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Information technology — Artificial intelligence (AI) — Use cases

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

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 42, *Artificial intelligence*.

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 use cases of artificial intelligence (AI) applications in a variety of domains.

In total, 132 AI use cases were submitted by experts between July 2018 and the end of November 2019. In this document, the term “use cases” means “collection of submitted use cases”.

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;

— establishment of liaison organizations to collect requirements for AI via use cases;

— by investigating use cases, it is possible to find the new technical requirements (standardized demand) from the market, accelerating the transformation of science and technology 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, and their deployment models, and their application domains., which is shown in Clause 5.

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 B). Contributors were requested to submit use cases using the provided template.

For improving the quality of use cases, a guidance was provided for contributors. The guidance included identified acceptable sources (described in 6.3) and AI characteristics (described in 6.4) for preparing use cases.

In this document, subclause 6.5 includes basic statistics of use cases. Subclause 6.6 and Annex C describe the findings from use case analysis.

The use cases were grouped and categorized according to the identified application domains. In this document, use cases are summarized and grouped according to the application domains in Clause 7. Readers of this document can find use cases of specific application domains and their original submissions at https://standards.iso.org/iso-iec/tr/24030/ed-1/en.

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 terminological databases for use in standardization at the following addresses:

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

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

3.1
artificial intelligence
AI
<system> capability to acquire, process, create and apply knowledge, held in the form of a model, to conduct one or more given tasks

3.2
artificial intelligence
AI
<engineering discipline> discipline of developing and studying *artificial intelligence* (3.1)

3.3
quality
conformance to specified requirements

[SOURCE: ISO 13628-2:2006, 3.33]

3.4
machine learning
process using computational techniques to enable systems to learn from data or experience

3.5
deep learning
approach to creating rich hierarchical representations through the training of neural networks with many hidden layers

3.6
service
performance of activities, work, or duties

Note 1 to entry: A service is self-contained, coherent, discrete, and can be composed of other services.

Note 2 to entry: A service is generally an intangible product.

[SOURCE: ISO/IEC/IEEE 12207:2017, 3.1.50]

3.7
classification
task of assigning collected data to target categories or classes.

Note 1 to entry: Machine learning (ML) models can be designed/created either for binary classification, where they can learn to predict one of two different categories/classes; or for multiclass classification, where ML models learn to predict one of many different categories/classes.

Note 2 to entry: An example of classification is to predict if a photograph of an animal is a cat or a dog or even a different species. Classification employs supervised learning. Classification can employ supervised, semi-supervised, or unsupervised learning.

3.8
application
software or a program that is specific to the solution of an application problem

[SOURCE: ISO/IEC 11801:2002, 3.1.2]

3.9
neural network
network of primitive processing elements connected by weighted links with adjustable weights, in which each element produces a value by applying a nonlinear function to its input values, and transmits it to other elements or presents it as an output value

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

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

[SOURCE: ISO/IEC 2382: 2015, 2120625]

3.10
task
set of activities undertaken in order to achieve a specific goal

Note 1 to entry: These activities can be physical, perceptual and/or cognitive.

Note 2 to entry: While goals are independent of the means used to achieve them, tasks describe particular means of achieving goals.

Note 3 to entry: Examples of tasks include classification, regression, ranking, clustering and dimensionality reduction.

[SOURCE: ISO 9241-11:2018, 3.1.11, modified — Note 3 to entry has been added.]

3.11
parameter
<machine learning> variable of the model that affects its output any characteristic that can help in defining or classifying a particular system

3.12
artificial intelligence system
AI system
engineered information processing system featuring artificial intelligence

Note 1 to entry: AI systems are designed to operate with varying levels of autonomy.

3.13
training data
samples for training used to fit a machine learning model

3.14
cloud service
one or more capabilities offered through cloud computing invoked using a defined interface

[SOURCE: ISO/IEC 17788:2014, 3.2.8]

3.15
cloud computing
paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand

Note 1 to entry: Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

[SOURCE: ISO/IEC 17788:2014, 3.2.5]

3.16
automation
characteristic of a system where work is performed that might previously have been done by a living being and that is governed by rules determined outside of the system

Note 1 to entry: Such systems are subject to external control and oversight.

Note 2 to entry: Automation implies the (revocable) delegation to a machine of a specific and defined set of "skills", operations, processes, or procedures.

3.17
bias
systematic difference between true (or accepted) value and measured value

[SOURCE: ISO 14488:2007, 3.1]

3.18
data set
identifiable collection of data available for access or download in one or more formats

[SOURCE: ISO/IEC 20546:2019, 3.1.11]

3.19
natural language processing
<system> information processing based upon natural-language understanding

3.20
natural language processing
<engineering discipline> field of study within computer science and linguistics concerning automated processing, in whole or in part, of natural language

3.21
retraining
updating a trained model by training with different training data

3.22
computer vision
capability of a functional unit to acquire, process, and interpret visual data

Note 1 to entry: Computer vision involves the use of visual sensors to create an electronic or digital image of a visual scene.

Note 2 to entry: Not to be confused with machine vision.

Note 3 to entry: computer vision; artificial vision: terms and definition standardized by ISO/IEC [ISO/IEC 2382-28:1995].

Note 4 to entry: 28.01.19 (2382)

[SOURCE: ISO/IEC 2382:2015, 2123787]

3.23
trained model
result of model training

3.24
robot
automation system with actuators that performs intended tasks in the physical world, by means of sensing its environment and a software control system

Note 1 to entry: A robot includes a control system and interface of a control system.

Note 2 to entry: The classification of robot into industrial robot or service robot is done according to its intended application.

Note 3 to entry: In order to properly perform its tasks, a robot makes use of different kinds of sensors to confirm its current state and perceive the elements composing the environment in which it operates.

[SOURCE: ISO 18646-2:2019, 3.1, modified — Note 3 to entry has been added]

3.25
big data
extensive datasets — primarily in the data characteristics of volume, variety, velocity, and/or variability — that require a scalable technology for efficient storage, manipulation, management, and analysis

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

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

3.26
end user
individual person who ultimately benefits from the outcomes of the system

Note 1 to entry: The end user may be a regular operator of the software product or a casual user such as a member of the public.

[SOURCE: ISO/IEC 25000:2014, 4.7]

3.27
data analysis
systematic investigation of the data and their flow in a real or planned system

[SOURCE: ISO/IEC 2382:2015, 2122686]

3.28
pattern recognition
identification, by a functional unit, of physical or abstract patterns, and of structures and configurations

Note 1 to entry: This is an improved version of the definition in ISO/IEC 2382-12:1988.

Note 2 to entry: Pattern recognition: term and definition standardized by ISO/IEC 2382-28:1995.

Note 3 to entry: 28.01.13 (2382)

[SOURCE: ISO/IEC 2382:2015, 2123781]

3.29
anomaly detection
task of identifying data samples that do not conform to an expected pattern distribution, especially within data sets that appear to be homogeneous.

Note 1 to entry: Anomaly detection is mostly used for outlier detection, for example, fraud detection, detecting suspicious activities, etc. It may, therefore, also be called 'outlier detection'.

Note 2 to entry: With anomaly detection, the input data is all of one class and the ML model predicts if a data point is typical for a given distribution or not.

Note 3 to entry: Anomaly detection typically employs unsupervised learning.

3.30
stakeholder
person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity

[SOURCE: ISO 35001:2019, 3.2]

3.31
model
physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, process or data

[SOURCE: ISO/IEC 18023-1:2006, 3.1.11, modified — In the definition, "or data" has been added.]

3.32
knowledge
<artificial intelligence> information about objects, events, concepts or rules, their relationships and properties, organized for goal-oriented systematic use.

Note 1 to entry: Information can exist in numeric or symbolic form.

Note 2 to entry: Information is data that has been contextualized, so that it is interpretable. Data is created through abstraction or measurement from the world.

4 Abbreviated terms

ANN	artificial neural networks	LSTM	long short-term memory networks
API	application programming interface	MAE	mean absolute error
AR	augmented reality	ML	machine learning
AUC	area under the curve	MRI	magnetic resonance imaging
BDEC	big data and extreme-scale computing	NLP	natural language processing
BNN	binarized neural network	NLU	natural language understanding
CG	computer graphics	OLAP	online analytical processing
CNN	convolutional neural network	PoC	proof of concept
CPU	central processing unit	PSNR	peak signal-to-noise ratio
CT	computed tomography	QA	quality assurance
CV	computer vision	RAM	random access memory

DL	deep learning	RGB	red green blue
DNN	deep neural network	RMSE	root mean square error
E2E	end to end	RNN	recurrent neural networks
FPGA	field-programmable gate array	SaaS	software as a service
GAN	generative adversarial nets	SDGs	sustainable development goals
GB	giga byte	SID	infant death syndrome
GDPR	general data protection regulation	SIS	swarm intelligence system
GPS	global positioning system	SMS	short message service
GPU	graphics processing unit	SQL	structured query language
HDD	hard disk drive	SSIM	structural similarity
HPC	high performance computing	SVM	support vector machine
ICT	information and communication technology	TB	tera byte
IoT	internet of things	UCVA	uncorrected visual acuity
IP	internet protocol	UI	user interface
KPI	key performance indicator	UT	ultrasonic testing
KYC	know your customer	UTO	unattended train operation
LIDAR	laser imaging detection and ranging	V2V	virtual to virtual

5 Applications

5.1 General

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

5.2 Application domains

Twenty-four application domains from References [5] and [6] were considered as target domains for the use cases:

- agriculture;
- construction;
- defence;
- digital marketing;
- education;
- home/service robotics;
- ICT;
- knowledge management;
- legal;
- logistics;
- media and entertainment;
- mobility;
- public sector;
- retail;
- security;

— energy;
— fintech;
— healthcare;
— low-resource communities;
— maintenance and support;
— manufacturing;
— social infrastructure;
— transportation;
— work and life.

5.3 Deployment models

This document considers the use of AI applications[5] and lists the following possible deployment models of AI applications.

— cloud services;
— cyber-physical systems;
— embedded systems;
— hybrid;
— 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 Reference [5]. Each example in Table 1 has an application domain, deployment model 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.
Agriculture	Craftsmanship skill transfer	Cloud services	Learn about the best practices from craftsmen and provide feedback to others.
		On-premise systems	Not applicable
Agriculture	Cultivation management	On-premise systems	Monitor the field condition and manage the irrigation condition.
Construction	Construction planning	Cloud services	Learn about the best practices and apply them to future planning.
Construction	Robot construction	Cloud services	Provide autonomous construction robots to construction sites.
		On-premise systems	
Defence	Cyber security	Cloud services	Monitor cyber transactions against important defence assets and find out attack patterns and prevent their intrusion.
Defence	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	For example, Google, Amazon, Facebook, Apple (GAFA).

Table 1 *(continued)*

Application domain	Application	Deployment model	Short description
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	Learn about normal condition.
		On-premise systems	Find out abnormal condition compared with normal condition.
Healthcare	Medical platform	Cloud services	Accumulate and disseminate learning patterns and assistants as an integrated medical support system.
		Embedded systems	
		Hybrid	
		On-premise systems	
Healthcare	New drug development	Cloud services	Curation: Find out the correlation among submitted papers.
			Molecular pattern: Find out the effective coordination of target molecule.
Healthcare	Surgical automation	Cloud services	Accumulate disease patterns and healthy patterns.
		Embedded systems	Not applicable
Healthcare	Surgical automation	On-premise systems	Support identification of disease patterns on the premises.
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.
Logistics	Logistics in the base	Cloud services	Coordinate the best logistic move in the local procurement base warehouse.
		On-premise systems	
Logistics	Procurement logistics	Cloud services	Analyse the procurement context and propose the best procurement actions.
		On-premise systems	
Logistics	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	

Table 1 *(continued)*

Application domain	Application	Deployment model	Short description
Manufacturing	Development design	Cloud services	Accumulate design patterns to help designers.
		Hybrid	Not applicable
		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.
		Hybrid	Not applicable
Manufacturing	Production process	On-premise systems	Accumulate production throughput-related parameters and estimate the output throughput.
Mobility	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.
Mobility	Automatic cruise control	On-premise systems	Not applicable
Mobility	Autonomous driving	Cloud services	Update cruise control software dynamically. Accumulate road condition data and disseminate them to autonomous agents. Mainly realized on cars.
		Embedded systems	Enable autonomous driving without any help from connected devices. Mainly realized on cars.
		On-premise systems,	Not applicable
Mobility	City-wide traffic control	Cyber-physical systems	Optimize city-wide traffic flow by inspecting real-time traffic images and controlling traffic signals.
Mobility	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.
		Hybrid	Not applicable
		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
Mobility	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.
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	
Retail	Autonomous driving store	On-premise systems	Provide autonomous driving sales robots.
Retail	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.
Social infrastructure	Abnormality or malfunction prediction	Cloud services	Accumulate normal signal patterns to learn normal signals.
		Hybrid	Not applicable
		On-premise systems	Find out abnormal signal patterns on the premises.
Social infrastructure	Equipment operation	Cloud services	Accumulate operational parameters and learn normal operations.
		On-premise systems	Monitor operations and find out abnormal operation patterns.
Social infrastructure	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.
Social infrastructure	Landslide, flood prediction	Cloud services	Monitor weather and ground conditions in real time and predict disasters such as landslides, floods, etc.
		On-premise systems	
Social infrastructure	Power demand forecasting	Cloud services	Learn about demand patterns with other significant parameters and forecast future demand
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 132 use cases available at https://standards.iso.org/iso-iec/tr/24030/ed-1/en. Some use cases use trademark 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 the trademark names.

Subclause 6.4 describes a template that is used for collecting use cases, and Annex B shows a blank template. Subclauses 6.2 and 6.3 provide a list of acceptable sources and guidance for submitting use cases. Some basic statistics of the use cases are shown in 6.5. Societal concerns relating to the use cases are described in 6.6.

6.2 Acceptable sources of use cases

For improving the quality of use case descriptions, acceptable sources are:

— peer-reviewed scientific/technical publications on AI applications[1];

— patent documents describing AI solutions[2][3];

— technical reports and presentations by renowned AI experts[4];

— high-quality company whitepapers and presentations;

— publicly accessible sources in sufficient detail;

— press releases and brochures.

This list is not exhaustive. Other credible sources can be acceptable as well.

6.3 Guidance for submitting use cases

For preparing use cases that cover both the most important application areas and the most relevant AI technologies, use case contributors can consider the following AI characteristics as useful selection guidance.

— Data focus and learning: Use cases for AI systems that utilize machine learning, or that use a fixed a-priori knowledge base.

— Level of autonomy: Use cases demonstrating several degrees (dependent, autonomous, human/critic in the loop, etc.) of AI system autonomy.

— Verifiability and transparency: Use cases demonstrating several types and levels of verifiability and transparency, including approaches for explainable AI, accountability, etc.

— Impact: Use cases demonstrating the impact of AI systems on society, the environment, etc.

— Architecture: Use cases demonstrating several architectural paradigms for AI systems (cloud, distributed AI, crowdsourcing, swarm intelligence).

6.4 Properties

6.4.1 General information on use case

General information on the use case includes the following items.

— Use case name: Use case name provided by the use case contributor.

— Application domain: Refers to 5.2.

— Deployment model: Refers to 5.3.

— Status: The status of the use case; includes prototype, proof of concept (PoC), and in operation.

— Scope of use case: The scope of the use case defines the intended area of applicability, limits, and audience.

— Objective(s): The intention of the system; what is to be accomplished; who/what would benefit.

— Narrative: Descriptions (short and complete) of the use case.

— Stakeholders: Stakeholders are those that can affect or be affected by the AI system in the scenario; e.g. organizations, customers, third parties, end users, the community, the environment, negative influencers, bad actors, etc.

— Stakeholders' assets, values: Stakeholders' assets and values that are at stake with potential risk of being compromised by the AI system deployment — e.g. competitiveness, reputation, trustworthiness, fair treatment, safety, privacy, stability, etc.

— System's threats and vulnerabilities: Threats and vulnerabilities can compromise the assets and values mentioned above – e.g. different sources of bias, incorrect AI system use, new security threats, challenges to accountability, new privacy threats (hidden patterns), etc.

— Key performance indicators (KPIs): Descriptions of KPIs for evaluating the performance or usefulness of the AI system. Descriptions include the KPI's name, description of the KPI, and reference to mentioned use case objectives.

— Features of use case: Descriptions of features of the use case for AI consideration. Descriptions include the following items.

  1) Task(s): The main task of the use case. A pull-down list includes the following terms: recognition, natural language processing, knowledge processing and discovery, inference, planning, prediction, optimization, interactivity, recommendation and other.

  2) Method(s): AI method(s)/framework(s) used in development.

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

  4) Topology: Topology of the deployment network architecture.

  5) Terms and concepts used: Terms and concepts used here are desired to be consistent with existing ISO definitions.

— Standardization opportunities/requirements: Descriptions of standardization opportunities/requirements that are derived from the use case.

— Challenges and issues: Descriptions of challenges and issues of the use case.

— Societal concerns:

  1) Description: Description of societal concerns related to the use case;

  2) SDGs to be achieved: the Sustainable Development Goals (SDGs), 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.

6.4.2 References of use case

Reference information related to the use case includes the following items.

— Type: Document type of the reference (e.g. standards, paper, patent, press release).

— Reference: Title of the reference.

— Status: The status of the referenced document.

— Impact on use case: Where does the document influence the use case?

— Originator/organization: Who published the document?

— Link: If available, a public link can be provided.

6.5 Basic statistics

6.5.1 Use cases by application domain

Figure 1 describes the percentage of use cases by application domain. Some use cases that are identified by multi-domains are counted multiple times in Figure 1. Figure 1 does not include the following application domains because no use cases were submitted:

— construction;

— defence;

— low-resource communities.

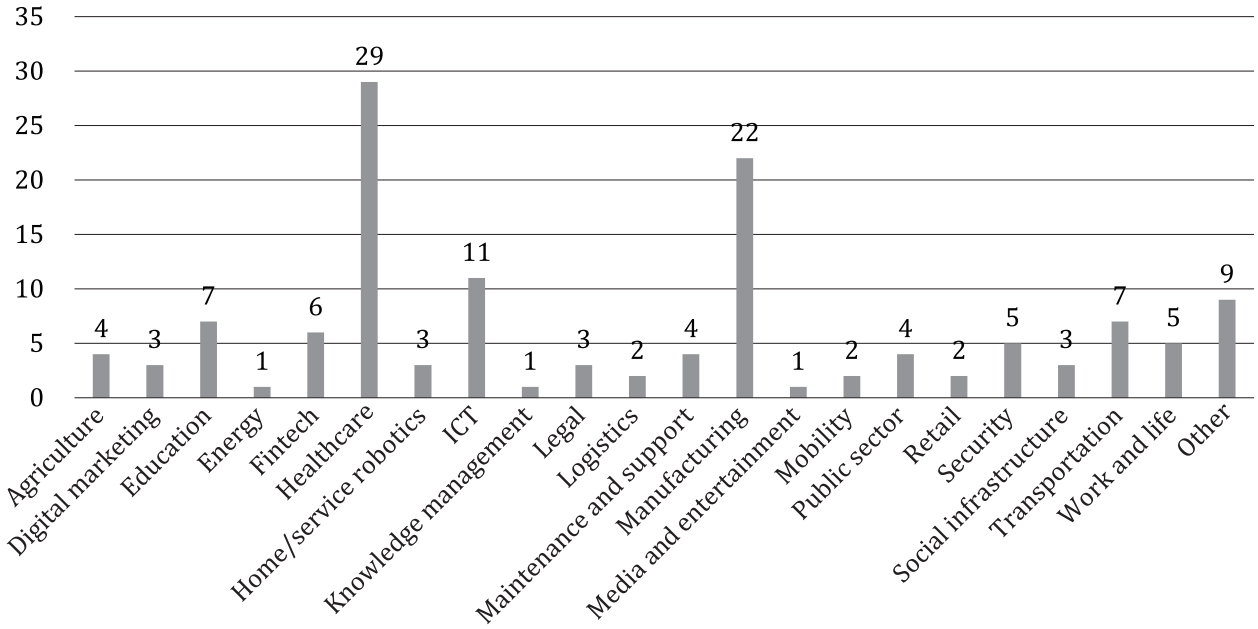

Figure 1 — Distribution of use cases by application domain

6.5.2 Use cases by status

Distribution of use cases by status is shown in Figure 2.

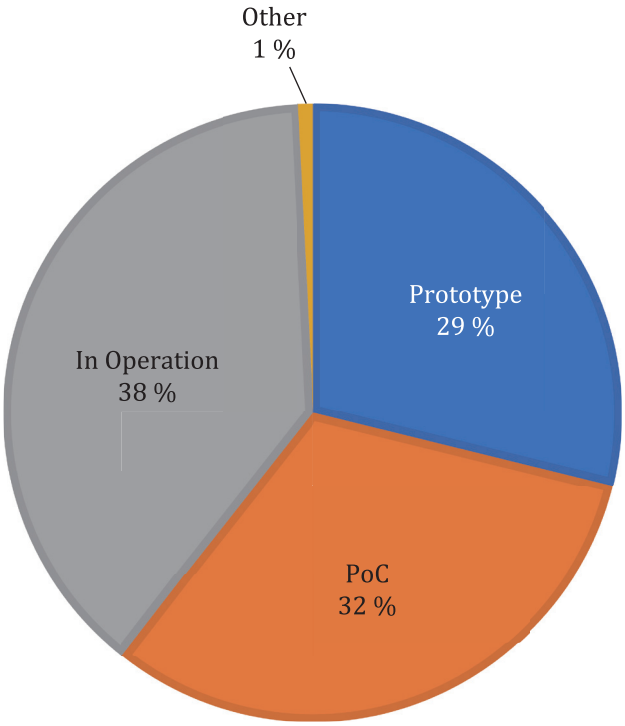

Figure 2 — Distribution of use cases by status

6.5.3 Use cases by task

Distribution of use cases by task is shown in Figure 3. Some use cases that include multi-tasks are counted multiple times in Figure 3.

