visualized. That can be in real time.

6.4.9.5 Variability

Changes in data rate, format, structure, semantics or quality.

6.4.9.6 Quality

Completeness and accuracy of the data with respect to semantic content as well as syntax of the data (e.g. presence of missing fields or incorrect values).

6.4.9.7 Protected attributes

An attribute for equal treatment across groups (e.g. gender, race, religion, legally regulated attribute).

6.4.10 Key performance indicators (KPIs)

This field describes the KPIs for evaluating the performance or usefulness of the AI system.

6.4.11 Features of use case

6.4.11.1 General

This field describes the features and AI characteristics of the use case.

6.4.11.2 Task(s)

The main task of the use case. A pull-down list includes recognition, natural language processing, knowledge processing and discovery, inference, planning, prediction, optimization, interactivity, classification, recommendation and others.

NOTE NLP includes the tasks such as natural language understanding (NLU), natural language generation (NLG), part of speech (POS), question answering, machine translations, relationship extraction sentiment analysis and automatic summarization. The details of NLP tasks are described in ISO/IEC 22989:2022, 9.2.2^[1] and ISO/IEC 22989:2022, 3.6^[1].

6.4.11.3 Level of automation

The level of automation of AI systems used in this use case.

AI systems can be compared based on the degree of automation and whether they are subject to external control. Autonomy is at one end of a spectrum and a fully human controlled system on the other, with degrees of heteronomy in between.

The level of automation includes the following options:

- full automation: the system can modify its operating domain or its goals without external intervention, control or oversight;
- high automation: the system can perform its entire mission without external intervention;
- conditional automation: the system performs parts of its mission without external intervention;
- partial automation: sustained and specific performance by a system, with an external agent being ready to take over when necessary;
- assistance: some sub-functions of the system are fully automated while the system remains under the control of an external agent;
- no automation: the system assists an operator.

See ISO/IEC 22989:2022, 5.12^[1] for more details on the levels of automation.

6.4.11.4 Method(s)

AI method or AI methods, model or models, or framework or frameworks used in development.

6.4.11.5 Platform

Platform (includes hardware system) used in development and deployment.

6.4.11.6 Topology

Topology of the deployment network architecture.

6.4.12 Threats and vulnerabilities

This field describes threats and vulnerabilities relevant to the use case, such as unwanted bias, incorrect AI system use, security threats, challenges to accountability and privacy threats (hidden patterns).

6.4.13 Challenges and issues

Descriptions of challenges and issues of the use case.

6.4.14 Trustworthiness considerations**6.4.14.1 General**

The trustworthiness of AI system is defined as ability to meet stakeholder expectations in a verifiable way (see ISO/IEC 22989:2022, 3.5.16^[1]). This field is used to describe how the use case addresses the characteristics of trustworthiness that include, for instance, reliability, availability, resilience, security, privacy, safety, accountability, transparency, integrity, authenticity, quality and usability.

6.4.14.2 Bias mitigation

ISO/IEC TR 24027^[3] defines bias as systematic difference in treatment of certain objects, people or groups in comparison to others. In this part of the trustworthiness field, the use case can describe how biases such as human cognitive bias, confirmation, data bias and statistical bias are detected and mitigated in the AI system. The use case can also discuss how the organization has approached bias goals and challenges.

See ISO/IEC TR 24027^[3] for further information.

6.4.14.3 Ethical and societal concerns

In this part of the trustworthiness field, the use case can describe how societal and ethical concerns related to the AI system are understood, identified, controlled and mitigated. Current or future measures to address potential ethical and societal risks can also be described, along with protected attributes.

Societal concerns can be a factor when an organization is choosing or recommending an AI technology. Taking context, scope, nature and risks into consideration can mitigate undesirable societal outcomes. In the absence of such considerations, the technology itself can perform flawlessly from a technical perspective but have undesirable social or ethical impacts.

AI ethics is one important aspect of societal concerns that addresses the ethical issues arising from the use of AI systems. AI ethics are being considered in various countries and organizations in the form of principles, guidelines or regulations that ethical AI can follow.

AI ethics and ethical risks is based on the four ethical principles of trustworthy AI of EU high-level expert group (HLEG)^[19]:

- respect for human autonomy;
- prevention of harm;
- fairness;
- explainability.

The four ethical principles encompass additional ethical principles described by other AI principles or guidelines. Ethical risk can be defined as a problem caused by an AI system that does not follow the above ethical principles.

6.4.14.4 Explainability

ISO/IEC 22989:2022, 5.14.6^[1] defines explainability as a property of an AI system to express important factors influencing the AI system results in a way that humans can understand. In this part of the trustworthiness field, the use case can describe the degree to which the AI system results are explainable and discuss how the organization has approached explainability goals and challenges.

6.4.14.5 Controllability

ISO/IEC 22989:2022, 5.14.5^[1] defines controllability as a property of an AI system that a human or other external agent can intervene in the system's functioning. A key aspect of controllability is the determination of which agent(s) can control which components of the AI system (e.g. the service provider or product vendors, the provider of the constituent AI, the user or an entity with regulatory authority). In this part of the trustworthiness field, the use case can describe the degree to which the AI system is controllable and discuss how the organization has approached controllability goals and challenges.

6.4.14.6 Predictability

ISO/IEC 22989:2022, 5.14.7^[1] defines predictability as a property of an AI system that enables reliable assumptions by stakeholders about the output. In this part of the trustworthiness field, the use case can describe the degree to which the AI system results are predictable and discuss how the organization has approached predictability goals and challenges.

6.4.14.7 Transparency

ISO/IEC 22989:2022, 5.14.8^[1] defines transparency as a property of a system where appropriate information about the system is communicated to relevant stakeholders in system domain. In this part of the trustworthiness field, the use case can describe the degree to which the AI system results are transparent and discuss how the organization has approached transparency goals and challenges.

6.4.14.8 Verification

ISO/IEC 22989:2022, 5.14.9^[1] defines verification as confirmation, through the provision of objective evidence, that specified requirements have been fulfilled. In this part of the trustworthiness field, the use case can discuss how the organization has approached verification goals and challenges.

6.4.14.9 Robustness, reliability and resilience

ISO/IEC 22989^[1] defines robustness, reliability and resilience as follows:

- robustness: ability of a system to maintain its level of performance under any circumstances;
- reliability: property of consistent intended behaviour and results;
- resilience: ability of a system to recover operational condition quickly following an incident.

In this part of the trustworthiness field, the use case can describe the degree to which the AI system is robust, reliable and resilient, and discuss how the organization has approached goals and challenges of these characteristics.

6.4.15 Use of standards; opportunities for future standardization

Descriptions of standardization opportunities or requirements associated with use case.

6.4.16 SDGs to be achieved

The Sustainable Development Goals (SDGs)¹⁾, otherwise known as the Global Goals, are a collection of 17 global goals set by the United Nations General Assembly. SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

6.5 Basic statistics

6.5.1 Use cases by application domain

[Figure 1](#) shows the percentage of use cases per application domain. [Figure 1](#) only takes into account the 81 use cases described in [Clause 7](#).

NOTE The classification of some use cases was changed for consistency reasons.

1) <https://sdgs.un.org/goals>

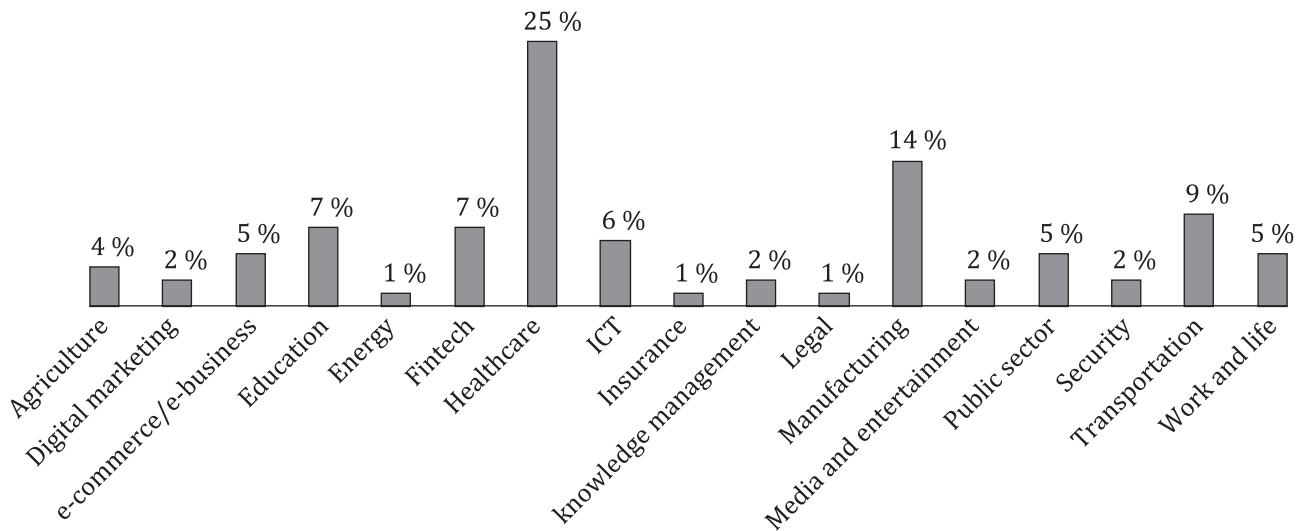


Figure 1 — Distribution of use cases by application domain

6.5.2 Use cases by task

[Figure 2](#) shows the distribution of the 81 use cases according to the tasks listed in [6.4.11.2](#). Some use cases that include multi-tasks are counted multiple times in [Figure 2](#).

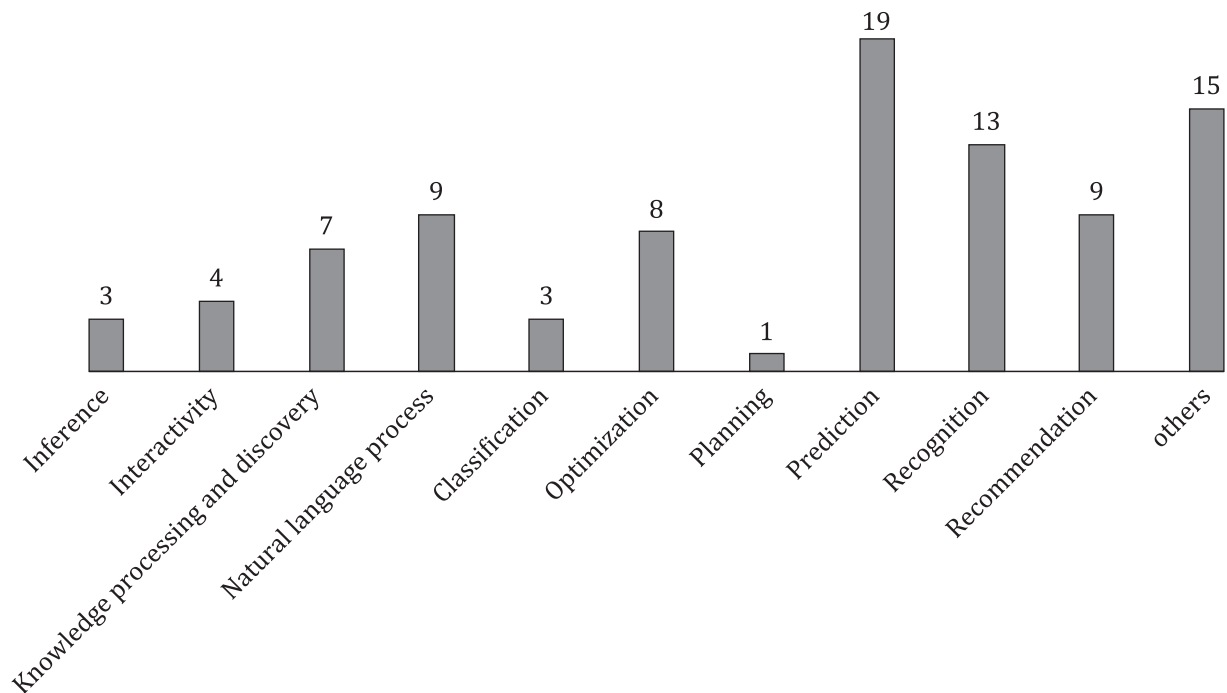


Figure 2 — Distribution of use cases by task

6.5.3 Use cases by relevant SDGs

[Figure 3](#) shows the distribution of the 81 use cases according to relevant SDGs, as identified in [Table 2](#). Some use cases that contribute to several SDGs are counted several times in [Figure 3](#).

NOTE The list of SDGs for certain use cases was modified for consistency reasons.

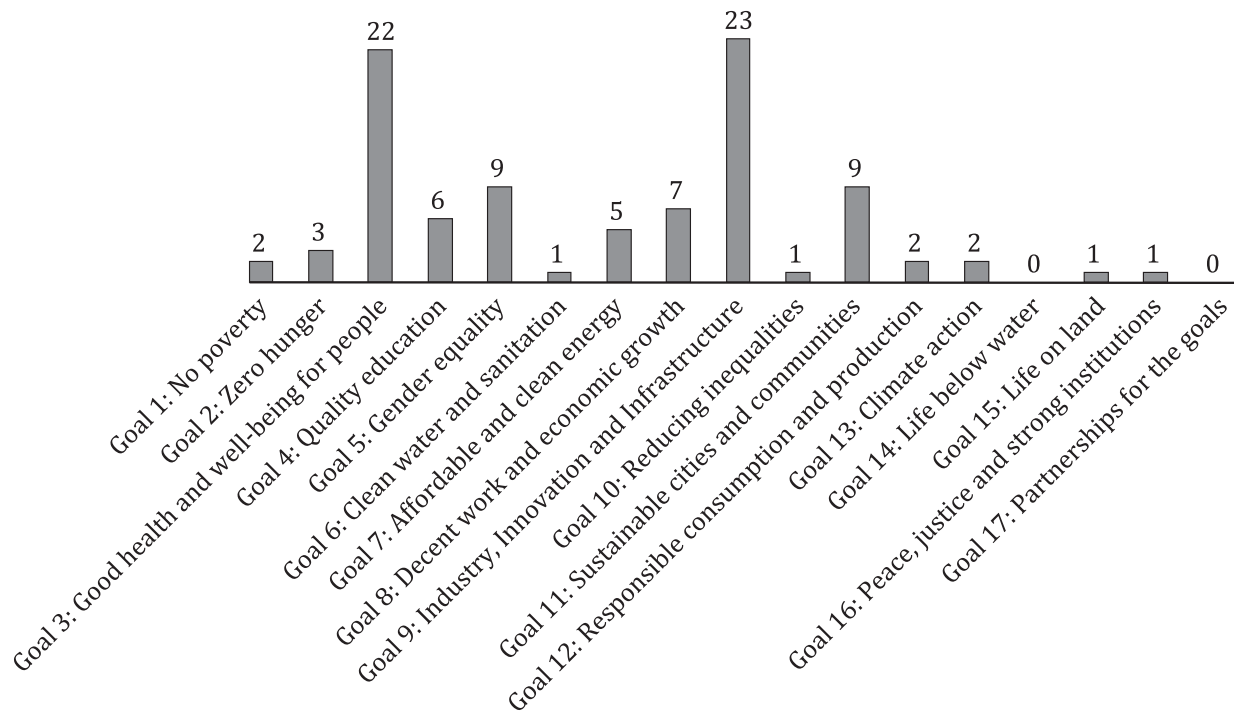


Figure 3 — Distribution of use cases by relevant SDGs

6.6 Societal concerns

ISO/IEC TR 24368^[5] identifies a number of ethical and societal concerns. The major topics in this document - accountability, fairness and non-discrimination, transparency and accountability, privacy, security, human control of technology and human-centred design - remain relevant. Since its publication additional trustworthiness characteristics have been identified: most notably the associated impact on environmental sustainability and the degree of societal risk resulting from the use of AI systems and applications. Broadly speaking, the use cases in this second edition reflect the additional attention these characteristics are receiving from consumers, producers, legislators and other AI stakeholders.

7 Use cases summaries

7.1 General

[Table 2](#) provides a summary of information for each of the 81 selected use cases, including the selected application domain, the name of the use case, the subclause in which it is described, its deployment model and relevant SDGs. [Subclauses 7.2](#) to [7.19](#) provide details of the selected use cases, grouped by application domain

AI is an emerging field, with use cases and solutions that have a wide range of maturity and success. Use case descriptions written by practitioners in their respective fields can include field specific wording. The descriptions are given for the convenience of users of this document and do not constitute an endorsement by ISO. Hyperlinks in the use cases were understood to be active at the time of submission. Not all fields were populated by the use case submitters. Therefore, some fields are blank.