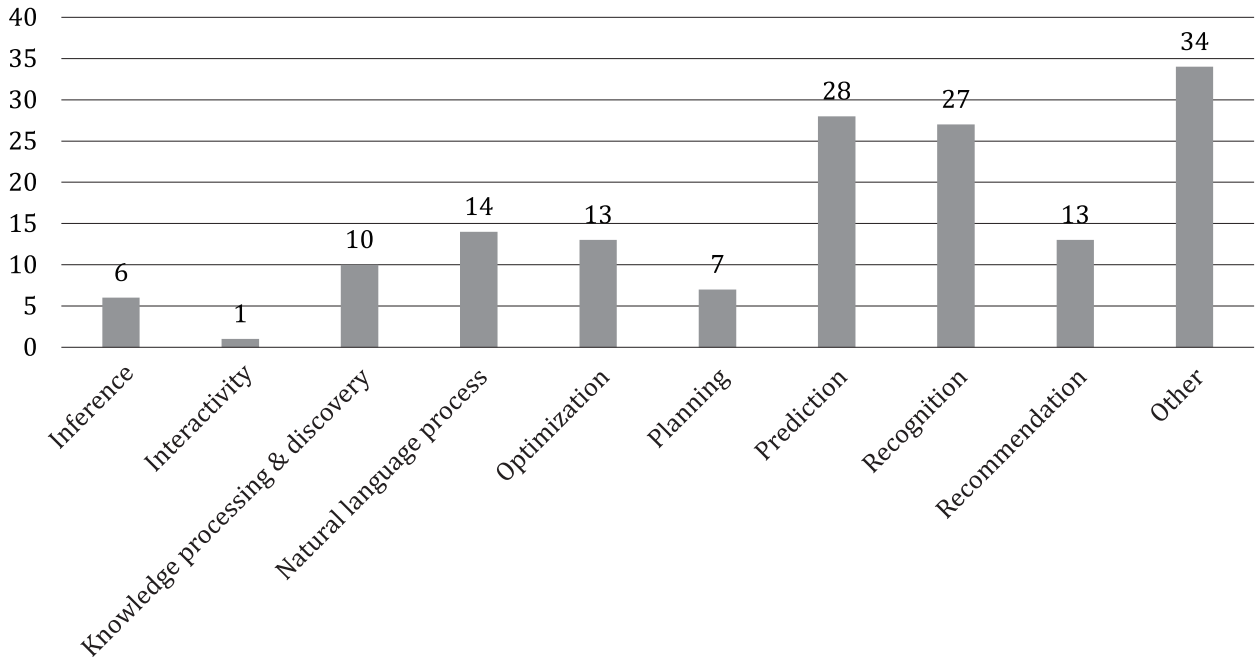

Figure 3 — Distribution of use cases by task

6.6 Societal concerns

6.6.1 General

Societal concerns taking the context, scope, nature and risks of AI technology into consideration come into play when an organization is choosing an AI technology or making recommendations that can affect the outcome in a socially and/or ethically undesirable way. In the absence of such considerations, the technology itself can perform flawlessly from a technical perspective, but with possible social, business or ethical costs. This document focuses on the impact analysis of use cases to consider the societal concerns of using AI systems.

6.6.2 Impact analysis

AI systems can be compared based on the potential impact of failure or unexpected behaviour. AI systems fall on a spectrum of risk, determined by the severity of the potential impact of a failure or unexpected behaviour. Relevant aspects for assessing the level of risk include:

1) the type of action space the system is operating in (e.g. recommendations vs direct action in an environment);

2) the presence/absence of external supervision;

3) the type of external supervision (automated or manual);

4) the ethical relevance of the task and/or domain;

5) the level of transparency of decisions or processing steps;

6) the degree of system autonomy[7];

7) the fundamental rights relevance of the task and/or application domain[8] (e.g. healthcare, transport, public sector and other application domains directly affect the safety of citizens' lives and property);

8) the robustness and accuracy of the system[8] (whether the system behaves reliably as intended).

For example, a system that only gives recommendations and cannot act on its own, in a domain that has no ethical relevance, and has no autonomy, would be considered low risk. Conversely, we would consider a system to be highly critical if its actions have direct impact on human lives, it operates autonomously and without external supervision, and its decision-making is opaque.

Annex A is a list of impact analysis items that are used for case studies. Submitted case studies cover numerous topics, from manufacturing and healthcare to mobility and transportation. Few of the use cases include a description of any societal concerns. The details in the use cases are varied, making it difficult to fully analyse the application and its implications. The benefits are also rarely defined. There is a disproportionate number of cases in manufacturing and mobility. The initially submitted use cases are more detailed and complete than later ones. Few of the case studies identify stakeholders. Note that there are a few "use cases" that are not an application of an AI system, but provide possible insights that can be leveraged in AI standardization work. These "use cases" cannot be analysed for societal impacts.

Societal impacts are generally not well defined in the use cases submitted. Vulnerable users are not generally identified. The explainability of the technology or use case is not present. The potential biases and equity issues are not presented. Data and privacy issues are not presented. Potential interactions and feedbacks that can have adverse impacts are not presented.

6.7 Use case analysis for standardization opportunities and requirements

An in-depth analysis of use case 51 was conducted to extract possible useful directions for future AI standards and standardization. The details of this analysis are presented in Annex C.

7 Use cases summaries

7.1 General

Table 2 shows summary information for each of the 132 use cases, including name, application domain(s), deployment model(s), and status. Subclauses 7.2 to 7.22 provide details on each use case, listed 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 inappropriate wordings. The descriptions are given for the convenience of users of this document and do not constitute an endorsement by ISO. Submitted use cases are not edited in this document. 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

Category	Subclause	Use case name	Application domain	Deployment model	Status
Agriculture	7.2.1	AI to understand adulteration in commonly used food items	Agriculture	Cloud services	PoC
	7.2.2	bioBotGuard	Agriculture	Cloud services	PoC
	7.2.3	Ecosystems management from causal relation inference from observational data	Agriculture, knowledge management, ICT	Cloud services, on-premise systems, embedded systems, hybrid	PoC
	7.2.4	Real-time segmentation and prediction of plant growth dynamics using low-power embedded systems equipped with AI	Agriculture	Embedded systems	In operation
Digital marketing	7.3.1	Improving conversion rates and return on investment (RoI) with AI technologies	Digital marketing	On-premise systems	In operation
	7.3.2	Logo and trademark detection	Digital marketing	Hybrid	PoC
	7.3.3	Flavorlens	Digital marketing	Cloud services	Prototype
Education	7.4.1	VTrain recommendation engine	Education	On-premise systems	In operation
	7.4.2	RAVE	Education	Hybrid	PoC
	7.4.3	IFLYTEK intelligent marking system	Education	On-premise systems	In operation
	7.4.4	Intelligent educational robot	Education	On-premise systems	In operation
	7.4.5	AI solution to intelligence campus	Education	Cloud services	In operation
	7.4.6	AI adaptive learning platform for personalized learning	Education	Cloud services	In operation
	7.4.7	AI adaptive learning mobile app	Education	Hybrid	In operation
Energy	7.5.1	AI-dispatcher (operator) of large-scale distributed energy system infrastructure	Energy	On-premise systems	PoC

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Fintech	7.6.1	Detection of frauds based on collusions	Fintech	On-premise systems	In operation
	7.6.2	Credit scoring using KYC data	Fintech	On-premise systems	PoC
	7.6.3	Virtual bank assistant	Fintech	Cloud services	In operation
	7.6.4	Forecasting prices of commodities	Fintech	On-premise systems	In operation
	7.6.5	Finance advising and asset management with AI	Fintech	Cloud services	In operation
	7.6.6	Loan in 7 minutes	Banking and financial services	On-premise systems	In operation
Healthcare	7.7.1	Explainable artificial intelligence for genomic medicine	Healthcare	Cloud services	Prototype
	7.7.2	Revolutionizing clinical decision-making using artificial intelligence	Healthcare	On-premise systems	PoC
	7.7.3	Computer-aided diagnosis in medical imaging based on machine learning	Healthcare	On-premise systems	PoC
	7.7.4	AI solution to predict post-operative visual acuity for LASIK surgeries	Healthcare	Cloud services	In operation
	7.7.5	Chromosome segmentation and deep classification	Healthcare	Hybrid	PoC
	7.7.6	AI solution for quality control of electronic medical records (EMR) in real time	Healthcare	Cloud services	In operation
	7.7.7	Dialogue-based social care services for people with mental illness, dementia and the elderly living alone	Healthcare	Hybrid	Prototype
	7.7.8	Pre-screening of cavity and oral diseases based on 2D digital images	Healthcare	Hybrid	Prototype
	7.7.9	Real-time patient support and medical information service applying spoken dialogue system	Healthcare	Hybrid	Prototype
	7.7.10	Integrated recommendation solution for prosthodontic treatments	Healthcare	Hybrid	Prototype
	7.7.11	Sudden infant death syndrome (SIDS)	Healthcare	Cloud services	Prototype
	7.7.12	Discharge summary classifier	Healthcare	On-premise systems	In operation
	7.7.13	Generation of clinical pathways	Healthcare	On-premise systems	In operation
	7.7.14	Hospital management tools	Healthcare	On-premise systems	In operation

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Healthcare	7.7.15	Predicting relapse of a dialysis patient during treatment	Healthcare	Cloud services	In operation
	7.7.16	Instant triaging of wounds	Healthcare	Cloud services	In operation
	7.7.17	Accelerated acquisition of magnetic resonance images	Healthcare	Hybrid	Prototype
	7.7.18	AI based text to speech services with personal voices for people with speech impairments	Healthcare	On-premise systems	Prototype
	7.7.19	AI platform for chest CT-scan analysis (Early stage lung cancer detection)	Healthcare	Cloud services	In operation
	7.7.20	AI-based design of pharmacologically relevant targets with target properties	Healthcare	On-premise systems	Prototype
	7.7.21	AI-based mapping of optical to multi-electrode catheter recordings for atrial fibrillation treatment	Healthcare	Embedded systems	PoC
	7.7.22	AI solution for end-to-end processing of cell microscopy images	Healthcare	Embedded systems	PoC
	7.7.23	Generation of computer tomography scans from magnetic resonance images	Healthcare	Embedded systems	PoC
	7.7.24	Improving the knowledge base of prescriptions for drug and non-drug therapy and its use as a tool in support of medical professionals	Healthcare	Cloud services	Prototype
	7.7.25	Neural network formation of 3D-model orthopedic insoles	Healthcare	Client and server systems	In operation
	7.7.26	Search for undiagnosed patients	Healthcare	Social networks	In operation
	7.7.27	Support system for optimization and personalization of drug therapy	Healthcare	On premise system	PoC
	7.7.28	Syntelly — computer-aided organic synthesis	Drug design, digital pharma	System for the prediction of the properties of pharmaceutically relevant molecules	Prototype
	7.7.29	WebioMed clinical decision support system	Healthcare	Cloud services	In operation
Home/service robotics	7.8.1	Robot consciousness	Home/ service robotics	Embedded systems	PoC
	7.8.2	Social humanoid technology capable of multi-modal context recognition and expression	Home/ service robotics	Embedded systems	Prototype
	7.8.3	Application of strong artificial intelligence	Hi-tech labour market	Artificial agents	In operation

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
ICT	7.9.1	Autonomous network and automation level definition	ICT	Cyber-physical systems	PoC
	7.9.2	Autonomous network scenarios	ICT	Cyber-physical systems	PoC
	7.9.3	A judging support system for gymnastics using 3D sensing	ICT	On-premise systems	PoC
	7.9.4	Active antenna array satellite	ICT	Cyber-physical systems	Prototype
	7.9.5	Carrier interference detection and removal for satellite communication	ICT	On-premise systems	PoC
	7.9.6	Ontologies for smart buildings	ICT	Hybrid	Prototype
	7.9.7	Product failure prediction for critical IT infrastructure	ICT	On-premise systems	In operation
	7.9.8	Data compression with AI techniques	ICT	On-premise systems	Prototype
	7.9.9	Optimization of software configurations with AI techniques	ICT	On-premise systems	Prototype
	7.9.10	Better human-computer interaction with advanced language models	ICT	Hybrid	Prototype
Legal	7.10.1	Tax rules updates and classification	Legal	On-premise systems	PoC
	7.10.2	AI contract management	Legal	On-premise systems	In operation
	7.10.3	Semantic analysis of legal documents	Legal	On-premise systems	Prototype
Logistics	7.11.1	Improving productivity for warehouse operation	Logistics	On-premise systems	PoC
	7.11.2	AI based dynamic routing SaaS	Logistics	Cloud services	In operation
Maintenance and support	7.12.1	Anomaly detection in sensor data using deep learning techniques	Maintenance and support	Hybrid	PoC
	7.12.2	Jet engine predictive maintenance service	Maintenance and support	Cloud services	Prototype
	7.12.3	Detection of fraudulent medical claims	Maintenance and support	On-premise systems	In operation
	7.12.4	AI virtual assistant for customer support and service	Maintenance and support	Embedded systems	In operation

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Manufacturing	7.13.1	AI solution to calculate amount of contained material from mass spectrometry measurement data	Manufacturing	Embedded systems	PoC
	7.13.2	AI solution to quickly identify defects during quality assurance process on wind turbine blades	Manufacturing	On-premise systems	In operation
	7.13.3	Solution to detect signs of failures in wind power generation system	Manufacturing	On-premise systems	PoB
	7.13.4	Generative design of mechanical parts	Manufacturing	On-premise systems	In operation
	7.13.5	Information extraction from hand-marked industrial inspection sheets	Manufacturing	Cloud services	PoC
	7.13.6	Automated defect classification on product surfaces	Manufacturing	On-premise systems	PoC
	7.13.7	Robotic task automation: Insertion	Manufacturing	Hybrid	PoC
	7.13.8	Powering remote drilling command centre	Manufacturing	Cloud services	In operation
	7.13.9	Leveraging AI to enhance adhesive quality	Manufacturing	On-premise systems	In operation
	7.13.10	Machine learning-driven approach to identify weak spots in the manufacturing of circuit breakers.	Manufacturing	On-premise systems	Prototype
	7.13.11	Machine learning-driven analysis of batch process operation data to identify causes of poor batch performance	Manufacturing	On-premise systems	Prototype
	7.13.12	Empowering autonomous flow meter control - reducing time taken for “proving of meters”	Manufacturing	Cloud services	In operation
	7.13.13	Adaptable factory	Manufacturing	Hybrid	PoC
	7.13.14	Order-controlled production	Manufacturing	Cloud Services	Prototype
	7.13.15	Value-based service	Manufacturing	Hybrid	PoC
	7.13.16	Improvement of productivity of semiconductor manufacturing	Manufacturing	On-premise systems	In operation
	7.13.17	AI decryption of magnetograms	Manufacturing, gas and oil	Client and server systems	In operation
	7.13.18	Analysing and predicting acid treatment effectiveness on bottom hole zone	Manufacturing, gas and oil	Client and server systems	In operation
	7.13.19	Automatic classification tool for full size core	Manufacturing, gas and oil	Client and server systems	In operation
	7.13.20	Intelligent technology to control manual operations via video — “Norma”	Manufacturing	On-premise systems	Prototype
	7.13.21	Optimization of ferroalloy consumption for a steel production company	Manufacturing	Embedded systems	PoC
	7.13.22	Device control using embedded AI with cloud computing	Manufacturing	Learning in both cloud and embedded	In operation

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Media and entertainment	7.14.1	Predictive analytics for the behaviour and psycho-emotional conditions of eSports players using heterogeneous data and artificial intelligence	eSports	Cyber-physical systems	Prototype
Mobility	7.15.1	Autonomous apron truck	Mobility	Embedded systems	PoC
	7.15.2	AI solution to help mobile phones to have better picture effect	Mobility	Hybrid	In operation
Public sector	7.16.1	AI ideally matches children to day-care centres	Public sector	On-premise systems	In operation
	7.16.2	AI sign language interpretation system for people with hearing impairment	Public sector	Embedded systems	Prototype
	7.16.3	AI situation explanation service for people with visual impairments	Public sector	Hybrid	Prototype
	7.16.4	Predictive maintenance of public housing lifts	Public sector	Embedded systems	PoC
Retail	7.17.1	Emotion-sensitive AI customer service	Retail	On-premise systems	In operation
	7.17.2	Deep learning-based user intent recognition	Retail	On-premise systems	In operation
Security	7.18.1	Behavioural and sentiment analytics	Security	On-premise systems	PoC
	7.18.2	AI (swarm intelligence) solution for attack detection in IoT environment	Security	Hybrid	Prototype
	7.18.3	Use of robotic solution for traffic policing and control	Security	On-premise systems	PoC
	7.18.4	Robotic solution for replacing human labour in hazardous conditions	Security	On-premise systems	PoC
	7.18.5	Non-intrusive detection of malware	Security	Cloud services	In operation
Social infrastructure	7.19.1	Deep learning technology combined with topological data analysis successfully estimates degree of internal damage to bridge infrastructure	Social infrastructure	Cloud services	PoC
	7.19.2	Water crystal mapping	Social infrastructure	Cloud services	Prototype
	7.19.3	System for real-time earthquake simulation with data assimilation	Social infrastructure	On-premise systems	Prototype

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Transportation	7.20.1	AI components for vehicle platooning on public roads	Transportation	Self-driving vehicles	Prototype
	7.20.2	Self-driving aircraft towing vehicle	Transportation	Self-driving vehicles	Prototype
	7.20.3	Unstaffed protective vehicle for road works on motorways	Transportation	Self-driving vehicles	Prototype
	7.20.4	Enhancing traffic management efficiency and infraction detection accuracy with AI technologies	Transportation	Hybrid	In operation
	7.20.5	AI solution for traffic signal optimization based on multi-source data fusion	Transportation	Cloud services	In operation
	7.20.6	Automated travel pattern recognition using mobile network data for applications to mobility as a service	Transportation	Activity- based modelling for new mobility services	PoC
	7.20.7	Autonomous trains (Unattended train operation (UTO))	Transportation	Self-driving vehicles	prototype
Work and life	7.21.1	Robotic prehension of objects	Work and life	Embedded systems	PoC
	7.21.2	Robotic vision – scene awareness	Work and life	Embedded systems	PoC
	7.21.3	Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain	Work and life	Cloud services	In operation
	7.21.4	Cooking recipes without border (CRWB) recommendation benchmark	Work and life	Cloud services	Prototype
	7.21.5	Improving the quality of online interaction	Work and life	Cloud services	In operation

Table 2 *(continued)*

Category	Subclause	Use case name	Application domain	Deployment model	Status
Others	7.22.1	AI solution to automatically identify false positives from a specific check for "untranslated target segments" by an automated quality assurance tool	This would be relevant for content across all domains	Cloud services	PoC
	7.22.2	AI solution for car damage classification	Insurance	Cloud services	PoC
	7.22.3	Causality-based thermal prediction for data centre	Data centre	On-premise systems	Prototype
	7.22.4	Machine learning tools in support of transformer diagnostics	Performance evaluation and diagnostics	Prototype	Prototype
	7.22.5	Video on demand publishing intelligence platform	TMT industry, technology department	On-premise systems	In operation
	7.22.6	Predictive testing	TMT industry – application development	On-premise systems	PoC
	7.22.7	Predictive data quality	Data management	Hybrid	PoC
	7.22.8	Expansion of AI training dataset and contents using artificial intelligence techniques	IT, AI, future services	Server systems	Prototype
	7.22.9	Open spatial dataset for developing AI algorithms based on remote sensing (satellite, drone, aerial imagery) data	Earth science, digital cartography	On-premise systems	In operation

7.2 Agriculture

7.2.1 AI to understand adulteration in commonly used food items (use case 19)

7.2.1.1 Scope of use case

Understand the patterns in hyperspectral/near infrared (NIR) or visual imaging specifically for adulteration in milk, bananas and mangoes.

7.2.1.2 Objective

To devise a simple, cost effective tool to identify adulteration in food items at point of purchase.

7.2.1.3 Narrative (short description)

Food adulteration is one of the big challenges of modern society. Adulterated milk is a hazard for children, and many ailments including cancer and kidney failure are due to consumption of adulterated food. Hyperspectral technology was evaluated to find out adulteration in food items.

7.2.1.4 Challenges and issues

Large scale data collection, miniaturization of frugal NIR/hyperspectral sensor.

7.2.1.5 Societal concerns

If the AI system is rolled out and taken to be reliable, then it is expected to be able to perform in all cases and scenarios. Incorrect classification can lead to false accusations.

SDGs to be achieved: Good health and well-being for people

7.2.2 bioBotGuard (use case 54)

7.2.2.1 Scope of use case

Use visual recognition to identify and help fight parasites attacking organic farms.

7.2.2.2 Objective

The use case shows how AI is contributing to modernization of the agriculture industry.

7.2.2.3 Narrative (short description)

BioBotGuard defines itself as an initiative of precision farming as a service. From an IT perspective, it uses drones with GPS and high-resolution cameras to monitor crops. The images are then processed by computer vision API in order to spot diseases and harmful insect attacks, building a georeferenced risk map of the crop. This can be used to send operational drones to provide treatment (or antagonist insects) only when and where it is necessary.

7.2.2.4 Challenges and issues

Acquire field as well as crop images at different distances and normalize image recognition and pattern detection.

7.2.2.5 Societal concerns

None identified

7.2.3 Ecosystems management from causal relation inference from observational data (use case 96)

7.2.3.1 Scope of use case

Infer important latent variables to control a whole ecosystem using a database including human observation and sensor data.

7.2.3.2 Objective

To provide some suggestions for managing ecosystems and repeatedly improve management with the introduction of possibly latent variables and new data.

7.2.3.3 Narrative (short description)

We can find diverse relations between climate, animals and plants that infer an ecologically consistent structure.

To determine the factors that support a species' niche, it is necessary to diversify the polyculture in ecological optimum, which is a complex entanglement that depends on environmental conditions, associated biodiversity, farming options, etc.

In the Synecoculture project, polyculture with ecological optimum requires a huge amount of information on biodiversity, interactions, and vegetation succession parameters. This information is generally sparse and possibly biased, open-ended, etc., because it relies on human observation. Still, this information can bring useful understanding and intriguing insight on management if powerful algorithmic analysis is combined with appropriate human evaluation.

7.2.3.4 Challenges and issues

None identified

7.2.3.5 Societal concerns

SDGs to be achieved: No poverty; Zero hunger; Good health and well-being; Clean water and sanitation; Decent work and economic growth; Industry, innovation and infrastructure; Reduce inequalities; Responsible consumption and production; Climate action; Life on land; Partnerships for the goals.

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

7.2.4.1 Scope of use case

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.

7.2.4.2 Objective

Prediction of harvest, biomass/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.

7.2.4.3 Narrative (short description)

Research efforts towards low-power sensing devices with fully functional AI on board are still fragmented. In our project, we present an embedded system enriched with AI that ensures the continuous analysis and in-situ prediction of the 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. The proposed approach guarantees the system autonomous operation for 180 d using a standard Li-ion battery. We rely on state-of-the-art mobile graphic chips for smart analysis and control of autonomous devices. The data was used for training and testing the recurrent neural network, convolutional neural network algorithms, and the segmentation algorithms. All this allows for high performance in-situ optimization of plant growth dynamics and resource consumption.

7.2.4.4 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 amount 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.

7.2.4.5 Societal concerns

— Good health and well-being for people

— Elimination of hunger

— Availability of cheap and healthy food for everyone

— Colonization of harsh environments on earth and in space exploration

SDGs to be achieved: Good health and well-being; Zero hunger.

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 Scope of use case

Utilizing AI technologies in digital marketing.

7.3.1.2 Objective

— 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.

7.3.1.3 Narrative (short description)

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, we can predict the services that users may be interested in, improve marketing effectiveness and enhance user experience.

7.3.1.4 Challenges and issues

National and regional legislation and regulations can affect how to collect, utilize and protect user information.

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

7.3.1.5 Societal concerns

— 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.

SDGs to be achieved: Sustainable cities and communities.

7.3.2 Logo and trademark detection (use case 56)

7.3.2.1 Scope of use case

Identification of logos/trademarks in pictures, optionally performing sentiment analysis associated with the product.

7.3.2.2 Objective

Understand usage of retail or fashion products and, optionally, sentiment associated with it based on pictures posted on the internet or social networks by customers.

7.3.2.3 Narrative (short description)

The case is about being able to identify logos and trademarks in pictures provided to the AI systems, and optionally derive a positive or negative sentiment toward the product based on the written context that was provided with the picture.

7.3.2.4 Challenges and issues

The primary challenge is to be able to correctly identify trademarks in all situations (even under bad lighting, image distortion, dirt, etc.) and interpret the sentiment and tone in different countries and languages, as people can use slang and irony.

7.3.2.5 Societal concerns

Automated analysis of public posts on social networks can be seen as unethical in certain cultures.

7.3.3 Flavorlens (use case 76)

7.3.3.1 Scope of use case

Sharing of multi-sensing dish tasting experiences in a social media ecosystem.

7.3.3.2 Objective

Users share their experiences and dish recommendations.

7.3.3.3 Narrative (short description)

Social network to enable sharing of dish tasting experiences.

7.3.3.4 Challenges and issues

Personal expectations related to flavour, taste and texture.

7.3.3.5 Societal concerns

Local healthy dishes that provide user satisfaction and meet preferences.

SDGs to be achieved: Good health and well-being for people

7.4 Education

7.4.1 VTrain recommendation engine (use case 23)

7.4.1.1 Scope of use case

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

7.4.1.2 Objective

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

7.4.1.3 Narrative (short description)

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

7.4.1.4 Challenges and issues

Large amounts of training data are necessary; predicting human behaviour is tricky.

7.4.1.5 Societal concerns

Employees can feel challenged or demoralized.

SDGs to be achieved: Decent work and economic growth.

7.4.2 RAVE (use case 55)

7.4.2.1 Scope of use case

Use of advanced and multimodal sensing ability to facilitate a complex task.

7.4.2.2 Objective

An avatar and social robot interact with babies with hearing impairments for facilitating language learning.

7.4.2.3 Narrative (short description)

The RAVE system is an integrated multi-agent system involving a robot and virtual human designed to augment language exposure for 6-month-old to 12-month-old infants. The system is an engineered robot and avatar to provide visual language to effect socially contingent human conversational exchange. The team demonstrated the successful engagement of our technology through case studies of infants with and without hearing impairments.

7.4.2.4 Challenges and issues

Ability to decode a learner's cognitive status and his/her attention level.

7.4.2.5 Societal concerns

None identified

7.4.3 IFLYTEK intelligent marking system (use case 83)

7.4.3.1 Scope of use case

The system can perform intelligent detection and grading of subjective questions.

7.4.3.2 Objective

To significantly reduce labour and organizational costs.

7.4.3.3 Narrative (short description)

The IFLYTEK intelligent marking system is based on core technology design research, including IFLYTEK independent intellectual property rights, handwritten recognition, natural language understanding, intelligent evaluation and other artificial intelligence. It can detect 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.

7.4.3.4 Challenges and issues

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

7.4.3.5 Societal concerns

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

Significantly reduced labour and organizational costs.

SDGs to be achieved: Quality education.

7.4.4 Intelligent educational robot (use case 84)

7.4.4.1 Scope of use case

The robot is designed to support children’s education.

7.4.4.2 Objective

To improve the pleasure of learning.

7.4.4.3 Narrative (short description)

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.

7.4.4.4 Challenges and issues

— Be able to sense students' emotions like teachers.

— Accurately capture students' gestures, postures, face information, etc.

7.4.4.5 Societal concerns

— Give students emotional support.

— Stimulate students' interest in learning.

SDGs to be achieved: Quality education.

7.4.5 AI solution to intelligent campus (use case 85)

7.4.5.1 Scope of use case

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

7.4.5.2 Objective

This scheme provides a comprehensive intelligent sensing environment and comprehensive information service platform for teachers and students, so as to integrate human and business information.

7.4.5.3 Narrative (short description)

Based on big data and artificial intelligence technology, the scheme 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, in order to:

— help teachers and students to teach and learn according to their aptitude and individualized learning;

— help managers to supervise and assist decision making; and

— greatly promote the transformation of education, learning and management to intelligence.

7.4.5.4 Challenges and issues

The implementation of an intelligent campus requires the collection and processing of large quantities of data on students and teachers, which is likely to lead to the disclosure of private data. Therefore, the data privacy protection mechanism is expected to be strengthened in the intelligent platform.

7.4.5.5 Societal concerns

This intelligent campus solution brings artificial intelligence technology onto the campus and into the classroom, promotes students' learning and teachers' teaching and facilitates teaching management.

SDGs to be achieved: Quality education.

7.4.6 AI adaptive learning platform for personalized learning (use case 102)

7.4.6.1 Scope of use case

2,5 million users.

7.4.6.2 Objective

Open access, interactive tasks, personalization, user-generated content, learning graph. In summary, equal access to high-quality education.

7.4.6.3 Narrative (short description)

The adaptive learning platform (AiEd platform) is an e-learning platform and course-builder that uses AI for forming adaptive learning paths.

7.4.6.4 Challenges and issues

Edstories (micro-learning video stories) are necessary to be included to satisfy the pedagogical model of movement-based learning.

7.4.6.5 Societal concerns

The system is expected to be integrated into secondary and tertiary school systems that still face legal boundaries and limitations for scaling.

SDGs to be achieved: Quality education.

7.4.7 AI adaptive learning mobile app (use case 124)

7.4.7.1 Scope of use case

A foreign language learning mobile program for all age groups that adapts to the student and builds an individual learning track based on artificial intelligence.

7.4.7.2 Objective

Providing easy, convenient and adaptive learning of English with the help of a virtual teacher based on artificial intelligence.

7.4.7.3 Narrative (short description)

A mobile application for learning English, which is based on a program that adapts content to the student and learns with them. During registration, the program analyses the user's account on a social network and draws up an individual training plan based on the student's interests.

7.4.7.4 Challenges and issues

The development of a personalized approach to learning.

7.4.7.5 Societal concerns

This case of the use of artificial intelligence in the educational process can complement teachers as knowledge transmitters and make education accessible to everyone. At the same time, artificial intelligence, performing the functions of analytics, packaging and personalization of educational content, is much more effective than a person in the role of an assistant to a teacher and shifts the role of a classical teacher towards mentoring.

SDGs to be achieved: Quality education.

7.5 Energy

7.5.1 AI-dispatcher (operator) of large-scale distributed energy system infrastructure (use case 109)

7.5.1.1 Scope of use case

Monitoring, optimization and control of large-scale distributed energy systems using deep reinforcement learning (gas, oil, power, heat and water transmission and distribution infrastructure systems).

7.5.1.2 Objective

To develop an effective industrial AI solution that is able to recommend the optimal control of energy infrastructure systems in real-time in order to:

— satisfy the energy demands of consumers;

— minimize possible negative impacts on the environment;

— reduce operational costs through systems' real-time continuous optimization in a self-adaptive manner.

7.5.1.3 Narrative (short description)

An AI solution is currently in development that uses hybrid models (based on both traditional physics models and artificial neural networks), "digital twins," and deep reinforcement learning to support decision making and control of energy infrastructure systems in real-time.

7.5.1.4 Challenges and issues

— To achieve a high level of efficiency of a complex energy system's optimization and dispatching control.

— To learn from human-beings, including machine teaching techniques.

— To employ meta-learning techniques in real industrial environments, which can help AI-agents to adapt efficiently to different systems (for example, from small scale to large scale industrial systems, from gas to oil transmission systems, from power to heat infrastructure systems, and vice versa).

— To deal effectively with partially observed systems.

— To develop an AI-solution that reacts reliably to rare events.

7.5.1.5 Societal concerns

Safety, security and reliability of AI solutions that are used in energy infrastructure management.

SDGs to be achieved: Affordable and clean energy.

7.6 Fintech

7.6.1 Detection of frauds based on collusions (use case 20)

7.6.1.1 Scope of use case

Validating the predicted collusion set is effort-intensive and investigative and legal expertise are necessary.

7.6.1.2 Objective

Automatic unsupervised detection of frauds based on collusions.

7.6.1.3 Narrative (short description)

A set of unsupervised machine learning algorithms to detect collusion-based frauds, particularly circular trading and price manipulation in stock market trading.

7.6.1.4 Challenges and issues

Actual examples of collusion-based frauds may not be readily available, even for evaluation and testing.

7.6.1.5 Societal concerns

Incorrect detection of collusions and frauds can cause unnecessary stress in stock traders.

SDGs to be achieved: Decent work and economic growth.

7.6.2 Credit scoring using KYC data (use case 27)

7.6.2.1 Scope of use case

Building a risk scorecard for loan applicants using KYC data for better risk management and high population coverage.

7.6.2.2 Objective

Assigning a risk score to every loan applicant in real time, using just KYC data, which would ensure both new-to-credit and mature customers can be assessed for their creditworthiness, and offered loans on appropriate terms.

7.6.2.3 Narrative (short description)

It can often be difficult to build a risk scorecard using only KYC data, which often has noise and incompleteness issues. However, if realized, it can be used to provide an objective score to all loan applicants, even new-to-credit ones. Non-linear classification algorithms are suitable for this purpose.

Several variables are collected from the customer during the KYC process, such as the age of the customer, self-reported income, type of occupation, loan purpose, etc. All these features can be added to a non-linear risk model and their complex interactions allowed to take place.

7.6.2.4 Challenges and issues

— KYC data obtained from very rural areas can be noisy, can have several missing values, and appropriate pre-processing and treatment are necessary before feeding to the model algorithm.

— Non-linear models like random forest and XGBoost need significant computational power during the training phase.

7.6.2.5 Societal concerns

We do not see any societal concerns if it is used.

7.6.3 Virtual bank assistant (use case 57)

7.6.3.1 Scope of use case

Use of advanced chatbots and dialogue systems to automatize part of call centre activities.

7.6.3.2 Objective

Provide better quality help desk support to employees.

7.6.3.3 Narrative (short description)

A bank's virtual assistant is the first point of contact for branch operators, who receive immediate answers at any time — it allows optimization of the time during which the service desk can be staffed by human operators, who are dedicated to activities of greater value.

7.6.3.4 Challenges and issues

Provide natural and consistent interaction with users who have different levels of experience (and thus terminology) and different backgrounds.

7.6.3.5 Societal concerns

None identified

7.6.4 Forecasting prices of commodities (use case 91)

7.6.4.1 Scope of use case

Build a neural network to forecast the price of base metal commodities.

7.6.4.2 Objective

Use forecasted prices to interpret trading trends.

7.6.4.3 Narrative (short description)

A trading company is necessary to improve the forecast accuracy of price points for specific commodities.

7.6.4.4 Challenges and issues

Challenge in modelling a neural network model that ingests a large and wide array of data, while calibrating for variables that have short term versus long term impact.

7.6.4.5 Societal concerns

Unpredictable flow of materials and commodities due to price shocks.

SDGs to be achieved: Reducing inequalities.

7.6.5 Finance advising and asset management with AI (use case 114)

7.6.5.1 Scope of use case

Financial advising and portfolio management for financial institutions and consumers.

7.6.5.2 Objective

Designed to manage exchange-traded securities portfolios of conservative investors in real time, using asset price data and macroeconomic data, to make the most accurate decisions at a given yield and moderate risk. Prediction of significant depreciation of exchange-traded asset prices as a result of a sharp monetary contraction (financial crisis).

7.6.5.3 Narrative (short description)

The core of the system carries out a structured collection from open sources and multi-threaded parallel analysis of information. It regulates the application of basic algorithms and rules for changing these algorithms that change the purpose of the task. (Intermediate goal setting is one of the elements of "Strong AI".) One of the tasks is to assess market trends, as well as market and interest rate risk. Changes in the algorithm of actions depend on the macroeconomic information received from the outside. It translates notoriously weakly formalized parameters into specific decisions on the formation of investment portfolios and issues orders to brokers to purchase, rebalance or sell assets in stock exchanges.

The macroeconomics unit is an autonomous system that generates indicators of time periods and geographical areas with different weights of investment potential.

7.6.5.4 Challenges and issues

— Data can be noisy, can have several missing values, and needs appropriate pre-processing and treatment before feeding to the model algorithm.

— Working with financial assets requires high reliability of computing systems and replication systems.

7.6.5.5 Societal concerns

SDGs to be achieved: No poverty.

7.6.6 Loan in 7 minutes (use case 119)

7.6.6.1 Scope of use case

A completely automated solution that analyses customer behaviour and makes the best loan offers for the customer.

7.6.6.2 Objective

Create lending products for clients of medium and large businesses (LMB) with the shortest delivery time possible, taking into account the extremely detailed customer profile.

7.6.6.3 Narrative (short description)

Loan in 7 minutes is the first solution in the world where the credit decision is made by artificial intelligence in just a few minutes without human participation.

A complex machine learning settlement system was implemented on one of the largest Hadoop-clusters in Eastern Europe (tens of petabytes of data) and integrated into the bank's corporate lending business process.

The new project has significantly improved customer experience:

— eliminated the need for the client to contact the bank in person for a loan;

— requires no additional documents from the client to get a decision;

— bank’s automated systems were improved in terms of automatic transaction creation;

— substantially simplified the process of issuing a loan.

7.6.6.4 Challenges and issues

Non-linear models based on big data need significant computational power during the training phase.

7.6.6.5 Societal concerns

Investment in technological innovation and infrastructure is a crucial driver of higher levels of productivity and economic growth.

SDGs to be achieved: Industry, innovation, and infrastructure.

7.7 Healthcare

7.7.1 Explainable artificial intelligence for genomic medicine (use case 1)

7.7.1.1 Scope of use case

To explain the reason and basis behind AI-generated findings in genomic medicine.

7.7.1.2 Objective

To improve the efficiency of investigatory work for experts in genomic medicine.

7.7.1.3 Narrative (short description)

This technology was deployed to improve the efficiency of investigatory work for experts in genomic medicine, utilizing training data and a knowledge graph that made use of public databases and medical literature databases in the field of bioinformatics. It was then evaluated to validate that it was possible to find and link the basis supporting findings with regard to phenomena whose interrelationships are only partially understood.

7.7.1.4 Challenges and issues

— Challenges: To reduce experts' workloads, shortening determination periods in genomic medicine.

— Issues: The inability to explain the reason behind inferences from the learning algorithm of black-box AI.

7.7.1.5 Societal concerns

— Accountability for using AI in medical examinations.

— Incorrect explanation would cause an increase in the determination periods.

SDGs to be achieved: Good health and well-being for people

7.7.2 Improve clinical decision-making and risk assessment in mental healthcare (use case 2)

7.7.2.1 Scope of use case

To improve clinical decision-making and the accurate assessment of risks for individual patients of mental healthcare.

7.7.2.2 Objective

Halving the time to pre-screen patient records and giving more time for patient consultations.

7.7.2.3 Narrative (short description)

The solution has halved the time required for the preliminary assessment of patient records, increasing the time available for consultations.

7.7.2.4 Challenges and issues

The incorporation of many different types of data is revolutionizing the healthcare sector. The ability to apply semantic and analytic technologies to this heterogeneous mass of data, as well as traditional healthcare data, to discover hidden correlations, identify care patterns and support clinical decision-making is paving the way for a new generation of improved healthcare services.

7.7.2.5 Societal concerns

Incorrect decision and unexplainable result.

SDGs to be achieved: Good health and well-being for people

7.7.3 Computer-aided diagnosis in medical imaging based on machine learning (use case 6)

7.7.3.1 Scope of use case

Detecting image anomalies.

7.7.3.2 Objective

Provide an AI method to alleviate the growing burden of histopathological diagnosis by humans.

7.7.3.3 Narrative (short description)

The advances in image recognition technology enable the machine learning system to support diagnosis in medical imaging. This technology is expected to contribute to a great reduction of the burden on doctors and the improvement of diagnostic accuracy when it is used for screening and double checking. Specifically, a support system is currently under development that analyses histopathological images to automatically detect suspected lesions.

7.7.3.4 Challenges and issues

None identified

7.7.3.5 Societal concerns

None identified

7.7.4 AI solution to predict post-operative visual acuity for LASIK surgeries (use case 24)

7.7.4.1 Scope of use case

Predicting post-operative visual acuity for laser-assisted in SItu keratomileusis (LASIK) surgeries from retrospective LASIK surgery data with patient follow-ups.

7.7.4.2 Objective

— Given: Pre-operative examination results and demography information about a patient.

— Predict: Post-operative UCVA one day, one week and one month after surgery.

7.7.4.3 Narrative (short description)

Laser-Assisted in SItu Keratomileusis (LASIK) surgeries have been quite popular for treatment of myopia, hyperopia and astigmatism over the past two decades. In the past decade, over ten million LASIK procedures have been performed in the United States alone with an average cost of approximately 2 000 USD/s. While 99 % of such surgeries are successful, the commonest side effect is a residual refractive error and poor uncorrected visual acuity (UCVA). In this work, we aim at predicting the UCVA post LASIK surgery. We model the task as a regression problem and use the patient demography and pre-operative examination details as features. To the best of our knowledge, this is the first work to systematically explore this critical problem using machine learning methods. Further, LASIK surgery settings are often determined by practitioners using manually designed rules. We explore the possibility of determining such settings automatically to optimize for the best post-operative UCVA by including such settings as features in our regression model. Our experiments on a dataset of 791

surgeries provides an RMSE of 0,102, 0,094 and 0,074 for the predicted post-operative UCVA one day, one week and one month after surgery, respectively.

7.7.4.4 Challenges and issues

The problem is challenging because:

1) a large amount of data about such surgeries is not easily available;

2) there are a lot of pre-operative measurements that can be used as signals; and

3) data is sparse, i.e. there are a lot of missing values.

7.7.4.5 Societal concerns

SDGs to be achieved: Good health and well-being for people

7.7.5 Chromosome segmentation and deep classification (use case 44)

7.7.5.1 Scope of use case

Karyotyping of chromosomes is restricted to healthy patients.

7.7.5.2 Objective

— Automating karyotyping of chromosomes in cell spread images.

— Segmentation of chromosomes in images by a non-expert crowd.

7.7.5.3 Narrative (short description)

Karyotyping of the chromosomes micro-photographed under metaphase is done by characterizing the individual chromosomes in cell spread images. Currently, considerable effort and time is spent to manually segment out chromosomes from cell images, and classify the segmented chromosomes. We proposed a method to segment out and classify chromosomes for healthy patients using a combination of crowdsourcing, pre-processing and deep learning, wherein the non-expert crowd from an external crowdsourcing platform is utilized to segment out the chromosomes, which are then classified using a deep neural network. Results are encouraging and promise to significantly reduce the cognitive burden of segmenting and karyotyping chromosomes.

7.7.5.4 Challenges and issues

Crowd's job satisfaction and spamming in annotated data.

7.7.5.5 Societal concerns

Inaccurate classification of chromosomes can lead to stress in patients if classification is not reviewed by expert doctors.

SDGs: Good health and well-being for people

7.7.6 AI solution for quality control of electronic medical records (EMR) in real time (use case 50)

7.7.6.1 Scope of use case

Detecting defects in EMRs by inspecting unstructured data based on natural language processing (NLP) ability.

7.7.6.2 Objective

To ensure the completeness, consistency, punctuality and medical compliance of EMRs written by physicians.

7.7.6.3 Narrative (short description)

This AI solution in the ET Medical Brain medical service support system was developed to simultaneously detect mistakes while physicians write the electronic medical record (EMR).

Using NLP ability, it can process a large amount of unstructured text and judge its accuracy according to recognized medical references.

It achieved 80 % coverage of all EMR quality control requirements issued by the Chinese government, and reduced human labour for EMR quality control (QC) by 60 %, which translated into cost savings and enhanced physician education.

7.7.6.4 Challenges and issues

— Challenges: Achieve all EMR QC requirements in different disease areas.

— Issues: 1) lack of medical reference data; 2) lack of medical knowledge graph.