Table 2 — List of use cases

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Agriculture	7.2.1	Real-time segmentation and prediction of plant growth dynamics using low-power embedded systems equipped with AI	Embedded system	Good health and well-being for people; zero hunger
	7.2.2	Smart agriculture	Embedded system	Zero hunger
	7.2.3	Forecasting of crop yield using decision support system	Cloud services	Zero hunger
Digital marketing	7.3.1	Improving conversion rates and return on investment (RoI) with AI technologies	On-premise systems	Sustainable cities and communities
	7.3.2	AI system for digital marketing in retail services	Hybrid	Responsible consumption and production
e-commerce/ e-business	7.4.1	Emotion-sensitive AI customer service	On-premise systems	Industry, innovation, and infrastructure
	7.4.2	Deep learning-based user intent recognition	Cloud services	Decent work and economic growth
	7.4.3	AI virtual assistant for customer support and service	On-premise systems	Affordable and clean energy
	7.4.4	Customer relation management (CRM)	Hybrid	Responsible consumption and production; gender equality
Education	7.5.1	A recommendation system for industrial training	On-premise systems	Decent work and economic growth
	7.5.2	An intelligent marking system	On-premise systems	Quality education
	7.5.3	Intelligent educational robot	On-premise systems	Quality education
	7.5.4	AI system to intelligent campus	Cloud services	Quality education
	7.5.5	AI adaptive learning platform for personalized learning	Cloud services	Quality education; gender equality
	7.5.6	AI adaptive learning mobile app	Hybrid	Quality education; gender equality
Energy	7.6.1	Smart energy grid	Embedded systems	Affordable and clean energy

Table 2 (continued)

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Fintech	7.7.1	Detection of frauds based on collusions	On-premise systems	Decent work and economic growth
	7.7.2	Virtual bank assistant	Cloud services	Industry, innovation and infrastructure
	7.7.3	Forecasting prices of commodities	On-premise systems	Reducing inequalities
	7.7.4	Finance advising and asset management with AI	Cloud service	No poverty
	7.7.5	Loan in 7 minutes	On-premise systems	Industry, innovation, and infrastructure; No poverty; Decent work and economic growth; Gender equality
	7.7.6	Predictive risk intelligence	Hybrid	Industry, innovation, and infrastructure; Gender equality

Table 2 (continued)

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Healthcare	7.8.1	AI system to predict post-operative visual acuity for LASIK surgeries	Cloud services	Good health and well-being for people; Gender equality
	7.8.2	AI system for quality control of electronic medical records (EMR) in real time	Cloud services	Good health and well-being for people
	7.8.3	Discharge summary classifier	On-premise systems	Good health and well-being for people
	7.8.4	Generation of clinical pathways	On-premise systems	Good health and well-being for people
	7.8.5	Hospital management tools	On-premise systems	Good health and well-being for people
	7.8.6	Predicting relapse of a dialysis patient during treatment	Cloud services	Good health and well-being for people
	7.8.7	Instant triaging of wounds	Cloud services	Good health and well-being for people
	7.8.8	Detection of fraudulent medical claims	Embedded systems	Sustainable cities and communities
	7.8.9	AI platform for chest CT-scan analysis (early stage lung cancer detection)	Cloud services	Good health and well-being for people
	7.8.10	Neural network formation of 3D-model or-thopaedic insoles	Hybrid	Good health and well-being for people
	7.8.11	Search for undiagnosed patients	Social networks	Good health and well-being for people
	7.8.12	A clinical decision support system	Cloud services	Good health and well-being for people; Gender equality
	7.8.13	Symptom assessment (hypothetical)	Mobile applications accessing AI backends running on a cloud platform. Stand alone offline mobile applications.	Good health and well-being for people; Gender equality
	7.8.14	Making using evidence-based medicine and AI	Cloud services	Good health and well-being for people
	7.8.15	AI-service for blood cells and bone marrow scans analysis	Cloud services	Good health and well-being for people

Table 2 (continued)

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Healthcare	7.8.16	AI-service for chest X-ray and chest CT	On-premise systems	Good health and well-being for people
	7.8.17	Intelligent video analytics system	On-premise systems	Good health and well-being for people
	7.8.18	Retrospective analysis	Cloud services	Good health and well-being for people
	7.8.19	Robotization of the federal hotlines on COVID-19 issues	Cloud services	Good health and well-being for people
	7.8.20	Use of computer vision innovative technologies for analysis of medical images and further application	Hybrid	Good health and well-being for people
Home and service robotics	7.9.1	Device control using AI consisting of cloud computing and embedded system	Hybrid	Affordable and clean energy
ICT	7.10.1	AI system to help mobile phones to have better picture effect	On-premise systems	Industry, innovation, and infrastructure
	7.10.2	Product failure prediction for critical IT infrastructure	On-premise systems	Industry, innovation, and infrastructure
	7.10.3	AI-based optimized field dispatch	On-premise systems	Industry, innovation and infrastructure
	7.10.4	Wireless network failure prediction	Cloud services	Industry, innovation and infrastructure
	7.10.5	AI performance evaluation of AI-powered messaging bots	cloud services	Decent work and economic growth
Insurance	7.11.1	AI services for health insurance companies	Embedded systems	Good health and well-being for people
knowledge management	7.12.1	Water crystal mapping	Cloud services	Clean water and sanitation
	7.12.2	AI system with a digital knowledge centre for utilizing the knowledge in the organization	Cloud services	Industry, innovation, and infrastructure
Legal	7.13.1	AI contract management	On-premise systems	Industry, innovation, and infrastructure

Table 2 (continued)

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Manufacturing	7.14.1	Quality assurance solution based on AI, to detect defects on wind turbines blades	On-premise systems	Affordable and clean energy
	7.14.2	Generative design of mechanical parts	Cloud services	Industry, innovation, and infrastructure
	7.14.3	Powering remote drilling command centre	On-premise systems	Industry, innovation, and infrastructure
	7.14.4	Quality improvement of adhesive products, based on AI	Cloud services	Industry, innovation, and infrastructure
	7.14.5	Empowering autonomous flow meter control – reducing time taken for “proving of meters”	On-premise systems	Industry, innovation, and infrastructure
	7.14.6	Improvement of productivity of semiconductor manufacturing	Hybrid	Industry, innovation, and infrastructure
	7.14.7	AI decryption of magnetograms	Hybrid	Industry, innovation and infrastructure; Affordable and clean energy
	7.14.8	Analysing and predicting acid treatment effectiveness on bottom hole zone	Hybrid	Industry, innovation, and infrastructure
	7.14.9	Automatic classification tool for full size core	Hybrid	Industry, innovation, and infrastructure
	7.14.10	Collaborative AI to assist workers with production and assembly in factories	On-premise systems	Industry, innovation and infrastructure
Media and entertainment	7.15.1	Video on demand publishing intelligence platform	Hybrid	Industry, innovation and infrastructure
	7.15.2	AI system for promoting DX in customer attraction services at a museum	Hybrid	Quality education
Public sector	7.16.1	AI ideally matches children to day-care centres	On-premise systems	Decent work and economic growth; Gender equality
	7.16.2	Open spatial data set for developing AI algorithms based on remote sensing (satellite, drone, aerial imagery) data	Hybrid	Sustainable cities and communities
	7.16.3	Smart city	On-premise systems	Sustainable cities and communities
	7.16.4	AI tool for species categorization for wildlife population monitoring	On-premise systems	Life on land
Security	7.17.1	Non-intrusive detection of malware	Others	Sustainable cities and communities
	7.17.2	Detect pickpockets in a crowd - training with privacy-sensitive data	Social networks	Good health and well-being; Peace, justice and strong institutions

Table 2 (continued)

Application domain	Subclause	Use case name	Deployment model	Relevant SDGs
Transportation	7.18.1	Enhancing traffic management efficiency and infraction detection accuracy with AI technologies	Cloud services	Sustainable cities and communities
	7.18.2	AI system for traffic signal optimization based on multi-source data fusion	Hybrid	Sustainable cities and communities
	7.18.3	Dynamic routing software as a service (SaaS) based on artificial intelligence	On-premise systems	Climate action
	7.18.4	Misbehaviour detection (MBD) for V2X	Cloud services	Industry, innovation and infrastructure
	7.18.5	AI system to estimate or predict congestion length for traffic signal control	Cloud services and on-premise system	Sustainable cities and communities
	7.18.6	Traffic signal control using artificial intelligence	Traffic signals, distributed networks and LTE	Industry, innovation and infrastructure
	7.18.7	AI system for predicting rivers' water levels during flooding	on-premise systems or cloud services	Climate action
Work and life	7.19.1	Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain	Cloud services	Industry, innovation and infrastructure
	7.19.2	Improving the quality of online interaction	Hybrid	Good health and well-being for people
	7.19.3	Business use of IoT for surveillance	Hybrid	Decent work and economic growth
	7.19.4	Video surveillance	Hybrid	Sustainable cities and communities

7.2 Agriculture

7.2.1 Real-time segmentation and prediction of plant growth dynamics using low-power embedded systems equipped with AI (use case 126)

7.2.1.1 Objectives

The project is devoted to the development of a low-power embedded system and AI algorithm for real-time plant segmentation and prediction of its growth. The proposed distributed system is aimed for use in greenhouses and remote areas, where edge-computing autonomous systems are in demand. A branch of this project also aims to develop the payload for drones for the segmentation of harmful plants in real-time.