7.7.6.5 Societal concerns

Achieved 80 % coverage of all EMR quality control requirements issued by the Chinese government, and reduced human labour for EMR QC by 60 %, which translated into cost savings and enhanced physician education.

SDGs to be achieved: Good health and well-being for people

7.7.7 Dialogue-based social care services for people with mental illness, dementia and the elderly living alone (use case 63)

7.7.7.1 Scope of use case

Daily life support AI services that provide an interaction with humans using natural language.

7.7.7.2 Objective

Dialogue-based interaction between people and machines using artificial intelligence technology helps people with accessibility issues to IT devices.

7.7.7.3 Narrative (short description)

Daily life support services based on artificial intelligence conversation technology that can perform information processing tasks through natural language conversation with users.

7.7.7.4 Challenges and issues

— Multimodal data handling-based multimodal interaction.

— Multimodal data analysis.

— Multimodal data-based inferences.

7.7.7.5 Societal concerns

Promoting welfare and supporting social activities for people with mental illness, dementia and the elderly living alone.

SDGs to be achieved: Good health and well-being for people

7.7.8 Pre-screening of cavity and oral diseases based on 2D digital images (use case 67)

7.7.8.1 Scope of use case

Artificial intelligence-based oral examination platform.

7.7.8.2 Objective

— AI-based oral disease self-examination solution.

— Self-care, prevention and management of cavities, periodontal disease, oral disease, tooth care and oral care.

7.7.8.3 Narrative (short description)

This service utilizes artificial intelligence technology to analyse oral conditions by sending oral images to the diagnostic server without the user having to visit the dentist.

7.7.8.4 Challenges and issues

Dental image processing using artificial intelligence.

7.7.8.5 Societal concerns

Elimination of inequalities in regional health care services.

SDGs to be achieved: Good health and well-being for people

7.7.9 Real-time patient support and medical information service applying spoken dialogue system (use case 68)

7.7.9.1 Scope of use case

Medical business support system using artificial intelligence-based human-computer interface technology.

7.7.9.2 Objective

Acquisition, retrieval and provision of patient information and related data needed by medical staffs in real time through a voice dialogue interface during medical treatment.

7.7.9.3 Narrative (short description)

The service is a medical system that provides patient information and related data for treatment in real time based on a voice dialogue interface to help hands-on medical activities, such as dental, first aid, and surgery.

7.7.9.4 Challenges and issues

— Dialogue service in medical data and knowledge.

— Question and answering by a medical expert system.

— Multi-task handling in a dialogue-based interfacing environment.

— Remote speech recognition.

7.7.9.5 Societal concerns

Improving medical service efficiency and patient satisfaction.

SDGs to be achieved: Good health and well-being for people

7.7.10 Integrated recommendation solution for prosthodontic treatments (use case 69)

7.7.10.1 Scope of use case

In order to support complicated prosthetic treatments according to the patient's condition, the artificial intelligence technology provides a comprehensive analysis of the given information and situations to recommend various prosthetic treatment methods and visualize them to support doctors and patients.

7.7.10.2 Objective

Various knowledge in dentistry and related patient data for prosthodontic treatment are collected in advance.

Suggesting recommended cases and possible solutions for the prosthesis.

7.7.10.3 Narrative (short description)

This service includes sufficient dental knowledge and patient data for prosthodontic treatment, and uses a variety of artificial intelligence techniques to provide recommended practices and possible solutions for prosthodontics.

7.7.10.4 Challenges and issues

— Discovery of satisfying solutions based on medical knowledge and clinical data.

— Reasoning out of novel cases by combining expert knowledge and case studies.

7.7.10.5 Societal concerns

Improving medical service efficiency and patient satisfaction.

SDGs to be achieved: Good health and well-being for people

7.7.11 Sudden infant death syndrome (SIDS) (use case 74)

7.7.11.1 Scope of use case

Use of facial recognition in healthcare.

7.7.11.2 Objective

Lowering the statistical chance of infant death syndrome (SIDS).

7.7.11.3 Narrative (short description)

ML-based facial recognition technology detects when an infant is lying on his/her back or face down, alerting the care taker to intervene when the infant is on his/her stomach, hence lowering the statistical chance of infant death syndrome (SIDS).

7.7.11.4 Challenges and issues

— Explainability and transparency regarding the training data used, from the perspective of privacy concerns, and racial and ethnic biases that may be unintentionally built into the trained model.

— Need a structured, common and standardized way to describe the stages of the machine learning model training process, and the types and aspects of the data used in the various stages of the process so the stakeholders (policy makers, privacy advocates and customers) can build confidence and trust in such ML-based product or service. The various aspects of the data are described in the ISO/IEC 19944 series.

7.7.11.5 Societal concerns

— Cost and availability of the ML-based service for low income populations who may not have access to high speed internet or may not be able to afford the ML-based cloud service.

— Any unintentional bias built into the training data that may hinder the effectiveness of the algorithm when used with infants from other races or ethnic backgrounds.

SDGs to be achieved: Good health and well-being for people

7.7.12 Discharge summary classifier (use case 79)

7.7.12.1 Scope of use case

Decision tree, random forest, SVM, BNN, deep learning

7.7.12.2 Objective

Classification of discharge summaries

7.7.12.3 Narrative (short description)

This system proposes a method for construction of classifiers for discharge summaries.

7.7.12.4 Challenges and issues

Computational complexity

7.7.12.5 Societal concerns

— Refinement of medical texts

— Medical hospital management

SDGs to be achieved: Good health and well-being for people

7.7.13 Generation of clinical pathways (use case 80)

7.7.13.1 Scope of use case

Decision tree, clustering

7.7.13.2 Objective

Nursing clinical pathway

7.7.13.3 Narrative (short description)

This system proposes a temporal data mining method to construct and maintain a clinical pathway used for schedule management of clinical care.

7.7.13.4 Challenges and issues

Computational complexity

7.7.13.5 Societal concerns

Good practice of medical services

SDGs to be achieved: Good health and well-being for people

7.7.14 Hospital management tools (use case 81)

7.7.14.1 Scope of use case

Temporal data mining, visualization

7.7.14.2 Objective

Hospital management

7.7.14.3 Narrative (short description)

Temporal data mining methods (Multi-scale comparison with clustering and temporal frequent item sets) is applied to hospital data.

7.7.14.4 Challenges and issues

Computational complexity

7.7.14.5 Societal concerns

Good practice of medical services

SDGs to be achieved: Good health and well-being for people

7.7.15 Predicting relapse of a dialysis patient during treatment (use case 87)

7.7.15.1 Scope of use case

Build an AI solution to augment dialysis nurses.

7.7.15.2 Objective

Use AI to predict if a patient can relapse during dialysis to reduce patient trauma.

7.7.15.3 Narrative (short description)

A deep learning model to learn from historical and real-time parameters about a patient to identify the probability he or she can relapse during dialysis.

7.7.15.4 Challenges and issues

Challenges in feature engineering the scores of datasets into a logical format that allows the prediction model to retrain without need for high compute.

7.7.15.5 Societal concerns

Lack of reliable and accessible healthcare facilities

SDGs to be achieved: Good health and well-being for people

7.7.16 Instant triaging of wounds (use case 89)

7.7.16.1 Scope of use case

Build an AI solution to augment triaging decisions by wound nurses.

7.7.16.2 Objective

Use AI to identify and classify the intensity of wounds.

7.7.16.3 Narrative (short description)

A computer vision model able to use RGB and infrared (IR) wavelengths to measure the size, depth and intensity of a wound.

7.7.16.4 Challenges and issues

Challenges in integrating RGB models and IR models into a single, interpretable visualization for the nurses

7.7.16.5 Societal concerns

Shortfalls in access to trained nurses and medical imaging technology

SDGs to be achieved: Good health and well-being for people

7.7.17 Accelerated acquisition of magnetic resonance images (use case 101)

7.7.17.1 Scope of use case

Innovations in MRI image formation

7.7.17.2 Objective

Developing new approaches to MRI image formation aimed at reducing image acquisition time while maintaining the diagnostic image quality.

7.7.17.3 Narrative (short description)

Magnetic resonance imaging (MRI) is an essential instrument in precision diagnostics of neurological, oncological, musculoskeletal and other diseases. However, long acquisition times combined with the requirement for patient stillness pose a challenge for both patient and the radiology department, leading to high exam costs. Recent advances in sparse raw signal acquisition and specific image reconstruction show that it is possible to significantly reduce the acquisition time.

7.7.17.4 Challenges and issues

— It is expected that image quality measurements correlate with the diagnostic value – extensive clinical validation and A/B testing is necessary, but it is expensive.

— It is necessary to guarantee quality for all possible combinations of MRI sequence parameters, anatomical areas, and patient cohorts, or to be very conservative in defining the limits of applicability.

7.7.17.5 Societal concerns

(If safety/quality were guaranteed), MRI imaging would be used more often and more images would be generated, which would increase radiologists' workloads. Development of AI-assisted image interpretation tools would be very much in demand.

SDGs to be achieved: Industry, innovation, and infrastructure

7.7.18 AI based text to speech services with personal voices for people with speech impairments (use case 103)

7.7.18.1 Scope of use case

All people who have some sort of speech impairment including but not limited to three basic types: articulation disorders, fluency disorders, and voice disorders.

7.7.18.2 Objective

People with speech impairments would be fully integrated into social processes without communication restrictions.

7.7.18.3 Narrative (short description)

Communication with other people can be difficult for those who have speech disorders. This seriously complicates communication during domestic processes and the involvement of a person in society. A personal wearable device is capable of online-synthesizing voice over text or correcting distorted speech. The voice can be fully synthesized with individually selected tone, timbre and pronunciation style settings.

7.7.18.4 Challenges and issues

— Minimization of source records to create a synthesized voice from tens of hours to several tens of minutes.

— Hardware requirements for voices based on neural networks are expected to be reduced to the level available on wearable devices.

— The ability to control intonations and speech style is expected to be expanded to enable natural dialogue between people.

7.7.18.5 Societal concerns

SDGs to be achieved: Good health and well-being for people

7.7.19 AI platform for chest CT-scan analysis (early stage lung cancer detection) (use case 105)

7.7.19.1 Scope of use case

Detecting malignant neoplasms (lungs) on chest CT-scans.

7.7.19.2 Objective

To facilitate early stage oncology chest CT-scans through the application of the Botkin.AI platform based on artificial intelligence.

7.7.19.3 Narrative (short description)

"Botkin.AI" is a software platform for the diagnosis and assessment of pathology risks using artificial intelligence technologies. The product supports radiologists and oncologists, facilitating the analysis and recognition of diagnostic images of CT-scans, digital X-rays and mammography. The project aims to reduce costs and improve diagnostic accuracy, while detecting pathologies at early stages.

7.7.19.4 Challenges and issues

Achieving a higher confirmed level than accredited radiologists in the detection of lung cancer.

7.7.19.5 Societal concerns

SDGs to be achieved: Good health and well-being for people

7.7.20 AI-based design of pharmacologically relevant targets with target properties (use case 107)

7.7.20.1 Scope of use case

AI-based engineering of G protein-coupled receptors with enhanced stability

7.7.20.2 Objective

— Given: protein template in the form of a protein sequence or structure; target properties.

— Predict: protein sequence that satisfies target properties and has minimal differences from the given template.

7.7.20.3 Narrative (short description)

Molecular design is one of the most important and rapidly developing fields in biotechnology, where protein engineering plays a significant role in major topics. With an accumulation of biophysical data, AI-based approaches become beneficial in protein design for biotechnology. A particular case is to design stable forms of pharmacological targets, such as G protein-coupled receptors (GPCRs). Malfunctions of these receptors typically lead to various diseases: neurodegenerative, oncological and cardiovascular diseases, asthma, depression, obesity, drug dependence, etc. GPCR receptors are one of the main targets for pharmacological companies, and about one third of all drugs produced in the world are oriented on GPCRs. Obtaining the spatial structure of a single receptor is an extremely difficult and resource-intensive task. We developed an innovative AI-based digital platform for GPCR design, which allowed for a technological breakthrough in obtaining spatial structures of GPCR for the rational development of a new generation of drugs.

7.7.20.4 Challenges and issues

Biophysical data is typically very noisy, and the results critically depend on the used experimental assay and initial conditions. Therefore, the training data is expected to be carefully processed with expert knowledge. Consequently, the derived prediction models are expected to be rigorously analysed for robustness, domain applicability and generalizing power.

7.7.20.5 Societal concerns

Discovery of more efficient, safer and personalized drugs.

SDGs to be achieved: Good health and well-being for people

7.7.21 AI-based mapping of optical to multi-electrode catheter recordings for atrial fibrillation treatment (use case 108)

7.7.21.1 Scope of use case

Predicting possible targets for atrial fibrillation ablation based on explanted human heart data of two modalities (multi-electrode mapping and near-infrared optical imaging).

7.7.21.2 Objective

— Given: Recordings from multi-electrode catheter grid, with ground-truth labels from near-infrared optical mapping, obtained from explanted hearts.

— Output: Possibility of recordings to be from source (driver) region of atrial fibrillation.

7.7.21.3 Narrative (short description)

Atrial fibrillation (AF) is the leading cause of stroke with low treatment rate maintained by micro-anatomic intramural re-entry called drivers. Unfortunately, the current clinical method to look for drivers [multi-electrode mapping (MEM)] suffers from many limitations, including poor resolution and only-surface tissue mapping. On the other hand, near-infrared optical mapping (NIOM) has one thousand times higher resolution and records electrical activity from the depth of atrial tissue (up to 5 mm), but needs specific voltage-sensitive dye. For our research, we used simultaneous recordings of AF episodes from Ohio State University. We predicted the possibility of AF drivers to be visible in the MEM recording as trained by the optical ex-vivo data. We created the machine learning classifier with ground-truth labels based on NIOM maps. As features, we used characteristics from the Fourier spectra of MEM recordings.

7.7.21.4 Challenges and issues

— There is only one laboratory in the world that provides the needed explanted human atria.

— The number of experiments is limited (approximately 20 atria per year), and collecting the data is difficult.

— Only a few experiments consist of two modalities recordings and are therefore suitable for this research.

7.7.21.5 Societal concerns

Better life quality for atrial fibrillation patients, diminishment of stroke accidents caused by atrial fibrillation genesis; as a result, decreased mortality of such patients.

SDGs to be achieved: Good health and well-being for people

7.7.22 AI solution for end-to-end processing of cell microscopy images (use case 115)

7.7.22.1 Scope of use case

Restoration of naturally distorted microscopy images for following visualization and analysis of meaningful patterns of protein formation inside living cells.

7.7.22.2 Objective

Create a method for automatic analysis and clustering of cell microscopy images, including microscopy of multilayer 3D objects, and implement the developed method for processing of 2D/3D images of cultured human cell models and clustering based on protein modification patterns.

7.7.22.3 Narrative (short description)

Patterns of protein modification inside cells play an important role in the regulation of gene expression. Here, we aim to develop a method allowing for a detailed analysis of the meaningful protein formation inside living cells with visualization and the processing of microscopy cell images. However, the observed microscopy images suffer from visible artefacts related to blurriness and noise. In this work, we aim to implement AI methods throughout the pipeline of microscopy cell image restoration and analysis. Thereafter, we plan to implement AI approaches for the extraction of meaningful patterns of protein modifications inside cells and use this information for effective cell clustering. Our experiments are on 2D images as well as multilayer 3D objects. To the best of the author's knowledge, this is the first work to apply AI for living cells featuring extraction and clustering.

7.7.22.4 Challenges and issues

— An effective localization of living cells without losing meaningful information is expected to be done.

— Multilayer 3D objects require more computational time and resources, as well as slightly different restoration approaches, due to the 3D object formation model, compared to 2D images.

7.7.22.5 Societal concerns

The developed method of analysis of protein modifications inside living cells is applicable to a wide range of biological and biomedical tasks, far beyond the scope of this project.

SDGs to be achieved: Good health and well-being for people

7.7.23 Generation of computer tomography scans from magnetic resonance images (use case 116)

7.7.23.1 Scope of use case

Train a model that generates CT images from MRI scans. Synthetic CT images can be used for radiation dose calculation in radiation therapy.

7.7.23.2 Objective

Generation of a CT image from a given MRI image.

7.7.23.3 Narrative (short description)

Generating radiological scans has grown in popularity in recent years. Here, we generate synthetic computed tomography (CT) images from real magnetic resonance imaging (MRI) data. Our architectures were trained on unpaired MRI-CT data and then evaluated on a paired brain dataset. The MRI-CT translation approach holds the potential to eliminate the need for the patients to undergo both examinations and to be clinically accepted as a new tool for radiotherapy planning.

7.7.23.4 Challenges and issues

— Large amounts of paired MRI-CT data are not easily available.

— Doctors are reluctant to accept synthetic CT scans.

7.7.23.5 Societal concerns

Savings for oncologic patients. Reduced radiation dosage.

SDGs to be achieved: Good health and well-being for people

7.7.24 Improving the knowledge base of prescriptions for drug and non-drug therapy and its use as a tool in support of medical professionals (use case 117)

7.7.24.1 Scope of use case

Providing the medical professional with methods and means that would allow, within the time allotted for the appointment of a patient with a known nosology, to make a high-quality choice of drugs and to formulate a prescription corresponding to “good medical practices”.

7.7.24.2 Objective

Helping a medical professional consider the influence of a selected drug therapy, as well as monitor the patient’s vital characteristics to reduce the risk of wrong prescriptions and to prevent negative consequences from the prescribed drugs.

7.7.24.3 Narrative (short description)

Generating radiological scans has grown in popularity in recent years. Here, we generate synthetic computed tomography (CT) images from real magnetic resonance imaging (MRI) data. Our architectures were trained on unpaired MRI-CT data and then evaluated on a paired brain dataset. The MRI-CT translation approach holds the potential to eliminate the need for the patients to undergo both examinations and to be clinically accepted as a new tool for radiotherapy planning. Services are developed and designed to improve the efficiency and quality of medical care in third-level medical organizations, which have in their structure units providing high-tech medical care. A knowledge base of prescribed drug and non-drug therapy was formed based on a row-level security database. For its improvement and scaling throughout the industry, it is advisable to use AI methods.

7.7.24.4 Challenges and issues

— The existence in parallel of several clinical recommendations (CR) used by doctors.

— The difference in the information of CR and instructions for medical usage (IMU).

— The need for complementing the information of CR and IMU.

— The discrepancy between the information of CR and the real situation in the pharmaceutical market.

7.7.24.5 Societal concerns

The widespread use of the solution is expected to allow the doctor to:

— develop competencies in the field of drug selection, considering vital characteristics (VC) and drug interactions when prescribing;

— reduce the risks of erroneous prescriptions;

— improve the quality of medical care.

In the end, this is expected to allow:

— preservation of the health of the patient, and of their loved ones;

— extension of the quality of a full life.

SDGs to be achieved: Good health and well-being for people

7.7.25 Neural network formation of 3D-model orthopedic insoles (use case 121)

7.7.25.1 Scope of use case

Artificial intelligence methods are used to construct individual medical products to reduce the risk of developing diseases of the musculoskeletal system.

7.7.25.2 Objective

Development of comfortable, individualized, anatomically correct orthopedic 3D insoles for the treatment of flat feet.

7.7.25.3 Narrative (short description)

Using artificial intelligence methods, the system converts a pre-scanned foot print into an innovative, medically based 3D-insole. The AI-system would independently make a medical decision based on the collected medical history, and anthropometric data.

Initial training of the AI-system would take place together with the doctor. In the future, the system would begin by independently choosing the most suitable location options for a patient's vaults and indentations and plan an anatomically correct and secure 3D-insole.

7.7.25.4 Challenges and issues

None identified

7.7.25.5 Societal concerns

SDGs to be achieved: Good health and well-being for people

7.7.26 Search for undiagnosed patients (use case 127)

7.7.26.1 Scope of use case

Search for undiagnosed patients with orphan diseases, define patients’ journey.

7.7.26.2 Objective

Deep semantic analysis of unstructured texts (based on meaning rather than keywords, i.e. using natural language processing technology).

7.7.26.3 Narrative (short description)

Knowledge extraction from the massif of user posts in patient forums, and physicians’ professional networks, health-related portals, etc.

7.7.26.4 Challenges and issues

Personal data of the subjects to be identified, especially patients’, i.e. special health information can potentially be at risk.

7.7.26.5 Societal concerns

SDGs to be achieved: Good health and well-being for people

7.7.27 Support system for optimization and personalization of drug therapy (use case 129)

7.7.27.1 Scope of use case

This system is a full range of integrated solutions for the selection of the optimal type of drug, its dose, and its combination with other drugs.

7.7.27.2 Objective

Support system for optimization of the patient's medical therapy, taking into account their individual physiological features, type, and disease severity.

7.7.27.3 Narrative (short description)

Data from the laboratory and clinical examinations of a particular patient are displayed in a single integrative medical record.

There is currently a significant amount of patient data available electronically. Based on the pool of data of patients receiving a known drug, training is conducted in the recommendation system using AI, taking into account their individual physiological characteristics, type, and severity of the disease, as well as the particular drug’s combined administration with other drugs.

When requesting recommendations for a patient, after entering information of their current condition, the system would give individualized recommendations for optimizing drug therapy. Furthermore, the system in the course of treatment, receiving fresh data, makes recommendations for the correction of therapy.

7.7.27.4 Challenges and issues

In addition to classic data analysis with new technologies to find hidden patterns in relation to health care, the possibility of using methods and technologies to analyse a heterogeneous mass of data with a significant percentage of omissions and uneven distribution of data by classes and categories is a challenge. Another challenge is identifying hidden correlations and thereby improving the quality of medical services.

7.7.27.5 Societal concerns

— Incorrect decision

— Unexplainable result

— Improving the effectiveness of drug therapy

SDGs to be achieved: Good health and well-being for people

7.7.28 Syntelly - computer aided organic synthesis (use case 130)

7.7.28.1 Scope of use case

Recent progress in deep learning has brought a revolution in many areas of science and technology. However, the potential of this method in drug discovery has not yet been fully elaborated. The Syntelly project intends to close this gap. We are developing a web-based platform that helps chemists navigate through chemical space by predicting synthetic availability and ways of synthesis for new drug candidates that have not yet been studied; it also estimates the potential efficiency and safety of specific molecules. We hope that the successful implementation of our project would reduce drug discovery costs and related risks, which would stimulate pharmaceutical companies to search for unexplored molecules as a base for a new generation of drugs.