Prediction of harvest, biomass or leaf area dynamics, leaf index, parameters describing the quality of produced food, consumption of resources from sequences of images of plant growth (including multispectral), data from sensors that describe environmental conditions and artificial growing system parameters representing the state of the growing system.

7.2.1.2 Narrative

Research efforts towards low-power sensing devices with fully-functional AI on board are still fragmented. This use case presents an embedded system enriched with the AI that ensures the continuous analysis and in situ prediction of plant leaf growth dynamics and other important growth parameters. The embedded

solutions, grounded on a low-power embedded sensing system with a graphics processing unit (GPU), are able to run the neural networks-based AI on board. Advantages of the proposed system include portability and ease of deployment. This use case uses a sequence of convolutional neural network (CNN) and a recurrent neural network (RNN) called the long-short-term memory network (LSTM) as the core of the AI in our system. The proposed approach guarantees the system autonomous operation for 180 d using a standard Li-ion battery. This use case relies on state-of-the-art mobile graphic chips for smart analysis and control of autonomous devices. This use case used 5 514 images as a source for automated leaf area calculation and follow the training of AI algorithms. Over one thousand records from sensors provide additional information about environmental conditions. All the data were used for training and testing the recurrent neural network, convolutional neural network algorithms, and the segmentation algorithms. This solution provides a root mean square error (RMSE) close to 4 cm² in a 3 h prediction horizon. All this allows for high performance in situ optimization of plant growth dynamics and resource consumption.

7.2.1.3 Stakeholders and stakeholder considerations

Stakeholders: agriculture, ecology management, sanitary services.

7.2.1.4 Data characteristics

Data from sensors that describe environmental conditions and artificial growing system parameters representing the state of the growing system.

The AI system used 5 514 images as a source for automated leaf area calculation and follow the training of AI algorithms. Over one thousand records from sensors provide additional information about environmental conditions. All those data were used for training and testing the recurrent neural network, convolutional neural network algorithms, and the segmentation algorithms.

7.2.1.5 KPIs

Accuracy of the predictions of harvest, biomass or leaf area dynamics, leaf index, parameters describing the quality of produced food, consumption of resources.

7.2.1.6 Features of use case

Task(s): prediction

Level of automation: conditional automation

Platform: GPU

7.2.1.7 Threats and vulnerabilities

Hidden patterns, incorrect AI system use.

7.2.1.8 Challenges and issues

The plant growth data significantly depends on multiple factors, including used solutions, illumination characteristics (for greenhouses), weather and seasonal conditions (for outdoors).

The architecture of the neural network is expected to have both high accuracy and high framerate, but a low number of layers and trained parameters for further inference on low-power embedded systems. These controversial factors are expected to be met since embedded systems have limited processing capabilities.

High diversity of data types and no standardization of data obtained by farmers.

7.2.1.9 Trustworthiness considerations

Improving the quality of data by adjusting the data for illumination characteristics (for greenhouses) and weather and seasonal conditions (for outdoors).

7.2.1.10 Use of standards and standardization opportunities

None identified.

7.2.2 Smart agriculture (use case 156)

7.2.2.1 Objectives

This platform is intended to provide personalised information to farmers on crop management.

Food production needs to increase its production levels by 70 % to feed the world's growing population by 2050. In addition, the current ecological footprint is twice the level that it is desired to be; leaving the agricultural sector with the colossal challenge of producing more food, while reducing their ecological impact. Agricultural big data, data analytics, and machine-learning algorithms are the catalysts that are expected to underpin the realization of the world's agricultural goals.

7.2.2.2 Narrative

This platform provides farmers with a range of crop management options within one comprehensive platform. It is intended to complement the company's other programmes, by personalising the exact purchase needs of farmers. The company collaborates with tech companies that can retrieve weather conditions, wind speeds, crop protection, and pest and agronomic data. The company then analyses these data to produce effective agricultural solutions to allow farmers to use their land more effectively.

The project consists of three fundamental components:

- information on local weather predictions, plant disease in situ detection, and recommendation of tools to minimize risk;
- crop and yield previews, farm efficiency and sustainability metrics, and early detection systems for weed, pests and disease;
- support system for farming consultants who are working with farmers to find ideal agricultural planning solutions.

7.2.2.3 Stakeholders and stakeholder considerations

Stakeholders: farmers, suppliers of agricultural products and services, farming consultants, environmental organisations and farmers representative groups.

Stakeholder considerations: overlap with systems threats and vulnerabilities.

7.2.2.4 Data characteristics

The data used in this use case include weather conditions, wind speeds, crop protection, and pest and agronomic data.

7.2.2.5 KPIs

Accuracy of data and recommendations.

7.2.2.6 Features of use case

Task(s): recommendation

Level of automation: high automation

7.2.2.7 Threats and vulnerabilities

Accuracy of data and recommendations: Algorithms can be fallible. There is a wide array of disparities with variables that measure weather, soil and plant disease, training of the image recognition software with accurate and wide variety of images of plant diseases. Natural variations from country-to-country and region-to-region, such as differences in pest management, climatic conditions, and crop types. The system will not replace an agronomist. The platform cannot establish a one-size-fits-all approach for their project and changes their algorithms for different regions. Precise record keeping by farmers is a challenge. Another constraint lies in the actual labour power required to maintain many farm management systems, requiring a large department to work on it. Particularly, when it comes to ensuring the safety and security of the farmer's data.

Privacy and security: The development team are aware of issues surrounding reverse engineering to access their algorithms, so they put great emphasis into securing all of their platforms. If their servers are secure and their software is fully encrypted and secured, then there is little chance that farmers' data will be breached, according to the interviewees.

7.2.2.8 Challenges and issues

Use: creating simple and effective user interfaces.

Data ownership and intellectual property securely protect this data from misuse, hacking, and misappropriation for economic or marketing purposes. It is stated that the company does not use the individual farmer's data to make comparisons between farms, and if this is done in the future, it would not be done without explicit informed consent from the farmers involved. Farmers own their data and can move it to another organization.

7.2.2.9 Trustworthiness considerations

One key factor in the creation of this project was ensuring that it was affordable and easy to use for farmers. The tool is free of charge. It is also for supporting farming consultants, which means that both explanations for farmers and those for farming consultants are to be provided.

Environmental protection: While concerns related to environmental protection were not requested by customers, the project does align with sustainability certification schemes.

7.2.2.10 Use of standards and standardization opportunities

How to deal with conflicting ethical issues and its transparency?

The researchers of this use case have drafted a proposal for guidelines for ethical AI, based on ITIL, COBIT, ISO/IEC 20000 series and CRISP-DM.

7.2.3 Forecasting of crop yield using decision support system (use case 173)

7.2.3.1 Objectives

Increasing the productivity of farms.

Operational adjustment of agricultural works.

7.2.3.2 Narrative

Technology has redefined farming over the years and technological advances have affected the agriculture industry in more ways than one. Agriculture is the mainstay occupation in many countries worldwide and with rising population, which as per UN projections will increase from 7,5 billion to 9,7 billion in 2050, there will be more pressure on land as there will be only an extra 4 % of land, which will come under cultivation by 2050.

This is driving farmers and agro companies to find newer ways to increase production and reduce waste. As a result, AI is steadily emerging as part of the agriculture industry's technological evolution. The challenge is to increase the global food production by 50 % by 2050 to feed an additional two billion people. AI-powered solutions will not only enable farmers to improve efficiencies but they will also improve quantity, quality and ensure faster goto-market for crops.

7.2.3.3 Stakeholders and stakeholder considerations

Agricultural holdings (agronomy, sales department)

7.2.3.4 Data characteristics

The outline of the fields.

Crop rotation history in: field id, sowing year, crop name or indication of land was left uncultivated or was re-cultivated, yield (centner/ha), date of sowing, date of harvest.

Weather data from the fields: date and time of observation, coordinates of the weather station, air temperature, relative humidity, wind speed, atmospheric pressure, precipitation, snow cover height, dew point

7.2.3.5 KPIs

The average error in estimating the yield on the farm is 5,7 %, for a different field it is 15 %.

7.2.3.6 Features of use case

Task(s): decision support system

Level of automation: high automation

Method(s): machine learning (embedding, gradient boosting (XGBoost))

Platform: yield forecast (centner/ha) for each field / farm gets displayed on the web page of the service with the possibility of uploading in tabular formatted CSV files.

Topology decision support system

7.2.3.7 Threats and vulnerabilities

Accuracy of data and recommendations: Algorithms can be fallible. There is a wide array of disparities with variables that measure weather, soil and plant disease, training of the image recognition software with accurate and wide variety of images of plant diseases. Natural variations from country-to-country and region-to-region, such as differences in pest management, limatic conditions and crop types.

7.2.3.8 Challenges and issues

AI solves the scarcity of resources and labour to a large extent and it will be a powerful tool that can help organizations cope with the increasing amount of complexity in modern agriculture.

7.2.3.9 Trustworthiness considerations

The abovementioned accuracy is achieved for the territories where the ML model has been trained, in other regions the accuracy can be slightly lower.

7.2.3.10 Use of standards and standardization opportunities

None identified.

7.3 Digital marketing

7.3.1 Improving conversion rates and return on investment (RoI) with AI technologies (use case 53)

7.3.1.1 Objectives

Utilizing AI technologies in digital marketing.

Help the operation team identify new business scenarios and seize more market opportunities.

Increase conversion rate and marketing effectiveness.

Improve user experience by providing individually customized services.

7.3.1.2 Narrative

Personalized digital marketing has become increasingly important in response to the needs of providing different services to different consumers. The combination of big data and AI algorithms is the core of personalized digital marketing. By modelling user preferences, the AI system can predict the services that users can be interested in, improve marketing effectiveness and enhance user experience.

With economic development, consumers become more emphatic about self-personality. Digital marketing has also begun to focus more on the consumer's personality instead of commonality. Personalized digital marketing has become increasingly important in response to the need to provide different services to different consumers.

The combination of big data and AI algorithms is the core of personalized digital marketing. By modelling user preferences, it can be predicted the services that users can be interested in, improve marketing effectiveness and enhance user experience. There are three main parts of personalized marketing technology:

- audience targeting: forecasting the people who can be interested in the marketing activities, focusing on high-conversion probability populations to increase conversion rates;
- smart subsidy: different marketing subsidies for different users to achieve higher conversion rates at lower cost;
- personalized recommendation: predict user preferences for services or items and recommend to users what they are most likely to be interested in, to increase conversion rates.

Through the application of AI technology, personalized digital marketing has achieved very significant results: the predicted population's conversion rates have shown an improvement of more than 30 %; in the subsidy scenario, personalized digital marketing has achieved a cost reduction of more than 10 % while achieving a 2 % increase in the conversion rate; in the coupon recommendation scenario, the conversion rate has improved by more than 70 %.

7.3.1.3 Stakeholders and stakeholder considerations

Stakeholders: Third-party payment companies, end users (customers), merchants

Stakeholders considerations: User experience, digital marketing RoI, conversion rate, marketing cost.

7.3.1.4 Data characteristics

Description: sample and feature data of marketing campaign.

Source: customers.

Type: log text.

Volume (size): ~500 GB/day.

Velocity: stream and batch.

Variety: device information, location information, conversion information (clicks, transactions), active level.

Variability (rate of change): subject to digital marketing effort (festival, on sale).

Quality: varies (depending on position of data collection and data reflow mechanism).

7.3.1.5 KPIs

Conversion rate: The percentage of users who are responsive to the marketing (e.g. clicks) out of the total number of visitors. The reference of this KPI to mentioned use case objectives is to increase the conversion rate.

RoI: $\text{RoI} = \text{conversion_rate} * (1 - k * \text{cost})$, k is the cost impact factor and can be adjusted to get a higher conversion rate or lower cost. The reference of this KPI to mentioned use case objectives is to increase marketing effectiveness.

7.3.1.6 Features of use case

Task(s): audience targeting, smart pricing, personalized recommendation

Level of automation: assistance

Method(s): machine learning, deep learning

7.3.1.7 Threats and vulnerabilities

Abuse of personal information, falsified or dirty data.

7.3.1.8 Challenges and issues

How to collect, utilize and protect user information within the scope of what is permitted by relevant national and regional legislation and regulations.

How to let the system evolve and improve continuously by applying new AI models and algorithms.

7.3.1.9 Trustworthiness considerations

For users: enjoy better service at a lower cost

For merchants: Increase profits and decrease costs

For cities and communities: Promote economic prosperity and develop a green economy

7.3.1.10 Use of standards and standardization opportunities

Technical framework of AI-enabled digital marketing system.

Guidelines for collecting, storing and handling of digital marketing data.

Guidelines for applying AI technology to digital marketing.

7.3.2 AI system for digital marketing in retail services (use case 185)

7.3.2.1 Objectives

To improve matching probability and added value of customer satisfaction in retail services by digital marketing introducing AI technologies.

7.3.2.2 Narrative

Through the smartphone application, a unique participant ID is issued to the participants of the campaign and questionnaires are conducted. Using participant's past purchase history data in retail services, probabilistic latent semantic analysis (PLSA) finds customer latent segments with similar purchasing behaviour. To characterize the customer segment Bayesian networks that represents the conditional probability, $P(\text{Seg} | Q_1, \dots, Q_n)$, the relationship between the questionnaire data and the customer segments are constructed. At the same time, conditional probabilities $P(\text{Product} | \text{Seg})$ are obtained from the result of PLSA. For new campaign participants and participants with no purchase history, an AI system can calculate the purchase prediction probability for particular participant, $P(\text{Product} | \text{Seg}) P(\text{Seg} | Q_1, \dots, Q_n)$ from the results of the questionnaire, and recommends the product with the highest value to the participant. When the products or services are recommended, discount coupons for real retail services can be offered. The fact that the recommendation was accepted can be verified by history of using the coupons. The AI system constantly collects data generated from the smartphone application and utilizes it to improve the matching probability and added value of customer satisfaction in retail services. $P(\text{Product} | \text{Segment})$ and $P(\text{Segment} | Q_1, \dots, Q_n)$ will be re-learned and the recommendation model will be updated. The AI system also forecasts demand and makes it possible to reduce inventory and waste loss. At the same time, looking at the distribution of customer segments, service providers and content providers optimize information content and merchandise.

7.3.2.3 Stakeholders and stakeholder considerations

Participants as both customers of retail services and AI customers.

Service providers as both providers of the retail service and AI customers.

AI research centre of a national institute as both AI producer and AI provider.

7.3.2.4 Data characteristics

Source: interactions with the AI system ("smartphone application") and past purchase history data in retail services.

Variety: structured.

Velocity: real-time.

Variability: what data to collect and its format can be changed when the questionnaires, products and services are reviewed.

Quality: high enough.

Protected attributes: collected data are anonymous.

7.3.2.5 KPIs

Effectiveness of recommendation: how effective the AI system's recommendation and coupons can be used in retail services.

Customer satisfaction: customer experience with the AI system's interaction with visitors.

7.3.2.6 Features of use case

Task(s): interactivity, recommendation and probabilistic inference.

Level of automation: assistance.

Method(s): Bayesian network, probabilistic latent semantic analysis. Human computer interaction, information recommendation using Bayesian network models.

Platform: Servers for running AI programs and storing data. Smartphone application system for interaction with participants.

Topology: Network of servers and smartphone application system.

7.3.2.7 Threats and vulnerabilities

None identified.

7.3.2.8 Challenges and issues

Since the smartphone application and server system are continual improvement, what data to collect and analyse and its format are under periodic review and subject to change.

7.3.2.9 Trustworthiness considerations

There are some concerns on the part of interaction with visitors, such as inappropriate recommendation due to poor user estimation.

7.3.2.10 Use of standards and standardization opportunities

Standard master tables for recommended products

Standard database of questionnaires

Standard database of coupons in retail services

7.4 e-commerce/e-business

7.4.1 Emotion-sensitive AI customer service (use case 42)

7.4.1.1 Objectives

Extracting sentiment and its intensity from customers' input, and responding with an appropriate attitude in order to improve the quality of customers' inquiry experience.

To design an efficient solution for detecting customers' sentiment and its intensity, especially in situations for which there is a limited training data set.