7.7.28.2 Objective

Exploration of chemical space is a very complicated task due to a large number of predicted chemical molecules. The number of described molecules is only several million compounds, but the estimated number of potentially synthetically accessible molecules is enormous: around 10^60, and neither human nor machine can directly process such a volume of data. The only hope is the development of methods and tools, based on deep learning, which would trigger a chemist-machine alliance to analyse chemical big data.

7.7.28.3 Narrative (short description)

The Syntelly project is directed to help organic chemists in chemical space exploration. Due to high risks and cost of new molecule trials, pharmaceutical companies do not prefer to open new chemical space areas in an experimental way. Using deep learning based on the chemical reaction databases, we predict the best retrosynthesis pathway to achieve the easiest way to a molecule synthesis. The next task is the prediction of the toxicity and bioconcentration of the molecule.

7.7.28.4 Challenges and issues

— The large size of chemical space implies the development of machine learning algorithms in two directions: to generate molecules and estimate their parameters, and for chemical space customization for new synthetic pathways.

— Characteristics of organic compounds are extremely diverse. They are collected from different sources and may be represented in many ways (i.e. toxicity can be measured on different animals).

— There are only two major players in the market of chemical and reaction data, and the possibilities of obtaining the whole datasets required for deep learning are heavily restricted.

— Synthetic and medical chemists prefer to ignore computer-based approaches.

7.7.28.5 Societal concerns

Our primary goal is to make the drug discovery process easier and cheaper. It would stimulate pharmaceutical companies and academic researchers to study new compounds and new scaffolds. Finally, society would obtain new effective drugs against the most dangerous bacterial and viral diseases. Reducing risks would generate interest in developing drugs for orphan diseases, which is now one of the biggest problems for society.

SDGs to be achieved: Good health and well-being for people; responsible consumption and production

7.7.29 WebioMed clinical decision support system (use case 131)

7.7.29.1 Scope of use case

Screening for cardiovascular disease risk prediction with machine and deep learning methods.

7.7.29.2 Objective

Advances in precision medicine would require an increasingly individualized prognostic evaluation of patients in order to provide the patient with appropriate therapy.

7.7.29.3 Narrative (short description)

Cardiovascular disease (CVD) continues to be the most relevant health problem of most countries in the world, including the Russian Federation. According to the World Health Organization, more than seventeen million people die each year from CVD worldwide, including more than seven million from coronary heart disease (CHD).

The machine learning models outperformed traditional approaches for CVD risk prediction (such as strategies concentrating on risk evaluation (SCORE), prospective cardiovascular Munster (PROCAM), and Framingham equations). This approach was used to create a clinical decision support system (CDSS). It uses both traditional risk scales and models based on neural networks. Of notable importance is the fact that the system can calculate the risk of cardiovascular disease automatically and recalculate immediately after adding new information to the EHR. The results are delivered to the user's personal account.

7.7.29.4 Challenges and issues

To provide physician tools to easily calculate cardiovascular risk anywhere in the world.

7.7.29.5 Societal concerns

One of the major concerns about AI-assisted CDSS is how the machines reach decisions, and whose decision is expected to prevail when there is disagreement between the CDSS and the medical professional. This lack of transparency is referred to as the black box of AI. In addition to the lack of transparency, the necessary use of large training data sets coupled with mathematical and statistical algorithms and sometimes neural networks, whether with or without full understanding of the internal workings, presents a challenge in educating doctors to use these tools in a clinically relevant way.

SDGs to be achieved: Good health and well-being for people

7.8 Home/service robotics

7.8.1 Robot consciousness (use case 61)

7.8.1.1 Scope of use case

A robot for museum tours equipped with the main capabilities of functional consciousness, accepted by and transparent to untrained users.

7.8.1.2 Objective

The robot “CiceRobot” offering guided tours in indoor and outdoor museums and equipped with capabilities of functional consciousness, posing no concerns regarding the robot qualitative experience. The objective of this case study is the acceptance and transparency of the autonomous behaviour of the robot in an environment populated with untrained users (museum visitors).

7.8.1.3 Narrative (short description)

The “CiceRobot” is a robot with capabilities associated with functional aspects of consciousness. CiceRobot offers indoor and outdoor guided tours. The anticipated outcome of the project is the acceptance and transparency of the autonomous behaviour of the robot among untrained visitors.

7.8.1.4 Challenges and issues

The primary challenge of robot consciousness is the transparency and acceptance of robot operations, important in environments populated by untrained people (tourists in an archaeological museum).

7.8.1.5 Societal concerns

The main concern can be the capability of the robot to act in a way that can be considered unethical to humans.

7.8.2 Social humanoid technology capable of multi-modal context recognition and expression (use case 65)

7.8.2.1 Scope of use case

Human-AI sympathetic technology expressing dynamic immersive dialogue with humans through a combination of various artificial intelligence technologies

7.8.2.2 Objective

— Sympathetic dialogue technology in order to understand socio-cultural consensus and emotions

— Creation of para-verbal expressions to induce sympathy with a speaker

— Representing non-verbal expressions reflecting the emphasis and intention of each utterance

— Deep dialogue management and combination of multimodal expressions for in-depth sympathy during conversations

7.8.2.3 Narrative (short description)

A highly immersive sympathetic conversation technology based on artificial intelligence that includes integrated understanding and expression skills of verbal, non-verbal and para-verbal information to derive complete communion with humans.

7.8.2.4 Challenges and issues

Multimodal data understanding/inference/representation

7.8.2.5 Societal concerns

The increase in the elderly population and the decrease in the total population are increasing the inequality of social welfare and benefits according to generation, class and region.

SDGs to be achieved: Industry, innovation, and infrastructure

7.8.3 Application of strong artificial intelligence (use case 111)

7.8.3.1 Scope of use case

Economic sectors and social services

7.8.3.2 Objective

Find accurate and universal application of strong artificial intelligence.

7.8.3.3 Narrative (short description)

Strong artificial intelligence is a digital twin of human intelligence, capable of learning, retraining, self-realization and development by improving functional activities through the mastery of creative and innovative high-tech professional and behavioural skills and competences according to criteria of preferences with qualitative choices.

7.8.3.4 Challenges and issues

Qualitatively new type of thinking not available to humans

7.8.3.5 Societal concerns

Security and ethical and legal aspects

SDGs to be achieved: Industry, innovation, and infrastructure

7.9 ICT

7.9.1 Autonomous network and automation level definition (use case 30)

7.9.1.1 Scope of use case

Communications network

7.9.1.2 Objective

To define an autonomous network concept and automation level for common understanding and consensus.

7.9.1.3 Narrative (short description)

With the goal of providing common understanding and consensus for an autonomous self-driving network, this use case delivers a harmonized classification system and supporting definitions that:

— define the concept of an autonomous network;

— identify six levels of network automation from “no automation” to “full automation”;

— base definitions and levels on functional aspects of technology;

— describe categorical distinctions for a step-wise progression through the levels;

— educate the wider community by clarifying for each level what role (if any) operators have in performing the dynamic network operations task while a network automation system is engaged.

7.9.1.4 Challenges and issues

Data usage and sharing, human expertise and competence

7.9.1.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.2 Autonomous network scenarios (use case 31)

7.9.2.1 Scope of use case

Communications network

7.9.2.2 Objective

Clarification and showcases of autonomous network usage

7.9.2.3 Narrative (short description)

Multiple scenarios of an autonomous network enabled by AI are addressed for improving operational efficiency, customer experience and service innovation, including improvement of wireless network performance, prediction of optical network failure, data centre energy saving, etc.

7.9.2.4 Challenges and issues

Data usage and sharing, human expertise and competence

7.9.2.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.3 A judging support system for gymnastics using 3D sensing (use case 70)

7.9.3.1 Scope of use case

Skeleton recognition for gymnastics

7.9.3.2 Objective

To support judgment of difficult elements at high level and high speed.

7.9.3.3 Narrative (short description)

We have been developing a judging support system for artistic gymnastics to enhance accuracy and fairness in judging. We developed a skeleton recognition technique using the learned model that we trained using a large amount of depth images of gymnastics created from CG in advance. With this technology, it is possible to recognize a human 3D skeleton from a depth image.

7.9.3.4 Challenges and issues

— Challenges: Recognize a skeleton performing all gymnastics elements

— Issues: Recognize a 3D skeleton performing complex gymnastics movements from a depth image

7.9.3.5 Societal concerns

Positive: Fairness of scoring, reducing the burden on the referee, and technical improvement of the gymnast

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.4 Active antenna array satellite (use case 71)

7.9.4.1 Scope of use case

Determine optimal spot beam patterns for communication satellites in order to react to changing geographic distribution and bandwidth requirements of terminals.

7.9.4.2 Objective

Optimize service quality and bandwidth allocation for users of a satellite system

7.9.4.3 Narrative (short description)

Future high throughput satellites (HTS) would be equipped with an active antenna array instead of a fixed multiple spot beam pattern. This enables the generation of multiple spot beams with different numbers, sizes and shapes. Moreover, the parameters (i.e. number, size and shape) can be adapted in a flexible way.

7.9.4.4 Challenges and issues

None identified

7.9.4.5 Societal concerns

Potential to provide demand-adapted service coverage in sparsely populated areas that cannot be well served in a fixed configuration scenario.

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.5 Carrier interference detection and removal for satellite communication (use case 72)

7.9.5.1 Scope of use case

Machine-learning-based detection, classification and removal of interference signals for satellite communication systems

7.9.5.2 Objective

Detection (and possibly classification) of interfering signals in satellite communication systems [e.g. digital video broadcasting - satellite - second generation (DVB-S2) or DVB-S2 extensions (DVB-S2x)], and removal of the interfering signal using the gained knowledge about the interference characteristics, with the aim of reducing the error rate at the receiver.

7.9.5.3 Narrative (short description)

In satellite communication systems, unintended or intended interferences are quite common. For instance, interferences can originate from a mispointed terminal antenna, a radar signal or another terrestrial radio source. In this use case, the intention is to detect the presence of an interferer in addition to the desired carrier and potentially classify it.

The setting for this use case is as follows:

— the terminal receives the desired carrier;

— the details of the desired carrier are known, e.g. a DVB-S2x carrier with known symbol rate and modulation scheme;

— there can be an interferer present with unknown frequency, bandwidth and structure;

— the objective is to detect the presence of such an interferer and to classify the interferer, e.g. in terms of power, bandwidth and type;

— additionally, it can be desired to remove the influence of the interferer from the signal.

7.9.5.4 Challenges and issues

Performance and robustness probably are necessary to be defined with reference to a certain class of signals (e.g. DVB-S but not generally).

7.9.5.5 Societal concerns

None identified

7.9.6 Ontologies for smart buildings (use case 78)

7.9.6.1 Scope of use case

Renovation of a building, improvement of the quality of life of the residents (limited to data issues in the building), audience: citizens, public and private actors, companies involved in the ICT system managing the building. The scope is not limited to the building management system (BMS). We would like to open it to data produced by residents, coupled with data coming from the BMS.

7.9.6.2 Objective

None identified

7.9.6.3 Narrative (short description)

The general question is how to build and standardize ontologies for data produced, in a broad sense, in a building. Data are coming both from the system managing the building and also from residents.

7.9.6.4 Challenges and issues

None identified

7.9.6.5 Societal concerns

None identified

7.9.7 Product failure prediction for critical IT infrastructure (use case 86)

7.9.7.1 Scope of use case

Building an AI solution to augment QA engineers

7.9.7.2 Objective

Reduce the likelihood of releasing defective batches of hardware

7.9.7.3 Narrative (short description)

A deep learning model to learn from a visual representation of the number of items that failed in a specific batch of hardware as well as the type of defect.

7.9.7.4 Challenges and issues

Challenges in identifying which deep learning model gives the best performance output, and challenges in indexing raw flat files into visualization images.

7.9.7.5 Societal concerns

Address issues of sustainable manufacturing and high-value technical jobs

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.8 Data compression with AI techniques (use case 98)

7.9.8.1 Scope of use case

Data centres/Supercomputing centres

7.9.8.2 Objective

Fast data transfer via wide area network (WAN)

7.9.8.3 Narrative (short description)

Improving data compression with a deep predictive neural network for time evolutional data

7.9.8.4 Challenges and issues

More accurate prediction of data to be compressed

7.9.8.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.9 Optimization of software configurations with AI techniques (use case 99)

7.9.9.1 Scope of use case

Data centres/Supercomputing centres

7.9.9.2 Objective

Optimization of software configurations

7.9.9.3 Narrative (short description)

Optimizing asynchronous multi-level checkpoint/restart configurations with machine learning

7.9.9.4 Challenges and issues

More accurate prediction for optimization

7.9.9.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.9.10 Better human-computer interaction with advanced language models (use case 100)

7.9.10.1 Scope of use case

Human-computer interaction

7.9.10.2 Objective

Improve the quality of human-computer interaction

7.9.10.3 Narrative (short description)

Better language models are crucial for improving the quality of human-computer interaction; for example, tasks like question answering and summarization. We use large-scale compute systems to develop better language models by exploiting the neural architecture search technique, large datasets and a holistic evaluation framework.

7.9.10.4 Challenges and issues

High computational costs

7.9.10.5 Societal concerns

SDGs to be achieved: Partnerships for the goals

7.10 Legal

7.10.1 Tax rules updates and classification (use case 95)

7.10.1.1 Scope of use case

Build an AI solution that identifies updates on tax laws and classifies them

7.10.1.2 Objective

Use NLP to identify new tax laws from different countries and classify them

7.10.1.3 Narrative (short description)

An NLP model that helps an investment firm identify tax laws and trends that have an impact on their current and future portfolio.

7.10.1.4 Challenges and issues

The classes are pre-determined, and if these are changed, it would affect the ability of the model to re-classify.

7.10.1.5 Societal concerns

Erratic changes in local and cross-border tax rules, which have repercussions on economic growth

SDGs to be achieved: Decent work and economic growth

7.10.2 AI contract management (use case 120)

7.10.2.1 Scope of use case

Building an AI contract management solution for automating business processes related to documents: data classification, automatic data extraction and contract monitoring.

7.10.2.2 Objective

Creating a solution that is able to standardize the contract management process, improve the quality of work on problematic contracts and claims, and optimize lawyers' working process and relieve them from routine tasks.

7.10.2.3 Narrative (short description)

The Mobile TeleSystems (MTS) AI contract management solution is built on our AI legal core, which includes technology that makes it possible to convert different types of documents into a digital format, replicate natural human-like text recognition and extract data to automate business tasks.

7.10.2.4 Challenges and issues

— Noisy data (different scan quality)

— Working with private data (information security)

— Non-linear models need significant computational power during the training phase

7.10.2.5 Societal concerns

We have created a helpful industrial solution that can optimize the current contract management process and assist to make the legal department's job easier.

SDGs to be achieved: Industry, innovation, and infrastructure

7.10.3 Semantic analysis of legal documents (use case 128)

7.10.3.1 Scope of use case

Semantic analysis of legal documents in the course of their development, verification and improvement

7.10.3.2 Objective

Machine understanding of the meaning of legal documents

The acquisition of semantic visual images of documents; the detection of contradictions and inaccuracies in legal documents describing similar objects of law for the task of classifying documents; quick document comprehension; and analysis of the consistency of the legal base.

7.10.3.3 Narrative (short description)

The software tool is oriented toward the analysis and representation of content of normative documents in the form of formal ontology [web ontology language (OWL) ontology] and the construction of their visual images for the subsequent detection of inaccuracies and contradictions using logical inference and visual analysis methods.

7.10.3.4 Challenges and issues

Different levels of abstraction of concepts in documents

7.10.3.5 Societal concerns

None identified

7.11 Logistics

7.11.1 Improving productivity for warehouse operation (use case 41)

7.11.1.1 Scope of use case

Big data analysis for enhancing productivity

7.11.1.2 Objective

To improve the productivity of warehouse operation by detecting and changing controllable factors.

7.11.1.3 Narrative (short description)

An AI-driven operating system that uses big data from work performance information to issue appropriate work instructions has been developed. In PoC, the picking operation was improved in a distribution warehouse. The result was an 8 % reduction in work.

7.11.1.4 Challenges and issues

Understanding workers' human factors (privacy, additional work, etc.)

7.11.1.5 Societal concerns

Solving the labour shortage problem and improving labour-related issues by aiming to improve productivity.

SDGs to be achieved: Industry, innovation, and infrastructure

7.11.2 AI based dynamic routing SaaS (use case 92)

7.11.2.1 Scope of use case

Build an ML model that dynamically corrects routes

7.11.2.2 Objective

Incorporate last minute human-driven factors into optimising delivery routes

7.11.2.3 Narrative (short description)

A machine learning model that dynamically corrects the delivery route and time to delivery.

7.11.2.4 Challenges and issues

Challenges in feature engineering static and dynamic variables, and the dynamic routing device's over-reliance on internet connectivity.

7.11.2.5 Societal concerns

Overutilization of resources and emittance of greenhouse gases to fulfil the e-commerce trend

SDGs to be achieved: Climate action

7.12 Maintenance and support

7.12.1 Anomaly detection in sensor data using deep learning techniques (use case 45)

7.12.1.1 Scope of use case

Temporal data captured from sensors

7.12.1.2 Objective

Identify anomalies and events by learning the temporal patterns of sensor data, based on deep learning techniques.

7.12.1.3 Narrative (short description)

Mechanical devices such as engines, vehicles, and aircrafts are typically instrumented with numerous sensors to capture the behaviour and health of the machine. The sensors' temporal data has several complex patterns that are very hard to identify using traditional methods. We have proposed the use of deep learning algorithms for analysing such temporal patterns for anomaly/event detection, diagnosis, and root cause analysis.

Algorithms proposed so far are long short-term memory networks for anomaly detection (LSTM-AD), encoder-decoder scheme for anomaly detection (EncDec-AD), and online recurrent neural networks for anomaly detection (RNN-AD). We used industrial datasets wherever possible and publicly available datasets in other scenarios. In most of the cases, our algorithms were significantly better than other methods.

7.12.1.4 Challenges and issues

— Noisy data

— Data with missing temporal features

— Rarity of anomalous data

7.12.1.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.12.2 Jet engine predictive maintenance service (use case 73)

7.12.2.1 Scope of use case

Use of jet engine telemetry data to train predictive maintenance algorithms

7.12.2.2 Objective

None identified

7.12.2.3 Narrative (short description)

ML-based jet-engine predictive maintenance technology predicts the next maintenance tasks proactively using a machine learning model trained by jet engine telemetry data and maintenance history.

7.12.2.4 Challenges and issues

— Explainability and transparency regarding the training data used, from the perspective of corporate confidentiality concerns.

— Need a structured, common and standardized way to describe the stages of the machine learning model training process, and the types and aspects of the data used in the various stages of the process so the stakeholders (policy makers, partners and customers) can build confidence and trust in such ML-based product or service, ensuring that their corporate trade secrets are not leaked when they contribute to shared pools of data used for model training. The various aspects of data are described in the ISO/IEC 19944 series.

7.12.2.5 Societal concerns

Ability for industry players to share their data with their partners to develop ML-based algorithms while protecting their IP, and interest would allow for flourishing of commercial AI/ML applications and solutions.

SDGs to be achieved: Industry, innovation, and infrastructure

7.12.3 Detection of fraudulent medical claims (use case 90)

7.12.3.1 Scope of use case

Build an ML model to classify if a particular claim can be fraudulent

7.12.3.2 Objective

Upgrade from an only-human-interpretation to ML-assisted fraud detection

7.12.3.3 Narrative (short description)

A machine learning model to identify true anomalies and trends of fraudulent claims was customized to classify the source of fraud.

7.12.3.4 Challenges and issues

The challenge was in building separate models for each major source of fraudulent claims.

7.12.3.5 Societal concerns

Unintended or unlawful use of funds that are meant for essential services to people

SDGs to be achieved: Sustainable cities and communities

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

7.12.4.1 Scope of use case

— Customer support service, product and service consulting

— Limitations - support for dialogs exclusively within MTS products

— Target audience - b2b, b2c clients of MTS Russia

7.12.4.2 Objective

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.

7.12.4.3 Narrative (short description)

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

7.12.4.4 Challenges and issues

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

— Biased customer attitudes towards chatbots

7.12.4.5 Societal concerns

SDGs to be achieved: Affordable and clean energy

7.13 Manufacturing

7.13.1 AI solution to calculate amount of contained material from mass spectrometry measurement data (use case 3)

7.13.1.1 Scope of use case

Calculating the amount of contained material from mass spectrometry measurement data using chromatography

7.13.1.2 Objective

To find an accurate and efficient solution to calculating the amount of contained material without dependence on individuals

7.13.1.3 Narrative (short description)

An AI solution was developed that can use deep learning to automatically pick the peak of contained material from measurement data. Compared with manual results by an experienced operator, the automated peak picking results using AI had a false detection rate of 7 % and an undetected rate of 9 %. The peak picking operation time using AI was estimated to be about one fifth.

7.13.1.4 Challenges and issues

— Challenges: Achieve the same level as experienced operators for peak picking

— Issues: 1) lack of training data per contained material, 2) how to create good images for deep learning from mass spectrometry measurement data

7.13.1.5 Societal concerns

None identified

7.13.2 AI solution to quickly identify defects during quality assurance process on wind turbine blades (use case 4)

7.13.2.1 Scope of use case

Detecting defects in products by inspecting non-destructive testing scanning data

7.13.2.2 Objective

To find an accurate and efficient solution to detect defects without compromising the detection of in-material damage and risking a loss in reputation

7.13.2.3 Narrative (short description)

An AI solution was developed that can automatically detect defects through deep learning together with what is called "imagification"; it achieved high coverage of various defects, and evaluation of each non-destructive testing scanning was reduced by 80 %, which translated into cost savings, reduced production lead times and increased productivity.