7.4.1.2 Narrative

Some customer service representatives have to deal with a large number of requests every day. Regular AI customer service systems, which are online 24/7, are capable of offering instant assistance, which frees up labour resources to a large extent. However, it is quite challenging, if not impossible, for those systems to interpret emotions from customer input and respond in as friendly a manner as a human being.

Against this background, based on a huge data set of customer comments and the rich experience of NLP, this AI system can automatically detect sentiments like "happy, angry, anxious," etc. Moreover, this system can also detect the intensity of the customer's sentiment. Furthermore, this use case adapts convolutional neural networks, a widely used technique in visual computing, to interpret the semantic meaning of the customer's expression. It can improve the system's performance for sentiment classification and intensity detection. Moreover, with the adoption of transfer learning, the system can also be applied to various types of data. To overcome the difficulty of limited training data, the AI system also use data augmentation methods such as reverse translation and data noise to increase the variability of training data.

Up to now, the system has reached 90 % recall and 74 % accuracy for sentiment classification over seven categories. The overall recall and accuracy for sentiment intensity are also around 85 %. The system has increased customer satisfaction by 57 %.

7.4.1.3 Stakeholders and stakeholder considerations

Stakeholders: Customer service and customers.

7.4.1.4 Data characteristics

Description: conversation data from after-sales customer services for sentiment classification. These data are annotated by professional annotators into seven categories of sentiments. For sentiment intensity detection: Consists of sentiment data for “angry” and “anxious” only; these data are annotated into three degrees of intensity: “low, medium, high”.

Source: conversation data from real-time customer services.

Type: text

Volume (size): around 60 000 sentences for sentiment classification and 20 000 for sentiment intensity detection.

Velocity: batch processing

Variety: real-time data from various categories of products.

Variability (rate of change): static

Quality: high

7.4.1.5 KPIs

Customer satisfaction: the rate of customer satisfaction when using this system for requests. The expectation is 100 %. The reference of this KPI to mentioned use case objectives is increasing the rate as much as possible.

Accuracy: the current overall rate of accurate prediction across all customer sentiment classifications is 76,4 %. The reference of this KPI to mentioned use case objectives is increasing the rate to 90 %.

Recall: the current overall rate of accurate prediction across all customer sentiment intensity detections is 90 %. The reference of this KPI to mentioned use case objectives is increasing the rate to 90 %.

Accuracy: the current overall rate of accurate prediction across all customer sentiment intensity detections is 85 %. The reference of this KPI to mentioned use case objectives is increasing the rate to 90 %.

Recall: the current overall rate of accurate prediction across all customer sentiment intensity detections is 85 %. The reference of this KPI to mentioned use case objectives is increasing the rate to 90 %.

7.4.1.6 Features of use case

Task(s): natural language processing

Level of automation: conditional automation

Method(s): deep learning, transfer learning, data augmentation

7.4.1.7 Threats and vulnerabilities

The low degree of humanization, and lack of semantic diversity for response.

Reducing the number of human customer service staff.

Identified privacy risks include specific data collected from customers.

7.4.1.8 Challenges and issues

Challenge: the system's performance is expected to be as good as a human customer server.

Issues: 1) limited training data; 2) sentiment classification among seven categories.

Adequately addressing identified privacy risks.

7.4.1.9 Trustworthiness considerations

Improving the efficiency of customer service, improving the customer service experience.

Reducing labour costs and reducing operating costs.

This use case raises serious privacy concerns, especially with respect to specific customer data.

7.4.1.10 Use of standards and standardization opportunities

The system can be promoted to as many customer services companies as possible once provided with enough training data for the specific application scenario.

7.4.2 Deep learning-based user intent recognition (use case 43)**7.4.2.1 Objectives**

Recognizing users' intent in order to solve their problems in e-commerce fields.

To recognize and understand users' intent using AI and deep learning technologies and apply such technologies to build chat bot systems to further reduce labour costs and for use in various fields.

7.4.2.2 Narrative

This intelligent customer service chat bot is mainly used to categorize users' questions, recognize users' intent and intelligently answer users' questions related to various business jobs. Currently, this chatbot is used to handle 90 % of online customer service and has saved the company on labour costs each year.

The AI provider is committed to using technology to drive business growth and improve the user experience in all areas of customer service.

Based on improved customer advice experience and the evolution of artificial intelligence technology, the company decided back in 2012 to develop intelligent chatbots to meet the needs of its growing business, to save on customer service costs and to increase service capability. Intent recognition is a key and core technology for building this type of intelligent customer service chat bot. By applying natural language processing technologies, deep learning technologies, and traditional machine learning algorithms, intent recognition accuracy has reached 95 %. Based on accurate intent recognition and a series of solution-finding algorithms, our chat bot can solve the user's problems in most cases and give the user a high-quality consulting experience. Finally, to provide diversified and personalized customer services, the AI system has continuously improved the accuracy of intent recognition, personalized solution generation, sentiment recognition, and image recognition. So far, intelligent customer service has revolutionized the traditional customer service consulting business.

7.4.2.3 Stakeholders and stakeholder considerations

Stakeholders: Customer service and customers

Stakeholder Considerations: Customer service expectations and customer experience

7.4.2.4 Data characteristics

Description: question response data from the online dialogue log

Source: customer dialogue log

Type: text

Volume (size): millions

Velocity: real time

Variety: various scenarios, various businesses, various categories of products

Variability (rate of change): nonlinear

Quality: good

7.4.2.5 KPIs

Accuracy: the percentage of users whose intent is correctly recognized over the total number of users. Currently, accuracy is 95 %. The reference of this KPI to mentioned use case objectives is to improve accuracy of recognizing users' intent.

Resolution: the percentage of questions solved over the total number of questions asked. The reference of this KPI to mentioned use case objectives is to improve resolution of questions from users.

Satisfaction: the percentage of users who are satisfied with customer service over the total number of users. The reference of this KPI to mentioned use case objectives is to improve user experience.

7.4.2.6 Features of use case

Task(s): natural language processing

Level of automation: conditional automation

Method(s): machine learning and deep learning

Platform: GPU and CPU

Topology: TensorFlow

7.4.2.7 Threats and vulnerabilities

High semantic ambiguity, multiple language expressions in one sentence.

Identified privacy risks include risks related to knowledge of user intent and training data.

7.4.2.8 Challenges and issues

Current challenges of deep learning and intent recognition:

- high semantic ambiguity, similar sentences can convey different meanings;
- unclear classification rules caused by complicated business logics;
- hard to answer reasoning questions;
- adequately addressing identified privacy risks.

7.4.2.9 Trustworthiness considerations

Solve problems intelligently to increase efficiency.

Free up labour from repetitive work to save a large amount of resources for society.

This use case raises serious privacy concerns, particularly with respect to the knowledge and training data related to user intent recognition.

7.4.2.10 Use of standards and standardization opportunities

Process standardization would improve quality and productivity.

7.4.3 AI virtual assistant for customer support and service (use case 106)

7.4.3.1 Objectives

Customer support service, product and service consulting.

Limitations - support for dialogues exclusively within the AI provider's products.

Target audience - b2b, b2c clients of the AI provider.

Optimization of company resources for support and customer service by automating the customer service process. As a result of the implementation of the system, the company was able to cover a greater volume of customer requests without necessity to increase its staff of operators. This prevented an increase in the company's operating expenses.

7.4.3.2 Narrative

The system automatically answers customer questions within the application and on the company website. At its peak, service automation reaches 85 %.

Chatbot assists the client in the selection of tariffs and services, and advises on the financial condition of the account. Chatbot promotes new products without the need for an operator. The client can ask a question in free form; the system would understand the request. If necessary, the system can ask additional questions before delivering its answer to the client.

Chatbot is integrated with internal billing systems, CRM, with a product catalogue and many other key services of the company. This allows each client to be provided with an individualized service. If chatbot is unable to help the client, or if the service procedure requires an operator, the dialogue is transferred to the operator. Currently, chatbot serves more than 1 million requests per month, working 24/7 to serve customers.

7.4.3.3 Stakeholders and stakeholder considerations

Stakeholders: Customer service department and customers.

Stakeholder considerations: Customer service department - maintaining / increasing customer loyalty, saving resources.

Stakeholder considerations: Customers - meeting expectations

7.4.3.4 Data characteristics

Source: customer profiles and a history of questions

Type: text, voice

Volume (size): Millions of hits (historical data)

Velocity: in real time

Variety: collected data sets

Variability (rate of change): the system is updated daily with new scenarios.

Quality: high

7.4.3.5 KPIs

Automation: solving a customer issue with a chatbot without operator intervention. The reference of this KPI to mentioned use case objectives is the optimization of customer service costs.

Quality: customer satisfaction rating. The reference of this KPI to mentioned use case objectives is to ensure high customer loyalty to the AI provider's brand.

7.4.3.6 Features of use case

Task(s): optimization, natural language understanding, dialogue management

Level of automation: assistance

Method(s): deep learning, NLP

7.4.3.7 Threats and vulnerabilities

Information security, communication secrecy and the safety of personal data

Identified security and privacy risks include security and privacy risks related to client profiles and question history.

7.4.3.8 Challenges and issues

The readiness of external systems' API for integration with the bot platform.

Biased customer attitudes towards chatbots.

Adequately addressing identified security and privacy risks.

7.4.3.9 Trustworthiness considerations

This use case raises serious security and privacy concerns, particularly with respect to client profiles and question history.

7.4.3.10 Use of standards and standardization opportunities

None identified.

7.4.4 Customer relation management (CRM) (use case 157)

7.4.4.1 Objectives

This use case focuses on determining which ethical issues arise in the use of AI in CRM and how can they best be addressed.

Smart information systems (SIS - big data and artificial intelligence) are used in customer relations management (CRM) to help manage large customer databases and improve customer interaction by companies.

The aim of the use case is to identify what ethical issues arise from the use of SIS in CRM, whether companies that use SIS for CRM have policies and procedures in place for addressing these concerns, and if practitioners are facing additional issues not addressed in the current literature.

The aim of the company's model is to further increase customer orientation and cost-efficiency.

7.4.4.2 Narrative

Customer relationship management deals with the processes and systems that support business strategies to build long-term and profitable relations with customers.

Access to customers' online data (through social networks, search engine history, cookies and other tracking systems) allow companies to gather a variety of information about customers. Such access also allows companies to create cloud systems with data, and strategize and automate CRM practices.

Data engineering blends data from all sources and builds ML models that will accurately predict the propensity of a customer to churn (cease to be a customer) as well as predict the propensity to buy a new product.

The use case identified the following issues: autonomy, control, manipulation, privacy, knowledge/lack of knowledge, informed consent, bias, responsibility and trust.

7.4.4.3 Stakeholders and stakeholder considerations

Stakeholders: Companies, marketers, customers and public.

Stakeholder considerations:

Autonomy, control and manipulation: there is a concern that the autonomy of customers is being undermined through the employment of data analytics. Data analysis techniques are not a neutral tool or measurement: they can expand, constrain or alter people's choices and behaviours, each of which has an influence over the user. Data analytics treats individuals as already having made or being inevitably about to make certain choices, often with a moral component. The rise in consumer debt occurred at the same time as the development of complex marketing profile methods that included neural networks and predictive models to target consumers.

Privacy and knowledge: accessing the internet using big tech companies' platforms results in the disclosure of personal information to the platforms and other websites, even if customers do not want to reveal this information. Therefore, privacy issues are a significant concern for CRM practices: people unknowingly and unintentionally are communicating personal data. For marketers, big data are powerful weapons for capturing consumer data directly, indirectly, unobtrusively, with and without permission and participation.

Bias: concerns of bias entering into AI and ML have been growing. Despite surface assumptions that computers are unbiased (as, for example, they do not recognize skin colour or gender) increasing research has been conducted evidencing the potential for the outputs of automated systems to be prejudiced against certain groups of society.

Responsibility and trust: the unequal power relationship between companies and consumers creates concerns of accountability, and data ownership. Thus, responsibility for the data are a key concern.

Transparency and the company's vulnerability: it is usually difficult to make algorithms public, and most customers would not have the ability to understand those algorithms or the input data needed to run them. Furthermore, the algorithms change quickly and models are constantly being updated. From this, one can see how the notion of public "acceptance" of certain algorithms does not really work.

7.4.4.4 Data characteristics

Description: customers' online data

Source: social networks, search engine history, cookies and other tracking systems

7.4.4.5 KPIs

To help manage large customer databases and improve customer interaction.

To predict the propensity of a customer to stop being a customer as well as the propensity to buy a new product.

7.4.4.6 Features of use case

Task(s): prediction

Level of automation: assistance

7.4.4.7 Threats and vulnerabilities

Informed Consent: A challenge to the collection and use of data for CRM and elsewhere is the possible lack of informed consent given by the consumer for data to be used. Some data is given initially for a particular reason, but can be replaced by other interests at a later date. In such cases the company can hold the data but not have received informed consent for its use to the latter end.

In the case of CRM, the data are collected by the company as customers subscribe to services, but customers do not always consent to having their data analysed for insights or profiling. Even when consent is given the apparent means of gaining consent can consist of merely ticking a box to say that it is agreed to the terms and conditions. However, it is widely accepted that very few people ever read these terms and conditions, and as such the validity of that consent is questionable.

GDPR and different regulations outside EU: It would be comparatively easy for a company based and operating outside of the EU jurisdiction to develop a data set that would be unethical or illegal to produce in Europe. Based on this data set, the company can then develop a highly effective AI which can then be sold in Europe. This would be economically advantageous to that non-EU company, provided no personal data collected in this manner ever entered the EU.

7.4.4.8 Challenges and issues

Lack of knowledge on behalf of the customers about what is happening with their data.

Guidelines to make informed consent more realistic (rather than clicking away the pop-up and unknowingly giving consent).

Adequately addressing identified privacy risks.

7.4.4.9 Trustworthiness considerations

There is a need to protect customers from being exploited and misguided through data manipulation and analysis. New advances in CRM practices and data technologies bring social benefits, but also ethical issues to be examined.

7.4.4.10 Use of standards and standardization opportunities

How to deal with conflicting ethical issues and its transparency?

The researchers of this use case have drafted a proposal for guidelines for ethical AI, based on ITIL, COBIT, ISO/IEC 20000 series and CRISP-DM.

7.5 Education**7.5.1 A recommendation system for industrial training (use case 23)****7.5.1.1 Objectives**

Find skill requirements and relevant training based on an employee's career objectives.

Recommend a personalized list of "best" training courses to an employee, which can help him/her meet his/her career objectives.

7.5.1.2 Narrative

The recommendation system helps employees improve their skills by recommending appropriate training courses from a given list and historical data.

Continuous training is crucial for creating and maintaining the right skill profile for an industrial organization's workforce. There is tremendous variety in the available training within an organization: technical, project management, quality, leadership, domain-specific, soft-skills, etc. Hence it is important to assist the employee in choosing the best training that perfectly suits his/her background, project needs and career goals. In this use case, the AI system is built on algorithms for recommending training in an industrial setting. The AI system provides training recommendations, taking into account the employee's training and work history. The AI producer has developed several new unsupervised sequence mining algorithms to mine past training data from the organization for making the next personalized training recommendation. Using real-life data about training 118 587 employees over 5 019 distinct training courses from a large multi-national IT organization, this use case show that these algorithms outperform several standard recommendation engine algorithms as well as those based on standard sequence mining algorithms.

7.5.1.3 Stakeholders and stakeholder considerations

The stakeholders include:

- AI producer: the organization that develops the recommendation system;
- data provider: the organization that provides the training course;
- AI users: the organization that adopts this recommendation system and the employees that use this recommendation system for industrial training.

The stakeholder considerations include:

- the AI users consider job requirements, skill profile, job description requirements and training requirements by using this recommendation system.

7.5.1.4 Data characteristics

The data used in this use case are the employee's training and work history from the organization which includes real-life data about training 118 587 employees over 5 019 distinct training courses.

7.5.1.5 KPIs

Prediction accuracy: number of employees undertaking courses from the recommended list. The reference of this KPI to mentioned use case objectives is to improve accuracy.

7.5.1.6 Features of use case

Task(s): recommendation

Level of automation: partial automation

Method(s): deep learning

Platform: GPU-enabled servers

Topology: GPU-enabled servers

7.5.1.7 Threats and vulnerabilities

The threats include that the different sources of bias based on model training, incorrect AI system use can cause stress in employees.

7.5.1.8 Challenges and issues

The challenges include that the large amounts of training data are desired and predicting human behaviour is tricky.

7.5.1.9 Trustworthiness considerations

This recommendation system is desired to consider the impact on the motivation of the AI user because the employees can feel challenged or demoralized by using recommendations.

7.5.1.10 Use of standards and standardization opportunities

The standards for the unsupervised sequence mining algorithms to mine the past data can be used for this system.

7.5.2 An intelligent marking system (use case 83)

7.5.2.1 Objectives

The system can realize intelligent detection and grading of all subjective questions to significantly reduce labour and organizational costs.