7.13.2.4 Challenges and issues

— Challenges: Achieve the same level as ultrasonic accredited engineers for detecting critical defects

— Issues: 1) lack of defect data per defect type; 2) how to create good images for deep learning from UT raw data; and 3) back wall detection

7.13.2.5 Societal concerns

SDGs to be achieved: Affordable and clean energy

7.13.3 Solution to detect signs of failures in wind power generation system (use case 5)

7.13.3.1 Scope of use case

Detect signs of malfunction (failure) in wind power generators

7.13.3.2 Objective

Detect signs of failure in wind power generation earlier than detection by human specialists

7.13.3.3 Narrative (short description)

A system is currently in development that uses machine learning to detect signs of equipment failure that would be difficult to detect from visual inspection. Currently, sensor data is being collected from 43 actual domestic large wind turbines, and large-scale verification testing is being conducted. The goal is for a paradigm shift from responding after the fact to maintenance that prevents problems and maintains safety.

7.13.3.4 Challenges and issues

None identified

7.13.3.5 Societal concerns

None identified

7.13.4 Generative design of mechanical parts (use case 15)

7.13.4.1 Scope of use case

Help mechanical engineers design lighter, strong and better parts

7.13.4.2 Objective

Create optimized parts following precise mechanical constraints while enabling cost savings by reducing the amount of material necessary to achieve goals

7.13.4.3 Narrative (short description)

Generative design is an iterative design process that involves a program that generates a certain number of outputs that meet certain constraints, and a designer that is possible to fine tune the feasible region by changing minimal and maximal values of an interval in which a variable of the program meets the set of constraints, in order to reduce or augment the number of outputs to choose from.

7.13.4.4 Challenges and issues

— Challenges: The engineers using this technology are still necessary to know how to define the constraints, start and end points for the piece.

— Issues: Pieces generated to satisfy a set of constraint can still have design flaws overlooked because of misunderstanding by the user.

7.13.4.5 Societal concerns

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.5 Information extraction from hand-marked industrial inspection sheets (use case 21)

7.13.5.1 Scope of use case

Localization and mapping of machine zones, arrows and text, to extract information from manually tagged inspection sheets

7.13.5.2 Objective

To create a pipeline to build an information extraction system for machine inspection sheets, by mapping the machine zones to the handwritten code using state-of-the-art deep learning and computer vision techniques

7.13.5.3 Narrative (short description)

Inspection sheets are filled regularly to detect defects and maintain heavy machines. Sheets contain a lot of unstructured information and require domain experts' intervention to read and digitize. We have proposed a novel pipeline to build an information extraction system for such machine inspection sheets, utilizing state-of-the-art deep learning and computer vision techniques.

7.13.5.4 Challenges and issues

— Quality of images

— Structural deformities of individual components (arrows, handwritten code)

— Quantity of data

— Cascading effect of errors at each stage of the pipeline

7.13.5.5 Societal concerns

Inspection engineers can be necessary to develop other skills.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.6 Automated defect classification on product surfaces (use case 33)

7.13.6.1 Scope of use case

Image analytics for water taps in sanitary industries

7.13.6.2 Objective

Image analytics using a combination of feature extraction and classification of defects on shining surfaces in sanitary industries

7.13.6.3 Narrative (short description)

A vision system that inspects and identifies the defects on water taps in sanitary industries. The system uses a combination of features for automatic defect classification on product surfaces. All defects

(fifteen types are identified) are classified into two major categories: real defects and pseudo-defects. The pseudo-defects cause no quality problems, while the real defects are critical as they can cause malfunction in the final products.

The AI system uses a support vector machine (SVM) classifier along with combined features to identify the defect types. With the vision system in place, the quality control process is fully automated without any human intervention.

7.13.6.4 Challenges and issues

Real-time implementation, accurately identify the nature of defects

7.13.6.5 Societal concerns

Promoting sustainable industries, and investing in scientific research and innovation, are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.7 Robotic task automation: insertion (use case 34)

7.13.7.1 Scope of use case

Robotic assembly

7.13.7.2 Objective

— Simple programming/instruction and flexibility in usage

— Automation of tasks lacking analytic description

— Reliability and efficiency

7.13.7.3 Narrative (short description)

An assembly process often includes steps where two parts are expected to be matched and connected to each other through the exertion of force. In ideal cases, perfectly formed parts can be matched and assembled with a predefined amount of force. Due to the imperfection of production steps, surface imperfections and other factors such as the flexibility of parts, this procedure can become complex and unpredictable. In such cases, a human operator can be instructed using simple terms and demonstrations and can perform the task easily, while a robotic system would need very detailed and extensive program instructions to be able to perform the task including required adaptation to the physical world. The need for such a complex program instruction would make use of automation cumbersome or uneconomical. Control algorithms that are based on machine learning, especially those including reinforcement learning, can become alternative solutions, increasing and extending the level of automation in manufacturing.

7.13.7.4 Challenges and issues

— Complex and unpredictable assembly processes due to the imperfection of production steps, surface imperfections and other factors, such as the flexibility of parts

— Accuracy of sensing

— Coworking with humans

7.13.7.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.8 Powering remote drilling command centre (use case 36)

7.13.8.1 Scope of use case

Oil and gas upstream (Deployed in 150 oil rigs and 2,5 billion+ data points each)

7.13.8.2 Objective

Automatic generation of a daily performance report, reduction in overall drilling time, reduction in invisible loss time and improvement of rig asset management

7.13.8.3 Narrative (short description)

It is important for a drilling contractor to monitor rig parameters in real time to optimize operations. The customer lacked granular insights during drilling and cannot ascertain the root cause of non-productive time, and manual interpretation of signals led to the failure to notice anomalies, further degrading performance.

7.13.8.4 Challenges and issues

Compliance of organizations

7.13.8.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.9 Leveraging AI to enhance adhesive quality (use case 37)

7.13.9.1 Scope of use case

Batch/continuous/discrete manufacturing (Deployed in 75+ manufacturing lines in 10+ countries; specifically identify the contributors to quality; predict potential quality failures)

7.13.9.2 Objective

Enhance adhesive quality, performance benchmarking

7.13.9.3 Narrative (short description)

The Cerebra IoT signal intelligence platform provides the ability to have a holistic perspective and understanding of the sensitivity of the key parameters affecting output quality and the ability to monitor and control the process in real-time. This would avoid variations in yields, build-up of inventories and missed customer deadlines.

7.13.9.4 Challenges and issues

Patented process if any, security restrictions

7.13.9.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.10 Machine learning-driven approach to identify weak spots in the manufacturing of circuit breakers (use case 38)

7.13.10.1 Scope of use case

Detecting issues in the manufacturing process that lead to early failure of the circuit breakers through data mining related to the manufacturing process

7.13.10.2 Objective

To generate actionable intelligence to improve the manufacturing process for circuit breakers through mining of manufacturing-related data

7.13.10.3 Narrative (short description)

An approach was developed that can mine manufacturing data related to circuit breakers through multiple machine learning algorithms. The approach can successfully identify weak spots in manufacturing where the failure rate jumps from 0,2 % to 7 % (35-fold higher than the usual probability of failure) and, hence, can identify candidates for improvement in the manufacturing process.

7.13.10.4 Challenges and issues

Discovering actionable insight with a partial data set and managing bias in ML models due to the limited number of failed cases

7.13.10.5 Societal concerns

Safe and reliable power delivery

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.11 Machine learning-driven analysis of batch process operation data to identify causes for poor batch performance (use case 39)

7.13.11.1 Scope of use case

Detecting issues in a batch manufacturing process that lead to bad quality products or longer cycle times for batch processing

7.13.11.2 Objective

Provide insight to the operation team to improve the productivity of batch manufacturing through machine learning on historical operation data

7.13.11.3 Narrative (short description)

An approach was developed that can use machine learning models to identify issues in batch manufacturing.

7.13.11.4 Challenges and issues

Discovering actionable insight with a limited industrial data set, handling dynamics in the process variables

7.13.11.5 Societal concerns

Consistent batch operation leads to enhanced productivity

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.12 Empowering autonomous flow meter control – reducing time taken for "proving of meters" (use case 40)

7.13.12.1 Scope of use case

Calibration of control devices

7.13.12.2 Objective

Reduce the time taken for trial and error methods to set the variable frequency device (VFD) and flow control valves (FCV) setpoints

7.13.12.3 Narrative (short description)

The customer had to set VFD and FCV percentages manually to achieve the desired flowrate using trial and error methods, which can take about 3 h to 4 h. The efficiency of proving the meters was very low, and improvement was necessary to remove any aberration in reading as it was time-consuming.

7.13.12.4 Challenges and issues

None identified

7.13.12.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.13 Adaptable factory (use case 46)

7.13.13.1 Scope of use case

(Semi-)Automatic change of a production system's capacities and capabilities from a behavioural and physical point of view.

7.13.13.2 Objective

The objective is to enable flexible production resources that enable fast reconfiguration and adaptation to change situations, contexts, and requirements, facilitating optimized resource usage under uncertainty.

7.13.13.3 Narrative (short description)

This use case describes rapid, and in some cases completely automated, conversion of a manufacturing facility, by changing both production capacities and production capabilities. This use case describes the adaptability of an individual factory by (physical) conversion and/or adaption of the behaviour of

the factory and its machines in order to adjust to changing situations like disruptions, material quality variation, production of new products, etc.

A prerequisite is a modular and thereby adaptable design for manufacturing within the factory. The result is a need for intelligent and interoperable modules that basically adapt to an altered configuration on their own, and standardized interfaces between these modules.

7.13.13.4 Challenges and issues

None identified

7.13.13.5 Societal concerns

Enabling flexible and autonomously reconfigurable production systems eases human-machine configuration, facilitates optimized machine use, reduces failures through autonomous compensation, and optimizes product quality through prediction techniques.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.14 Order-controlled production (use case 47)

7.13.14.1 Scope of use case

Automatic distribution of production jobs across dynamic supplier networks.

7.13.14.2 Objective

The objective is to enable automatic supplier contracting for optimized utilization of manufacturing capabilities at suppliers, and novel degrees of flexibility in contract manufacturing, and to enable (mass) customized customer ordering.

7.13.14.3 Narrative (short description)

A network of production capabilities and capacities that extend beyond factory and company boundaries allows for a quick order-controlled adaption to changing market and order conditions. The result is a largely fragmented and dynamic value chain network that changes as required by the individual order, and thereby makes the best use of capabilities and capacities of existing production facilities. The goal is to allow for automated order planning, allocation and execution, with a view to maximum automation of all production steps and facilities required to facilitate linking external factories into a company's production process.

7.13.14.4 Challenges and issues

None identified

7.13.14.5 Societal concerns

Enabling mass-customized production in global dynamic supply chains, and by that, easing the burden of production of small lot sizes for customized products.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.15 Value-based service (use case 48)

7.13.15.1 Scope of use case

Process and status data from production and product use sources are the raw materials for future business models and services.

7.13.15.2 Objective

The objective of this use case is the provision of remote services for products and production based on (generic) service platforms. This use case can be seen as a fundament for the deployment of arbitrary AI remote services.

7.13.15.3 Narrative (short description)

Service platforms collect data from product use – for example machines or plants – and analyse and process this data to provide tailor-made individualized services, e.g. optimized maintenance at the proper time, or the timely provision of the correct process parameters for a production task currently being requested. Companies offering these services (service providers) occupy the interface between the product provider and the user.

7.13.15.4 Challenges and issues

None identified

7.13.15.5 Societal concerns

The increasing complexity of modern cyber-physical production systems cannot be managed by humans. AI technologies provide one solution in this context for more reliable, fault-tolerant, safe and secure production systems.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.16 Improvement of productivity of semiconductor manufacturing (use case 82)

7.13.16.1 Scope of use case

Analysis of data taken from production equipment and improvement of productivity based on the analysis

7.13.16.2 Objective

Cost reduction of semiconductor manufacturing

7.13.16.3 Narrative (short description)

In modern semiconductor manufacturing, a huge amount of data is gathered and used to improve yields. However, it is difficult even for skilled engineers to promptly achieve the improvements by means of manual analysis because of the complexity of the production process and the scale of the data. In operations in Yokkaichi, where more than five thousand pieces of equipment are running and two billion records of data are created daily, it is difficult to secure enough engineers to resolve the problems that arise during production. Toshiba Memory Corporation tackled the issue with AI technology including machine learning. The endeavour resulted in an improvement in productivity through stable quality based on semi-automated data analysis.

7.13.16.4 Challenges and issues

— Guarantee of the correctness of analysis by AI

— Automatic physical model building for a failure

7.13.16.5 Societal concerns

Hollowing out of analytic know-how

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.17 AI decryption of magnetograms (use case 104)

7.13.17.1 Scope of use case

Oil and gas transportation. AI solution to quickly identify defects during the quality assurance process on a field pipeline

7.13.17.2 Objective

— Detection of internal defects (pits, ulcers, etc.)

— Detection of structural elements (welds, bends, etc.)

7.13.17.3 Narrative (short description)

A solution has been developed that allows for the detection of internal defects and structural elements.

7.13.17.4 Challenges and issues

— To achieve high level accuracy in recognizing defects and welds

— To reduce the processing time of magnetograms

7.13.17.5 Societal concerns

Minimizing the risk of environmental disasters associated with oil spills

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.18 Analysing and predicting acid treatment effectiveness on bottom hole zone (use case 110)

7.13.18.1 Scope of use case

Mining of oil and gas; digital assistant for analysing and predicting the effectiveness of acid treatments of the bottom hole zone.

7.13.18.2 Objective

Predict the effectiveness of acid treatments of the bottom hole zone

7.13.18.3 Narrative (short description)

Predicting the technological and economic efficiency of acid treatments of the bottom-hole zone of the well

7.13.18.4 Challenges and issues

To achieve high level accuracy of prediction efficiency of acid treatments

7.13.18.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are important for facilitating sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.19 Automatic classification tool for full size core (use case 112)

7.13.19.1 Scope of use case

Oil and gas exploration, classification of rock types, oil saturation, carbonate and fracture according to core images.

7.13.19.2 Objective

— Classification of rock types

— Classification of oil saturation

— Classification of carbonate

— Classification of fracture according to the core

7.13.19.3 Narrative (short description)

A solution has been developed that allows for the classification of rock types into four classes. This resulted in an 80 % reduction in core image analysis.

7.13.19.4 Challenges and issues

— To achieve the same level of accuracy of recognition of rock types as expert lithologists

— To minimize the set of laboratory tests due to visual recognition of rock types and their parameters from core images

7.13.19.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are important for facilitating sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.20 Intelligent technology to control manual operations via video — “Norma” (use case 118)

7.13.20.1 Scope of use case

Tooltip visualization technology (augmented reality) based on technological process and manual operations control in the assembly, maintenance, and repair of engineering products.

7.13.20.2 Objective

"Norma” technology will minimize, as far as possible, the number of errors made by technical personnel during manual assembly of products. It visually displays the correct sequence of actions to the user-assembler through augmented reality glasses, overlaying the process on top of the parts. Norma controls the accuracy of manual operations and the tools used. It fixes detected deviations in the electronic passport of the product. Additionally, Norma promptly reports identified violations of the process to the quality control department. Norma will dramatically improve the quality of production and technological operations without the widespread use of industrial robotics, which will avoid the negative social consequences caused by automation of production.

7.13.20.3 Narrative (short description)

Norma technology is designed to control manual operations during assembly, maintenance and repair of engineering products using video data.

7.13.20.4 Challenges and issues

— Small number of real photos (or none) for training — neural networks are expected to be trained using synthetic data.

— Synthetic data is expected to be generated to cover all possible light conditions in which the system can be used.

— The system operates in real time.

7.13.20.5 Societal concerns

Norma technology continues to improve the quality of production without the use of robotic systems, which is expected to avoid a reduction in jobs and therefore also negative social consequences.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.21 Optimization of ferroalloy consumption for a steel production company (use case 123)

7.13.21.1 Scope of use case

Recommendation for the optimal consumption of ferroalloys by the ladle furnace treatment during secondary steelmaking

7.13.21.2 Objective

Reducing the use of ferroalloys in metallurgical plants while maintaining alloy quality standards for steel. Improving production efficiency

7.13.21.3 Narrative (short description)

Digital advisor for steel ladle treatment. Recommends the optimal consumption of ferroalloys by the ladle furnace treatment during secondary steelmaking. The solution is based on physico-chemical technological models and machine learning models. Datana Smart uses historical data, different factors and correlations, with high accuracy based on real dependencies on the physical process.

7.13.21.4 Challenges and issues

— There is no data available for creating mathematical models.

— Incorrect/insufficient data; outliers, gaps, accumulated errors and inaccurate measurements.

7.13.21.5 Societal concerns

Promoting sustainable industries and investing in innovation are important for facilitating sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.13.22 Device control using AI consisting of cloud computing and embedded system (use case 132)

7.13.22.1 Scope of use case

Learn the user's preferred temperature in each situation for the control of home appliances (air conditioning equipment)

7.13.22.2 Objective

Keep rooms comfortable by running home appliances (air conditioning equipment) at the user's preferred temperature according to the situation

7.13.22.3 Narrative (short description)

The room temperature that the user finds comfortable depends on the situation, such as the time of day and the day of the week, so the user changes the set temperature whenever it becomes uncomfortable.

By learning the user's preferred temperature in each situation, home appliances (air conditioning equipment) can automatically keep the room comfortable.

Appliances can effectively learn operations that have a long-term cycle, such as a fixed operation for each day of the week, from the accumulated operation history. In this case, the model learns on the cloud.

For sudden operation pattern changes, such as when the outside temperature rises suddenly and the user reacts, high frequency online machine learning inside the appliance can adjust the model immediately.

It is necessary to be consistency between the model that learns by cloud computing and the model that is adjusted inside the equipment.

7.13.22.4 Challenges and issues

— During actual use, there is a possibility of significant difference between the model that learns by cloud computing and the model adjusted inside the air-conditioner. There is a significant change in the temperature setting if the model in the air conditioner is overridden by the model that learns on the cloud.

— How and when to detect whether there has been a significant difference.

— How the air-conditioner explains a significant difference when it is detected. Criteria for determining whether to explain this difference.

7.13.22.5 Societal concerns

By automatically adjusting the temperature to the user's preferred level, the appliance can limit excess power use due to overheating or overcooling.

SDGs to be achieved: Affordable and clean energy

7.14 Media and entertainment

7.14.1 Predictive analytics for the behaviour and psycho-emotional conditions of eSports players using heterogeneous data and artificial intelligence (use case 125)

7.14.1.1 Scope of use case

Prediction of psycho-emotional conditions of eSports players. To form predictions, we collect physiological data from wearables/video cameras/eye trackers, game telemetry data from keyboard/mouse/demo files, and environmental conditions followed by the application of machine learning methods for the analysis of the collected data.

7.14.1.2 Objective

Predict psycho-emotional conditions of eSports players in particular game scenarios based on collected heterogeneous data

7.14.1.3 Narrative (short description)

eSports is organized video gaming, where single players or teams compete against each other with the aim of achieving a specific goal by the end of the game. The eSports industry has progressed considerably within the last decade: a huge number of professional and amateur teams take part in numerous competitions where the prize pools amount to tens of millions of US dollars. Its global audience has already reached 380 million in 2018 and is expected to reach more than 550 million in 2021. However, there is a lack of tools to help assess the physiological and psycho-emotional conditions of eSports players.

In this project, we collect three classes of data (physiological, game telemetry, and environmental conditions) followed by data analysis using artificial intelligence based on machine learning algorithms. For example, we apply machine learning and recurrent neural networks with attention to assessing player performance dynamics.

7.14.1.4 Challenges and issues

The challenges are associated with data collection and data analysis. To create a reasonably large dataset, a high number of pro eSports athletes is required. Moreover, it is not a trivial task to collect data during competitions; the sensors ensure unobtrusive sensing. At the same time, the collected data is truly heterogeneous, e.g. video/time-series/tests, requiring new methods of data storage and data analysis.

7.14.1.5 Societal concerns

Although eSports has evolved from amateur video gaming to a developing and innovative industry, there is a sceptical attitude to eSports in our society. A common understanding in particular communities is that eSports can be dangerous and cannot serve as a profession of the future.

SDGs to be achieved: Good health and well-being for people

7.15 Mobility

7.15.1 Autonomous apron truck (use case 12)

7.15.1.1 Scope of use case

Automated transportation of luggage (carts) to requested destinations on an airport apron while following local traffic rules and resolving unplanned conflicts

7.15.1.2 Objective

Automate transport to increase reliability, precision, efficiency and safety

7.15.1.3 Narrative (short description)

An AI solution was planned that can operate a luggage truck on an airport apron where it interacts with aircrafts, other machines and humans. It avoids accidents with humans at all times and follows local traffic rules.

7.15.1.4 Challenges and issues

— Challenges: Achieve at least the same level as human truck operators

— Issues:

1) Detect other apron traffic participants (especially aircraft) including their intentions;

2) Multiplicity of various outside conditions (e.g. signs painted on the road but covered by ice and snow); and

3) Prediction of human behaviour (e.g. workers walking backward).

7.15.1.5 Societal concerns

Changed work environment for workers during loading/unloading with fewer interactions with co-workers but more non-social interactions (machines).

7.15.2 AI solution to help mobile phones to have better picture effect (use case 32)

7.15.2.1 Scope of use case

Better understanding the image and improving the image effect on a smartphone by using a DL model that is trained on the cloud or offline

7.15.2.2 Objective

To find an efficient solution to increase camera image quality on a smartphone without significantly increasing the operation and power burden on the mobile phone

7.15.2.3 Narrative (short description)

An AI solution was developed that can increase smartphone camera image quality. Using deep learning, the smartphone can identify more scenarios and objects than before. Based on the identified scenarios and objects, the smartphone can better understand the image and improve the image effect.

7.15.2.4 Challenges and issues

— Challenges: Achieve the same picture quality as a professional single-lens reflex camera (SLR) camera

— Issues:

  — lack of data for certain scenes;

  — lack of computing ability on the device side;

  — users can see an improvement in image quality but may not know that it is due to AI.