7.5.2.2 Narrative

This use case is an intelligent marking system based on core technology design research, including independent intellectual property rights of the AI producer, handwriting recognition, natural language understanding, intelligent evaluation and other artificial intelligence. It can realize the detection of blank questions for all question types except multiple choice questions, and computer intelligent evaluation of Chinese/English composition, English translation, literature synthesis category short answer questions and English blank questions. At the same time, for Chinese/English composition, it can also effectively detect abnormal answer papers which are highly similar to the dry content of the test paper or the content of the external model text.

The intelligent marking system can provide a new generation of intelligent scanning network evaluation solutions for large-scale pen and paper examinations combined with the mature scanning network evaluation technology. In the process of scanning, the detection and screening of similar volume and blank volume questions and the intelligent evaluation of subjective questions are carried out in real time. Taking the data outputted from the scanning link as the objective third party quality evaluation standard, the online or offline quality monitoring of the marking paper is carried out to improve the quality of the marking paper. At the same time, the computer intelligent evaluation of subjective questions can assist manual marking to a certain extent and effectively reduce the workload of manual marking of subjective questions.

The intelligent marking system has many advantages. First, it has a scientific and unified scoring standard, which can avoid the differences in the scoring scale and subjective interference among different reviewers, and ensure the fairness of the marking results. Second, the investment requires only a small number of technical personnel and servers, which can reduce the organizational cost of existing manual marking by about 50 %. Third, it can detect the abnormalities in the answers, such as blank questions and similar volumes. At the same time, through the real-time comparison with the manual marking data, it achieves quality monitoring.

7.5.2.3 Stakeholders and stakeholder considerations

Stakeholders: marking teachers and technicians

Stakeholder considerations: efficiency

The stakeholders include:

— AI users: marking teachers and technicians;

- data provider: the school that adopts this system and provides scanning student papers.

The stakeholder considerations include:

- AI users consider the efficiency of this system.

7.5.2.4 Data characteristics

Description: scanning student papers

Source: the data from scanning student papers

Type: text, picture

Velocity: batch processing

Variety: single source

Variability (rate of change): static

Quality: high

7.5.2.5 KPIs

The KPIs of this system include:

- cost: reduce the cost of existing manual marking;
- efficiency: improve the efficiency of existing manual marking;
- accuracy: improve the accuracy of existing manual marking.

7.5.2.6 Features of use case

Task(s): natural language processing

Level of automation: high automation

Method(s): deep learning, semantic recognition

7.5.2.7 Threats and vulnerabilities

The inadequate accuracy of the system is the threat to be considered.

7.5.2.8 Challenges and issues

The accuracy of marking papers is necessary to be further improved.

7.5.2.9 Trustworthiness considerations

There is a scientific and unified scoring standard, which can ensure the fairness of the marking results.

This system can significantly reduce labour and organizational costs. This use case can have impacts on teacher job descriptions and roles.

7.5.2.10 Use of standards and standardization opportunities

None identified.

7.5.3 Intelligent educational robot (use case 84)

7.5.3.1 Objectives

The robot is designed to support children's education and to improve the pleasure of learning.

7.5.3.2 Narrative

The educational robot is a new teaching tool to cultivate students' comprehensive ability. It mainly uses artificial intelligence technology, speech recognition technology and bionic technology to cultivate students' various abilities. Educational robots have hearing, vision, oral skills, recognition, emotional detection and the ability to interact for a long time.

An educational robot is designed for interaction with children, primary school students, and junior high school students. It can be used for study or entertainment.

It has teaching materials and lectures by famous teachers for all grades and disciplines, and students can receive high-quality teaching without leaving home. It can also present knowledge forgotten by students and solve students' learning problems in time. Moreover, it can correct students' bad habits such as overdependence on others, hating to get out of bed, and inattentiveness by giving instructions and intelligent reminders so as to cultivate students' good learning behaviour and living habits. For learning English, the robot can train students' oral English ability by practicing dialogue with them, and can also bring students' pronunciation more in line with the standard and improve students' communication ability.

7.5.3.3 Stakeholders and stakeholder considerations

The stakeholders include:

- AI users: students, parents and teachers;
- data provider: the learner provides the learner inputs.

The stakeholder considerations include:

- the teachers (AI users) consider the students' grades and learning interest.

7.5.3.4 Data characteristics

Description: learner input, including pronunciation, visual information, keystrokes, etc.

Source: data from the learner

Type: voices, visual information, keystrokes, etc.

Velocity: batch processing

Variety: multiple source

Variability (rate of change): static

Quality: high

7.5.3.5 KPIs

The KPIs of this system include:

- interest: improve students' interest in learning;
- grades: improve students' academic performance.

7.5.3.6 Features of use case

Task(s): recognition

Level of automation: high automation

Method(s): deep learning, automatic speech recognition, bionics techniques

7.5.3.7 Threats and vulnerabilities

The inadequate teaching effect of intelligent robot is the threat to be considered.

7.5.3.8 Challenges and issues

The challenges include:

- be able to sense students' emotions like teachers;
- accurately capture students' gestures, postures, face information, etc.

7.5.3.9 Trustworthiness considerations

This system is to consider the impacts on the students, such as the system can give students emotional support and stimulate students' interest in learning.

After repeated training, the intelligent educational robots can assist students' study like teachers. It is to consider the transparency, explainability and predictability of the actions of the robots.

7.5.3.10 Use of standards and standardization opportunities

None identified.

7.5.4 AI system to intelligent campus (use case 85)**7.5.4.1 Objectives**

This use case is a full range of products and integrated solutions for teaching, examination, evaluation, management and learning.

This use case provides a comprehensive intelligent sensing environment and comprehensive information service platform for teachers and students, so as to realize the integration of human and business information.

7.5.4.2 Narrative

Based on big data and artificial intelligence technology, the use case brings teaching, examination, learning and management into the integrated system of mutual cooperation, based on accompanying data acquisition and dynamic big data analysis, combined with process evaluation, to help teachers and students to realize teaching according to their aptitude and individualized learning, to help managers to supervise and assist decision-making, and to greatly promote the transformation of education, learning and management to intelligence.

In teaching, the AI system includes an intelligent and efficient classroom based on the cloud network end. Through docking the resource cloud platform and school-based resource library, it can realize synchronous push of high-quality resources and help teachers prepare classes efficiently.

In the area of examinations, the oral evaluation technology used in this AI system is the only technology to have passed the certification of the National Language Commission, widely used in the national Chinese Mandarin online test and used in classroom teaching. The AI provider applies its the industry-exclusive artificial intelligence core technology to the examination and automatic approval of traditional offline

homework, which greatly reduces the burden on teachers and digitalizes the daily examination process. Big data analysis technology can be used to promote personalized teaching and learning.

In learning, this AI system supports students' online adaptive learning by building a question bank system, evaluation system and online learning system. Through analysis of the students' examination results, the system can evaluate the students' mastery of knowledge points and the stability of their grades, and then combine the key points of the teaching materials with the high-frequency test points. Through intelligent analysis, the scheme can recommend the optimal learning path.

In the area of management, this AI system includes a smart campus solution that covers more than 10 departments such as the academic affairs office, student office and school office. The system provides more than 60 applications to meet the needs of normal campus management. It is worth mentioning that in order to cope with the challenges of educational administration brought by the new curriculum and the new college entrance examination, this AI system, based on the classification algorithm of a deep neural network, puts forward an intelligent course arrangement system, effectively avoids the conflict of course selection, and realizes the optimal voluntary satisfaction rate under the premise of uniform teaching and classroom resources, so that every student can attend classes according to his own volition.

7.5.4.3 Stakeholders and stakeholder considerations

Stakeholders: students, teachers, schools, governments

Stakeholder considerations: privacy

The stakeholders include:

- AI provider: the organization brings teaching, examination, learning and management into the integrated system of mutual cooperation;
- AI users: students, teachers, schools;
- data provider: the schools that adopt this AI system;
- AI subject: governments.

The stakeholder considerations include:

- AI provider considers the students' privacy.

7.5.4.4 Data characteristics

Description: the data comes from students and teachers as well as from their learning and administration processes.

Source: intelligent education products or platforms

Type: structured or unstructured data

Velocity: in real time

Variety: students information, teachers' information, information generated during the course of teaching, learning and management.

Variability (rate of change): in real time

7.5.4.5 KPIs

The KPIs of this system include:

- efficiency: improve students' learning and teachers' administration efficiency. The reference of this KPI to mentioned use case objectives is to improve efficiency.