7.15.2.5 Societal concerns

Incorrect object detection can lead to racial prejudice or privacy protection problems.

SDGs to be achieved: Industry, innovation, and infrastructure

7.16 Public sector

7.16.1 AI ideally matches children to day-care centres (use case 7)

7.16.1.1 Scope of use case

Assignment pattern that satisfies applicants' complex requirements

7.16.1.2 Objective

To automatically determine the assignment pattern that is expected to fulfil the preferences of as many applicants as possible

7.16.1.3 Narrative (short description)

This AI technology automatically determines the assignment pattern while fulfilling as many applicants' preferences as possible according to priority ranking using game theory.

7.16.1.4 Challenges and issues

— Challenges: Determine an optimal assignment pattern instantly and fairly depending on unique and complex rules in each local government

— Issues: Long calculation time is required in the case of a large number of children and siblings

7.16.1.5 Societal concerns

— Supporting working parents

— Resolving the problem of children waiting for day care

SDGs to be achieved: Decent work and economic growth

7.16.2 AI sign language interpretation system for people with hearing impairment (use case 62)

7.16.2.1 Scope of use case

Increase the convenience of public services to people with hearing impairment by providing a service to translate sign language image information into natural language

7.16.2.2 Objective

Supporting communication between people with hearing impairment and people without disabilities

7.16.2.3 Narrative (short description)

In this use case scenario, people with hearing impairment and people without disabilities are able to communicate with each other through the AI sign language-natural language interpretation service.

7.16.2.4 Challenges and issues

— Multimodal interactions

— Translation from visual information to textual information

— Translation from textual information to visual information

7.16.2.5 Societal concerns

Promoting welfare and supporting social activities for people with disabilities

SDGs to be achieved: Good health and well-being for people

7.16.3 AI situation explanation service for people with visual impairments (use case 64)

7.16.3.1 Scope of use case

A real-time situation explanation service through voice for people with visual impairments

7.16.3.2 Objective

— Recognizing texts around people with visual impairments

— Recognizing faces around people with visual impairments

— Recognizing objects around people with visual impairments

— Assisting the mobility of people with visual impairments

— Describing scenes and photos for people with visual impairments

7.16.3.3 Narrative (short description)

A daily life support service, based on artificial intelligence technologies, that can explain the situation around people with visual impairments while they move

7.16.3.4 Challenges and issues

Vision

7.16.3.5 Societal concerns

Promoting welfare and supporting social activities for people with visual impairments

SDGs to be achieved: Good health and well-being for people

7.16.4 Predictive maintenance of public housing lifts (use case 94)

7.16.4.1 Scope of use case

Build an AI solution that can predict malfunction in a lift

7.16.4.2 Objective

Use RNN to predict the possibility and type of malfunction in a lift

7.16.4.3 Narrative (short description)

An AI model that helps the facilities management company of public housing to move from reactive to predictive maintenance of lifts.

7.16.4.4 Challenges and issues

The model can at times predict false positives, which can lead to unnecessary deployment of repair and maintenance manpower.

7.16.4.5 Societal concerns

Disruptions to the public due to breakdown of shared infrastructure

SDGs to be achieved: Climate action

7.17 Retail

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

7.17.1.1 Scope of use case

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

7.17.1.2 Objective

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

7.17.1.3 Narrative (short description)

JD.com Int.'s emotion-sensitive AI customer service is supported by AI technology and the deep learning method. It was developed for ameliorating the accuracy of detecting customer sentiment and its intensity. The service has achieved 74 % accuracy and 90 % recall for sentiment classification, while for intensity detection it has achieved 85 % accuracy and 85 % recall. During the special "618" sale, it increased customer satisfaction by 57 %.

7.17.1.4 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

7.17.1.5 Societal concerns

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

— Reducing labour costs, and reducing operating costs

SDGs to be achieved: Industry, innovation, and infrastructure

7.17.2 Deep learning-based user intent recognition (use case 43)

7.17.2.1 Scope of use case

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

7.17.2.2 Objective

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

7.17.2.3 Narrative (short description)

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 chat bot is used to handle 90 % of online customer service and has enabled JD.com to save over 100 million yuan in labour costs every year.

7.17.2.4 Challenges and issues

Current challenges of deep leaning 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.

7.17.2.5 Societal concerns

— Solve problems intelligently to increase efficiency

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

SDGs to be achieved: Decent work and economic growth

7.18 Security

7.18.1 Behavioural and sentiment analytics (use case 14)

7.18.1.1 Scope of use case

Ascertain a person's emotional state and goal from their gestures, facial expression, and actions

7.18.1.2 Objective

Detect object theft and other criminal behaviours. Prevent undesired behaviours, adapt the narrative to suit the state of the person, and provide dynamic content according to the person's emotional responses

7.18.1.3 Narrative (short description)

None identified

7.18.1.4 Challenges and issues

— Challenges: Surveillance cameras often have low resolution, and can be in poorly lit environments with a poor top-down view angle. A lot of suspicious behaviour can be indiscernible behind passers-by or large crowds.

— Issues: Unwanted behaviours are much less frequent than normal behaviours and can take on various forms.

7.18.1.5 Societal concerns

Right to privacy

SDGs to be achieved: Peace, justice and strong institutions

7.18.2 AI (swarm intelligence) solution for attack detection in IoT environment (use case 22)

7.18.2.1 Scope of use case

Anomaly-based attack detection in an IoT environment using swarm intelligence

7.18.2.2 Objective

— Given: Advanced metering infrastructure (AMI) – smart meters in smart buildings in smart cities

— Detect: Detect energy theft/meter tampering by consumers in AMI or hacking attacks by external agents (man in the middle) in edge computing security scenarios with intermittent disconnection, near real-time response without using server or cloud-based analytics

7.18.2.3 Narrative (short description)

This is a unique approach to detect attacks in an IoT environment using anomaly-based attack detection that uses swarm intelligence methods. This is a key solution to detect energy theft scenarios in smart metering. The incidence of energy theft varies from 2 % in developed countries to 35 % in developing countries. This solution is complementary to traditional AI or other static rule-based analysis that is heavily dependent on analysis of huge amounts of data on centralized cloud infrastructure. This solution is simple, nimble and can be run on low-powered edge devices (IoT nodes) for near real-time, low latency, low power, small compute, small storage mist/edge computing scenarios.

7.18.2.4 Challenges and issues

The problem is challenging because:

1) varied data sets for different scenarios: itm is necessary to pre-process a large amount of data to reach the operation threshold parameters to be used for detection in real time;

2) IoT (edge) nodes are configured to suit specific environments: the swarm intelligence system (SIS) involves a swarm of devices. It is expected to be possible to easily configure the entire swarm for different network environments and locations;

3) flexible to reuse/customize the solution for different use cases/scenarios and scalability: it is necessary that the platform be able to provide facilities for different algorithms for anomaly detection to be plugged in with minimum modification, recoding and recompilation.

Solution for problems 1) and 2): Many reusable modules for logging, debugging and configuration through extensible mark-up language (XML) have been developed, which has enabled binary re-use without having to change any code to suit a new network environment.

Solution for problem 3): Completely dynamically pluggable algorithm binaries can be developed that conform to defined interface specifications, which gives flexibility to try out new algorithms, without necessity to change existing code or re-compile. Use of swarm intelligence ensures that much less localized communication is required. Furthermore, the swarm intelligence system communication capability also addresses throttling of network traffic because of multi-threading/queuing capability built in.

7.18.2.5 Societal concerns

Accuracy of the solution. Fraud (anomaly detection) usually entails a false positive alarm issue.

SDGs to be achieved: Responsible consumption and production

7.18.3 Use of robotic solution for traffic policing and control (use case 25)

7.18.3.1 Scope of use case

Robotics-based traffic policing system

7.18.3.2 Objective

Efficient traffic control through use of Humanoid robots for traffic control

7.18.3.3 Narrative (short description)

Creation of a humanoid robot that can be deployed for traffic monitoring and control on roads. The solution would use computer vision and would be enabled with IoT for centralized control and data collection. This would relieve the human police from working in a polluted environment.

7.18.3.4 Challenges and issues

The problem is challenging because accurate control instructions are crucial for proper traffic control.

7.18.3.5 Societal concerns

Addresses the pressing concern of effective traffic control.

SDGs to be achieved: Sustainable cities and communities

7.18.4 Robotic solution for replacing human labour in hazardous conditions (use case 26)

7.18.4.1 Scope of use case

Building an AI-based robotics solution for replacing human labour in hazardous conditions

7.18.4.2 Objective

Offer an AI-based robotic solution that can be customized to work in different kinds of hazardous work environments such as mines, blast furnaces and boilers

7.18.4.3 Narrative (short description)

Building an AI-based robotic solution enabled with computer vision and equipped with various sensors such as temperature, pressure and smoke detectors for effectively replacing human labour in risky work environments

7.18.4.4 Challenges and issues

The problem is challenging because the solution is expected to be customizable for different work environments.

7.18.4.5 Societal concerns

Addresses the issue of accidents in hazardous work environments.

SDGs to be achieved: Decent work and economic growth

7.18.5 Non-intrusive detection of malware (use case 93)

7.18.5.1 Scope of use case

Build an AI solution that detects malware activities

7.18.5.2 Objective

Use ML to flag activities induced by malware without access to personal data on local devices

7.18.5.3 Narrative (short description)

A machine learning model that interprets phone activities like battery use, data use, location services and microphone use to flag possible malware in a local mobile device.

7.18.5.4 Challenges and issues

The model has limitations because malware attacks are highly sophisticated and not easily detectable.

7.18.5.5 Societal concerns

Disparate non-institutional sources of cyber attacks.

SDGs to be achieved: Sustainable cities and communities

7.19 Social infrastructure

7.19.1 Deep learning technology combined with topological data analysis successfully estimates degree of internal damage to bridge infrastructure (use case 8)

7.19.1.1 Scope of use case

Estimate and detect the risk of catastrophic collapse of old bridges

7.19.1.2 Objective

Enable estimation of failure and state of degradation using surface-mounted sensors

7.19.1.3 Narrative (short description)

Development of sensor data analysis technology that can aggregate vibration data from sensors attached to the surface of a bridge, and then estimate the degree of the bridge's internal damage

7.19.1.4 Challenges and issues

— Challenges: Detecting the occurrence of internal stress using this technology allows for the estimation of damage in its earliest stages and can contribute to early countermeasures.

— Issues: Conducting trials using vibration data from actual bridges, with the goal of real-world usage.

7.19.1.5 Societal concerns

None identified

7.19.2 Water crystal mapping (use case 77)

7.19.2.1 Scope of use case

Increase citizen awareness of the quality of water

7.19.2.2 Objective

Map the similarity of water crystals

7.19.2.3 Narrative (short description)

Deep learning-based approach to automatically classify water crystals

7.19.2.4 Challenges and issues

Water quality, ice memory

7.19.2.5 Societal concerns

Sustainable Development Goal 6 - UN Sustainable Development (water)

SDGs to be achieved: Industry, innovation, and infrastructure

7.19.3 System for real-time earthquake simulation with data assimilation (use case 97)

7.19.3.1 Scope of use case

This system provides accurate information for evacuation in an earthquake disaster.

7.19.3.2 Objective

The system conducts large-scale simulation of 3D seismic wave propagation, and results are improved based on real-time data assimilation using observation and machine-learning.

7.19.3.3 Narrative (short description)

This system provides accurate information for evacuation in an earthquake disaster. The system integrates simulation, data analytics and learning (S+D+L) on the BDEC system with h3-Open-BDEC. It conducts large-scale simulation of 3D seismic wave propagation, and results are improved based on real-time data assimilation using observation and machine-learning. Observations of seismic activities at more than 2 000 points in Japan are obtained by JDXnet developed by ERI/U. Tokyo (Earthquake Research Institute, University of Tokyo) through SINET in real time. Construction of the detailed and accurate underground model is crucial for accurate simulations. The optimized underground model is also constructed by integrating (S+D+L). The BDEC system is a 40+PF heterogeneous supercomputer system that includes simulation nodes for S, data/learning nodes for D and L, and integration nodes. h3-Open-BDEC is a software infrastructure for application development towards integration of (S+D+L).

7.19.3.4 Challenges and issues

— Construction of a reasonable and realistic underground model for simulation

— Real-time earthquake simulation with data assimilation

7.19.3.5 Societal concerns

Earthquake disasters

SDGs to be achieved: Sustainable cities and communities

7.20 Transportation

7.20.1 AI components for vehicle platooning on public roads (use case 9)

7.20.1.1 Scope of use case

Trains of vehicles that drive very close to each other at nearly equal speed (platoons) on public roads, in particular platooning trucks on motorways.

7.20.1.2 Objective

The objectives of truck automation are energy saving and enhanced transportation capacity by platooning, and eventually possible reduction of personnel costs by unstaffed operation of following vehicles. In a variant of this concept, platoons of passenger cars follow a truck autonomously.

7.20.1.3 Narrative (short description)

The overall concept of automated platooning is that the lead vehicle would be driven as usual by a trained (professional) driver, and the following vehicles would be driven fully automatically by the system, allowing the drivers to perform tasks other than driving their vehicles. The EU roadmap for truck platooning [EU project - expectation and non-formal skills to empower migrants and to boost local economy (ENSEMBLE)] envisions market introduction of multi-brand platooning by 2025. Several pilot projects have been carried out since about the year 2000. While a few AI components are already used in the pilot projects (e.g. lane keeping), future products are likely to incorporate AI solutions on several functional levels.

7.20.1.4 Challenges and issues

Highly unpredictable traffic environment, legislative situation, standardization, stress and comfort of human drivers involved

7.20.1.5 Societal concerns

Stress or boredom for the drivers, big brother and constant monitoring, safety, system security and reliability, risk of hacking and hijacking a long-haul freight truck poses great danger, trust over system reliability when driving next to a computer-controlled platoon.

7.20.2 Self-driving aircraft towing vehicle (use case 10)

7.20.2.1 Scope of use case

Self-driving towing vehicle for aircrafts, operating on an airfield autonomously

7.20.2.2 Objective

A towing vehicle that would, on command, autonomously navigate to an assigned aircraft, attach itself, tow the aircraft to an assigned location (a runway for departures, a gate for arrivals), autonomously detach itself, and navigate to an assigned location, either a staging area or to service another aircraft.

7.20.2.3 Narrative (short description)

Self-driving vehicle technology is applied to the problem of towing aircraft at busy airports from gate to runway and runway to gate. Autonomous aircraft towing can be supervised by human ramp controllers, by air traffic controllers (ATC), by pilots, or by ground crew. The controllers provide route information to the tugs, assisted by an automated route planning system. The planning system and tower and ground controllers work in conjunction with the tugs to make tactical decisions during operations to ensure safe and effective taxiing in a highly dynamic environment.

7.20.2.4 Challenges and issues

Safe operations in the airfield environment, minimal changes to the airport infrastructure, minimal impact of their incorporation into normal operations

7.20.2.5 Societal concerns

If labour replacements are involved, then the use of autonomy is expected to provide an equivalent or greater benefit to some portion of the labour pool to offset the potential job loss; furthermore, the vehicles are expected to operate in a way that feels common and familiar to humans, and are expected to be perceived as completely safe, simple and non-intimidating.

7.20.3 Unstaffed protective vehicle for road works on motorways (use case 11)

7.20.3.1 Scope of use case

Unstaffed operation of a protective vehicle in order to reduce the risk for road workers in short-term and mobile road works carried out in moving traffic.

7.20.3.2 Objective

A vehicle that is able to automatically follow mobile road works on the hard shoulder of a German motorway.

7.20.3.3 Narrative (short description)

Mobile road works on the hard shoulder of German highways bear an increased accident risk for the crew of the protective vehicle safeguarding road works against moving traffic. The "automated unstaffed protective vehicle for highway hard shoulder road works" aims at the unstaffed operation of the protective vehicle in order to reduce this risk. The vehicle was first tested in a real operation on German highway A3 in June 2018. It was the first unstaffed operation of a vehicle on German roads in public traffic. The scientific challenges of the project are strongly related to the general challenges in the field of automated driving.

7.20.3.4 Challenges and issues

Safe operations in public traffic, compliance with ISO 26262

7.20.3.5 Societal concerns

None identified

7.20.4 Enhancing traffic management efficiency and infraction detection accuracy with AI technologies (use case 29)

7.20.4.1 Scope of use case

Utilizing AI technologies in traffic monitoring and management

7.20.4.2 Objective

To increase the accuracy and efficiency of infraction detection, traffic monitoring and flow analysis, while minimizing the human effort and the overall solution cost

7.20.4.3 Narrative (short description)

Big data-enabled AI technologies are applied to monitoring and managing the traffic in a large municipality in China. Multi-sourced data (traffic flow, vehicle data, pedestrian movement, etc.) is monitored, from which illegal operation of vehicles, unexpected incidents, surges of traffic, etc., are detected and analysed using ML methods. ML tasks (including training and deployment) are carried out on a platform supporting the integration of various ML frameworks, models and algorithms. The platform is based on heterogeneous computing resources. The efficiency and accuracy of infraction detection, and the effectiveness of traffic management are significantly improved, with much reduced human effort and overall solution cost.

7.20.4.4 Challenges and issues

— Constant improvement in hardware architecture to increase the performance and efficiency of running ML/DL tasks

— Consistent interfaces between applications, ML engines and heterogeneous resource pools

— Support of new models and emerging algorithms for growing functionalities

7.20.4.5 Societal concerns

AI's application in urban transportation significantly improves the quality of life for urban citizens, reduces the time wasted in heavy traffic and the air pollution from vehicles.

SDGs to be achieved: Sustainable cities and communities

7.20.5 AI solution for traffic signal optimization based on multi-source data fusion (use case 49)

7.20.5.1 Scope of use case

Generate traffic signal timing plans by analysing the traffic flow status and patterns based on fusing internet data, induction coils data and video data, and control the traffic signal with the generated timing plans in a real-time, self-adaptive and cooperative way.

7.20.5.2 Objective

To find an effective and efficient solution to improve road utilization efficiency by increasing traffic flow speed and reducing traffic flow waiting time

7.20.5.3 Narrative (short description)

An AI solution was developed that can recognize the real-time traffic flow status and abstract traffic flow patterns by fusing internet data, induction coils data and video data, and can generate an optimized traffic signal timing plan by self-adaptively responding to real-time traffic flow fluctuation and can provide traffic flow coordination among multiple intersections within a given region.

7.20.5.4 Challenges and issues

— Challenges: Traffic signal self-adaptive and coordinated control for a large number of intersections.

— Issues:

1) not all intersections are equipped with detectors such as induction coil or video;

2) the detectors can output abnormal values which need data clean processing.

7.20.5.5 Societal concerns

Relieve urban road congestion

SDGs to be achieved: Sustainable cities and communities

7.20.6 Automated travel pattern recognition using mobile network data for applications to mobility as a service (use case 52)

7.20.6.1 Scope of use case

Automatic travel pattern recognition from anonymized and aggregated mobile phone network data (MND)

7.20.6.2 Objective

— Phase 1: Attribute trip purpose and mode of transport to multimodal door-to-door journeys from a mobile phone network dataset using AI and machine learning techniques (activity-based model)

— Phase 2: Generate daily activities for static agents in the agent-based model

— Phase 3: Optimize new mobility services in integration with mass transit

7.20.6.3 Narrative (short description)

Activity-based modelling has the capability to exploit big data generated by smart cities to create a digital twin of urban environments to test mobility as a service scheme. MND data have been used to create activities for an agent-based model.

AI is used to automatically detect the purpose and mode of transport in multimodal round trips, from an anonymized and aggregated MND trip-chains dataset. Data fusion techniques and SQL queries were also used to consider land use and facilities in the urban area of interest.

7.20.6.4 Challenges and issues

The use of mobile phone network data is still not precise for shorter trips and internal trips that cannot be detected. However, with the introduction of 5G, MND would be even more reliable and available to use in transport modelling.

7.20.6.5 Societal concerns

The use of anonymization techniques minimizes the risk of disclosing personal information when analysing location-based data and mobile phone network data.

7.20.7 Autonomous trains [unattended train operation (UTO)] (use case 113)

7.20.7.1 Scope of use case

Freight and passenger trains operate autonomously, excluding any crew presence on board, but with remote operator attention involved.

7.20.7.2 Objective

The critical objective of automation in trains is to provide extra reliability and safety and to prevent accidents on railways, which tend to be caused by human error. Moreover, the provided innovation leads to energy consumption optimization, transport capacity increases and, eventually, possible reduction of personnel costs due to the autonomous operation.

7.20.7.3 Narrative (short description)

Regarding passenger transportation, UTO enables unattended operation of trains according to schedule. The system is responsible for the train's acceleration, braking, speed control, station departure, doors opening and closing, obstacle detection, management of hazardous conditions and emergency situations.

Autonomous trains obtain data from sensors [internal - GPS, various types of cameras, LIDARs, radio detection and ranging (radars)] and traffic control systems (train schedule, movement authority), in order to interact with passengers, other vehicles, and obstacles based on information about the environment.

7.20.7.4 Challenges and issues

None identified

7.20.7.5 Societal concerns

Safety, reliability, security, (potential) job loss

The improper operation of autonomous trains may endanger the lives of the passengers and pedestrians. The robustness and accuracy of the visual perception modules of autonomous trains are vulnerable to adversary attacks.

SDGs to be achieved: Industry, innovation, and infrastructure

7.21 Work and life

7.21.1 Robotic prehension of objects (use case 16)

7.21.1.1 Scope of use case

Outputting the end effector velocity and rotation vector in response to the view from a red–green–blue depth (RGB-D) camera located on a robot's wrist

7.21.1.2 Objective

Use reinforcement learning to train the robot to grasp miscellaneous objects in simulation and transfer this learning to real-life robots.

7.21.1.3 Narrative (short description)

It can be difficult and time-consuming for clients of assistive robotic arms to control them with the fine degree required for grasping household objects (such as in the context of having a meal). In order to improve their quality of life, we propose a method by which users can select the bounding box around the object they wish grasped, and the robot performs the grasping action. We use methods from reinforcement learning to train first in simulation, in order to reduce total training time and potential robot breakage, and then transfer this learning to real-life.

7.21.1.4 Challenges and issues

— Challenges: The camera cannot have a bird's eye view and instead moves with the robot. Sparse rewards can complicate learning. The environment can be cluttered, occlusions of the target can occur and objects can move around.

— Issues: For safety reasons, the speed and force of the robot are expected to be limited in an assistive environment to avoid harm. Human intervention can happen at any time.

7.21.1.5 Societal concerns

Prevent harm to people and animals near a robot when it is performing a grasping task

SDGs to be achieved: Good health and well-being for people

7.21.2 Robotic vision – scene awareness (use case 17)

7.21.2.1 Scope of use case

Determining the environment the robot is in and which actions are available to it

7.21.2.2 Objective

Robustly identify the scene from video and depth sensors. From the scene and the seen objects, propose actions to the human collaborator

7.21.2.3 Narrative (short description)

Household robots are expected to navigate a very diverse set of environments and be able to accomplish different tasks depending on their position and action set. To meet these goals, the robots are expected to quickly and accurately identify the visual context in which they operate and derive the set of possible actions from this context. They can then propose relevant actions to the end user so that he/she is not expected to define the context himself/herself and then sift through a long list of irrelevant actions.

7.21.2.4 Challenges and issues

— Challenges: The environment can be poorly lit, leading to difficult context recognition.

— Issue: Sensors can degrade.

7.21.2.5 Societal concerns

Privacy concerns (what data from sensors is kept, reviewed and used to improve models)

SDGs to be achieved: Industry, innovation, and infrastructure

7.21.3 Recommendation algorithm for improving member experience and discoverability of resorts in the booking portal of a hotel chain (use case 28)

7.21.3.1 Scope of use case

Building a personalized recommendation algorithm to help members of the hotel chain to find their desired hotel for the family holiday

7.21.3.2 Objective

Offering personalized recommendations by understanding the member preferences from past holiday patterns and searches in the booking portal. Various member and hotel features were also considered for the model.

7.21.3.3 Narrative (short description)

Refine the existing system and implement a new model that can give personalized recommendations to members and improve bookings at undiscoverable or not-so-popular hotels. The algorithm would help in reshaping the demand and increase the visibility of the hotels that are in the lower spectrum of demand.

We would include member and resort features along with interaction data like members visiting a hotel and giving a rating to a resort visit, etc.

7.21.3.4 Challenges and issues

— Cold start problem: Since the member has only visited certain hotels in the past, the interaction matrix is very sparse.

— The matrix computation at times is computational resource intensive, causing system failures.

7.21.3.5 Societal concerns

None identified

7.21.4 Cooking recipes without border (CRWB) recommendation benchmark (use case 75)

7.21.4.1 Scope of use case

Decision support for cooking recipe execution plans, and nutrition recommendation

7.21.4.2 Objective

Machine data understandable

7.21.4.3 Narrative (short description)

The recommendation benchmark is based on a cooking recipe dataset of cooking recipe execution plans.

7.21.4.4 Challenges and issues

Personal expectations related to flavour, taste and texture

7.21.4.5 Societal concerns

Local production for local consumption

SDGs to be achieved: Responsible consumption and production

7.21.5 Improving the quality of online interaction (use case 88)

7.21.5.1 Scope of use case

Build an AI solution to recommend relevant ideas to users in a chat interface

7.21.5.2 Objective

To improve the quality of conversations and translate online chats about meet-ups

7.21.5.3 Narrative (short description)

A recommendation engine operating live in a chat interface to help both users decide on the next steps they can take that are of high interest to both

7.21.5.4 Challenges and issues

Translating sociological theories, customized to Singapore's context, and then translating into data labelling for the first step of NLU

7.21.5.5 Societal concerns

Improper use of online engagements that compromise the culture of mutual respect and dignity

SDGs to be achieved: Good health and well-being for people

7.22 Others

7.22.1 AI solution to automatically identify false positives from a specific check for “untranslated target segments” by an automated quality assurance tool (use case 13)

7.22.1.1 Scope of use case

The scope of this use case is limited to automated linguistic quality assurance tools, but the outcome of this use case can be applicable to other areas, such as machine translation, automated post-editing, computer-aided translation analysis and pre-translation.

7.22.1.2 Objective

To reduce the number of false positive issues in the “check for untranslated target segments” in bilingual content with an in-house automated quality assurance tool.

7.22.1.3 Narrative (short description)

In the future, we aim to build an AI solution that can automatically identify likely false positive issues from the results of the "check for untranslated target segments" following an approach where we can use machine learning based on already identified false positives by our users.

The expected outcome would be to increase the end user’s productivity when reviewing automated quality assurance findings and to change user behaviour to pay more attention to this type of issue by reducing the number of false positives by 80 %. In addition, we would like to reduce the amount of time we spent on a yearly basis on refining this check manually based on users' feedback.

7.22.1.4 Challenges and issues

— Challenges: Try to achieve eventually 80 % of the accuracy of linguists when identifying false positives for untranslated target segments, minimizing false negatives as much as possible.

— Issues: Segmentation of false positive data according to the customer and product profile can be challenging.

7.22.1.5 Societal concerns

None identified

7.22.2 AI solution for car damage classification (use case 18)

7.22.2.1 Scope of use case

Car damage classification for common damage types such as bumper dent, door dent, glass shatter, head lamp broken, tail lamp broken, scratch and smash

7.22.2.2 Objective

— To create an automated system for car damage classification using CNNs.

— Experiment using transfer and ensemble learning to find which is better for training a CNN for car damage classification.

7.22.2.3 Narrative (short description)

Image-based vehicle insurance processing is an important area with large scope for automation. We have considered the problem of car damage classification. We explored deep learning-based techniques for this purpose. Initially, we tried directly training a CNN. However, due to the small set of labelled

data, it did not work well. Then, we explored the effect of domain-specific pre-training followed by fine-tuning. Finally, we experimented with transfer learning and ensemble learning. Experimental results show that transfer learning works better than domain specific fine-tuning. We achieved accuracy of 89,5 % with a combination of transfer and ensemble learning. We hosted the trained model on a cloud service that can be plugged into applications using API and can be used for automated first level assessment of damage in the car insurance sector.

7.22.2.4 Challenges and issues

— Small size of the damage

— Smaller quantity of data

— Ambiguity in damaged and non-damaged images

7.22.2.5 Societal concerns

Insurance agents can be expected to be re-skilled.

SDGs to be achieved: Decent work and economic growth

7.22.3 Causality-based thermal prediction for data centre (use case 35)

7.22.3.1 Scope of use case

Data centre cooling control involving use of air cooling to control hot spots in a data centre

7.22.3.2 Objective

Minimize energy usage in managing the data centre

7.22.3.3 Narrative (short description)

Data centres tend to be overcooled to prevent computing machines from failing due to heat. A reliable fine-grained control that can regulate the air control unit (ACU) supply air temperature or flow is necessary to avoid overcooling. Methods that are based on correlation-based techniques do not generalize well. Hence, we seek to uncover the causal relationship between ACUs supplying cool air and temperature at the cabinets to prioritize which ACUs are expected to be regulated to control a hot spot near a cabinet.

7.22.3.4 Challenges and issues

Data sufficiency

7.22.3.5 Societal concerns

Promoting sustainable industries and investing in scientific research and innovation are all important ways to facilitate sustainable development.

SDGs to be achieved: Industry, innovation, and infrastructure

7.22.4 Machine learning tools in support of transformer diagnostics (use case 51)

7.22.4.1 Scope of use case

Operation and maintenance of power transformers

7.22.4.2 Objective

Use of machine learning (ML) algorithms as supporting tools for the automatic classification of the operating conditions of power transformers

7.22.4.3 Narrative (short description)

The successful use of ML tools may find multiple applications in the industry such as providing fast ways of analysing new data streaming from online sensors, and evaluating the importance of individual variables in the context of transformer condition assessment and also the need for or adequacy of data imputation from the viewpoint of the common problem of missing data.

7.22.4.4 Challenges and issues

Data availability, missing data

7.22.4.5 Societal concerns

Safe and reliable power delivery

SDGs to be achieved: Industry, innovation, and infrastructure

7.22.5 Video on demand publishing intelligence platform (use case 58)

7.22.5.1 Scope of use case

Predictive maintenance platform for a video on demand content preparation process

7.22.5.2 Objective

The goals of the project are:

— process fault comprehension;

— fault prediction;

— fault recovery through a recommendation engine;

— productive interaction between the fault prediction and recovery recommendation engines for proactive process maintenance.

7.22.5.3 Narrative (short description)

An E2E platform was developed in order to achieve accurate fault prediction with machine learning and useful recovery action recommendation using reinforcement learning.

7.22.5.4 Challenges and issues

The machine learning engine processing time had to be very short.

7.22.5.5 Societal concerns

None identified

7.22.6 Predictive testing (use case 59)

7.22.6.1 Scope of use case

Automatic detection of inaccurate test outcomes in an application development process

7.22.6.2 Objective

The goal of the project is the improvement of the automation level in the application testing process. This is achieved by the automatic identification of inaccurate test outcomes, reducing the number of failure alerts.

7.22.6.3 Narrative (short description)

The solution adopts machine learning to analyse event logs of test results in order to reduce the number of wrongly failed tests.

7.22.6.4 Challenges and issues

Being able to manage and handle different types of data (including contextual information), and integrating the solution in the processes and procedures of the company

7.22.6.5 Societal concerns

None identified

7.22.7 Predictive data quality (use case 60)

7.22.7.1 Scope of use case

A solution for assessing data quality in data collection systems

7.22.7.2 Objective

Using machine learning techniques for identifying complex or unknown correlation among data in order to score its quality and enhance the confidence of the data consumer in using data for decision making processes

7.22.7.3 Narrative (short description)

The solution adopts machine learning methods to analyse collected data in order to identify complex correlation of data (unknown at priori) and predict data quality issues.

7.22.7.4 Challenges and issues

Being able to manage and handle different types of data, link data to a reference knowledge model, and change management in the organization

7.22.7.5 Societal concerns

None identified

7.22.8 Expansion of AI training dataset and contents using artificial intelligence techniques (use case 66)

7.22.8.1 Scope of use case

Data self-propagation and validation service for deep learning and contents services

7.22.8.2 Objective

— Self-propagation of data to enhance the performance of application systems and to support the expansion of data for deep learning

— Self-propagated data evaluation for qualitative verification

7.22.8.3 Narrative (short description)

The service expands the data used for deep learning for rapid commercialization of artificial intelligence technologies. The service includes quantitative extensions of the amount of learning data for high-quality in-depth learning and qualitative verification of extended data applied to machine learning or commercial content services.

7.22.8.4 Challenges and issues

The optimized self-propagation techniques for various types of data

7.22.8.5 Societal concerns

Technology polarization in the artificial intelligence technical area is becoming more and more serious.

SDGs to be achieved: Industry, innovation, and infrastructure

7.22.9 Open spatial dataset for developing AI algorithms based on remote sensing (satellite, drone, aerial imagery) data (use case 122)

7.22.9.1 Scope of use case

Analytical services for automatic detection of changes in the state of ground surface objects for administrative, government, and social purposes in different use-cases, such as:

— urban monitoring: cadastral data, land management, estimation of the living population, etc;

— emergency mapping: estimation of disaster damage;

— security and risk management monitoring of protected zones (powerlines, railroads, pipelines): detection of vegetation growth, control of safety, etc.

7.22.9.2 Objective

The growth of the Russian market for geo-analytical cloud services based on remote sensing data and AI technologies; open benchmark datasets for the research and development community; and bringing the power of AI and the global coverage of remote sensing imagery closer to the people.

7.22.9.3 Narrative (short description)

Despite the increasing number of datasets and competition in remote sensing data science (e.g. Spacenet), there is still a lack of geographical diversity, of training classes, and of interoperability of datasets.

The proposed approach is to be extended to different types of remote sensing data and application domains based on classification of the natural objects and objects made by humans that have a clear interpretation either in satellite or aerial imagery.

7.22.9.4 Challenges and issues

There is no standard or criteria regulating the process of labelling (manual or automatic) remote sensing [satellite, drone or unstaffed aerial vehicle (UAV)] images with a geographic reference. Development of such a standard is vital to AI algorithms for guaranteeing the quality of training data and for testing and benchmarking.

We consider the following criteria that the perfect dataset collection of electro-optical (EO) imagery is expected to match:

— georeference: annotated photos are not enough. Maps for data labelling (e.g. OpenStreetMap) require objects' coordinates;

— time series: to observe places dynamically and calculate comparative indicators. The main application is "emergency mapping" that requires the detection of changes in residential infrastructure analysis of before and post-event images;

— cartographic-styled labelling and classification: maps make an abstracted interpretation of earth observation images; we therefore believe that the previous approach of labelling images with boxes does not satisfy the criteria for accurate image segmentation and will not work. For neural networks, it is now necessary to compete with manual mapping, and to calculate its accuracy we need at least some ground truth that looks like a map. At the same time, there are many other sources beyond the EO imagery that can be useful for mapping, such as point of interest (POI), and collecting field works in order to accumulate addresses. At this moment our goal is to compare ML methods with the information that can be extracted by a cartographer using only optical bands of imagery and some geographic information system (GIS) software. For such purposes we proposed the basic classifier that is part of training and testing datasets;

— multispectral: next, we propose to extend this approach to advanced classification, which is comparable to thematic interpretation of satellite imagery with the help of different bands combination. That is why the proposed classifier includes classes that require even more specific training and non-optical bands for better recognition.

Providing open API and web tools to access and preview datasets. Despite the dataset collection representing structured data, it would be much more capable for further and updated use based on the standards for interoperability of geodata. In our work, we tried to join both mapping and data science approaches in the way we see new tools and services demanded by users. For many users from the data science community, maps and remote sensing are becoming just one of the sources of information that is necessary to be structured and classified. And for many mappers that are involved in the process of geodata interpretation and classification, the map itself is the perfect tool to interact with the data, no matter whether implemented in a python notebook or loaded in a desktop GIS application.

7.22.9.5 Societal concerns

Global extension of this technology brings society new possibilities of situational awareness and digital instruments for resources management (natural and made by humans).

SDGs to be achieved: Sustainable cities and communities

Annex A
(informative)

Impact analysis items

No.	Impact analysis items
1	Context or application area
2	Technologies
3	Title
4	Scope of use case
5	Identified benefits
6	Identified challenges
7	Identified societal concerns
8	Data
9	Are all key stakeholders identified?
10	Are there any vulnerable stakeholders (e.g. children, mothers with young children, racial minorities, cultural minorities, ethnic minorities, displaced persons, incarcerated persons, refugees, etc.)?
11	If there are vulnerable stakeholders, do they have an identified voice in the process or technology?
12	If they do not have a voice, how will their interests be protected?
13	Is the application, technology, system or process well-defined?
14	Is the application, technology, system or process transparent to the developers and engineers?
15	Is the application, technology, system or process transparent to the users of the system?
16	Is the application, technology, system or process transparent to other stakeholders?
17	Are there environmental or sustainability issues involved? (e.g. water management and access, pollution, energy, etc.)
18	Are there health and wellness issues?
19	Are there gender equality issues?
20	Are there workforce or economic equality issues?
21	Are there data or privacy issues that can adversely affect or unduly benefit specific individuals or stakeholders?
22	Are there intellectual property rights that are necessary to be considered and protected?
23	Does this technology, system, or process manipulate, bias, or alter (or seek to manipulate, bias or alter) an individual's behaviour, attitudes, ideas or actions?
24	Are there any aspects of the technology, system or process that would deny essential services to some stakeholders?
25	Are there cultural, economic, political, social or technical biases in the evaluation process?
26	Are there biases in the benefits of this technology or application?
27	Can there be any unanticipated feedback or interactions because of the complexity of the system, technology or process?

Annex B
(informative)

Use case template

This annex is the template used for collecting use cases. Tables B.1 to B.8 provide a blank template of a use case. The terms used in that template were defined in 6.2.

The template is based on ISO/IEC 20547-2, IEC 62559 and IEEE P7003.

Table B.1 — General information on use case

ID				
Use case name				
Application domain				
Deployment model				
Status				
Scope of use case				
Objective(s)				
Narrative	Short description (150 words max.)			
	Complete description			
Stakeholders				
Stakeholders' assets, values				
System's threats and vulnerabilities				
Key performance indicators (KPIs)	ID	Name	Description	Reference to mentioned use case objectives
Features of use case	Task(s)			
	Method(s)			
	Platform			
	Topology			
	Terms and concepts used			
Standardization opportunities/ requirements				
Challenges and issues				
Societal concerns	Description			
	SDGs to be achieved			

Table B.2 — Data characteristics

Data characteristics	
Description	
Source	
Type	
Volume (size)	
Velocity	
Variety	
Variability (rate of change)	
Quality	

Table B.3 — Process scenario and scenario conditions

Scenario conditions					
No.	**Scenario name**	**Scenario description**	**Triggering event**	**Pre-condition**	**Post-condition**

Table B.4 — Information on training scenario

Scenario name	**Training**				
Step No.	**Event**	**Name of process/ activity**	**Primary actor**	**Description of process/activity**	**Requirement**

Specification of training data	

Table B.5 — Information on evaluation scenario

Scenario name	**Evaluation**				
Step No.	**Event**	**Name of process/ activity**	**Primary actor**	**Description of process/activity**	**Requirement**

Input of evaluation	
Output of evaluation	

Table B.6 — Information on execution scenario

Scenario name	Execution				
Step No.	Event	Name of process/ activity	Primary actor	Description of process/activity	Requirement

Input of execution	
Output of execution	

Table B.7 — Information on retraining scenario

Scenario name	Retraining				
Step No.	Event	Name of process/activity	Primary actor	Description of process/activity	Requirement

Specification of retraining data	

Table B.8 — References of use case

References of use case						
No.	Type	Reference	Status	Impact on use case	Originator/organization	Link

Annex C
(informative)

In-depth analysis of machine learning tools in support of transformer diagnostics use case

C.1 General

To reflect on the context of the AI standardization work and determine its relevance to real-world AI applications, and that concerns/expectations of key stakeholders of AI standardization are brought up explicitly, one use case was analysed using a six-step process with mapping to a set of quality criteria.

The quality criteria consist of the use case selection guidance (see 6.3) and analysing the inputs in the "Standardization opportunities and requirements (see 6.4.1)" section to extract useful directions for the AI standardization work. This is the area that differentiates this document from other documents in the open domain.

C.2 Approach to use case analysis

This analysis uses a six-step process as follows:

Step 1: Use the definition of AI (3.1). Identify the different components of this definition in each use case.

Identify other foundational, trustworthiness, societal concerns, and life cycle elements corresponding to acquire/process/apply aspects in the use cases. Identify the additional essential requirements for AI software products as compared to conventional non-AI software products.

To come up with these requirements, each AI application can be evaluated considering the following three scenarios.

1) AI: Solution using existing AI approach

2) Human expertise: Solution using human expertise (but no AI software)

3) Non-AI: Solution that does not use either of the above two options

Each of the three options can be analysed with reference to acquire, process and apply requirements to explicitly address differences in requirements for AI application.

Step 2: Do the missing data (not filled in) on the submission template affect the quality and understanding of the use case?

Step 3: Apply the quality criteria (refers to 6.3) to the use cases.

Step 4: Identify use cases that have insufficient data or did not satisfy the selection criteria.

Step 5: Identify a typical use case from the collection that is deemed illustrative and best exemplifies AI applications. This use case can be used as a sample for potential submitters.

Step 6: Analyse in detail with reference to scenarios mentioned in step 1 and categorize the requirements to be specifically directed to other existing working groups.

C.3 Use case analysis result

The result of use case analysis is as follows.

Use case: Machine learning tools in support of transformer diagnostics (use case 51)

Table C.1, Table C.2 and Table C.3 analyse the use case to bring out specific requirements with reference to AI standardization.

Table C.1 — Use case scenarios as per step 1 (Table C.2) and selection guidance: Level of Autonomy

Scenario 1: AI	Scenario 2: Human expert	Scenario 3: Non-AI
Continuous monitoring and control to improve transformer diagnostics based on insights from AI.	Operate as per best practices evolved over a period of time based on experience of an expert.	Maintenance as prescribed by OEM based on design and average operating conditions.

Table C.2 — Analysis of acquire–process–apply framework for different scenarios[a]

Scenario	Acquire	Process	Apply
1	Operation hours of transformer + information on critical operation parameters + **additional information on temperature, vibration, noise, and other operational details for multiple transformers.** **(selection guidance: data focus and learning)**	**Artificial neural network** **(selection guidance: data focus and learning)**	**Partly explainable and improved maintenance schedule (over and above scenario 2) that can have probability to lead to safety and operational issues leading to grid failure.** **(selection guidance: verifiability and transparency data focus and learning)**
2	Operation hours of transformer + information on critical operation parameters	Reasoning based on expert analysis	Improved operation performance, based on maintenance trigger, that can be explained through expert reasoning
3	Operation hours of transformer	Simple logic as prescribed by OEM based on physics-based approach of transformer design and operation	Maintenance trigger based on the rules set by OEM

[a] AI-specific aspects are marked in bold letters.

Table C.3 highlights important issues that are to be addressed by standardization.

Table C.3 — Issues to be addressed by standardization (for items highlighted in bold in Table C.2)

	Acquire	Process	Apply
General	Missing data treatment	Criteria for training	Explainability of results
	Choice of data frequency	Criteria for validation	Acceptable output for commercialization
	Establishing bias in input data	Criteria for retraining	Fail safe mode of operation against biases, safety, health and environment impact
	Minimum size for training, data sufficiency	Implementation in existing systems	Risk-impact assessment considering all
	Context definition		
Specific	Capturing maintenance and event-related data		
	Aligning inputs from multiple equipment		
	Definition of fault and error codes		
	Input characterization		

Selection guidance:

— Impact (Societal concerns): Safe and reliable power delivery

— Architecture: On-premise system

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