



# **EXIN BCS Artificial Intelligence**

**FOUNDATION**

Certified by  


**Preparation Guide**

Edition 202201

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# 1. Overview

EXIN BCS Artificial Intelligence Foundation (AIF.EN)

## Scope

Candidates should be able to demonstrate a knowledge and understanding in the application of ethical and sustainable Artificial Intelligence (AI):

- Human-centric Ethical and Sustainable Human and Artificial Intelligence (AI);
- Artificial Intelligence (AI) and Robotics;
- applying the benefits of AI projects - challenges and risks;
- Machine Learning (ML) Theory and Practice – Building a Machine Learning (ML) Toolbox;
- the Management, Roles and Responsibilities of Humans and Machines – The Future of AI.

## Summary

Artificial Intelligence (AI) is a methodology for using a non-human system to learn from experience and imitate human intelligent behavior. The EXIN BCS Artificial Intelligence Foundation certification tests a candidate's knowledge and understanding of the terminology and general principles of AI. This preparation guide covers the potential benefits and challenges of ethical and sustainable robust Artificial Intelligence (AI); the basic process of Machine Learning (ML) – Building a Machine Learning (ML) Toolkit; the challenges and risks associated with an AI project, and the future of AI and Humans in work. This Foundation certificate includes and expands on the knowledge taught in the EXIN BCS Essentials Certificate in Artificial Intelligence.

## Context

The EXIN BCS Artificial Intelligence Foundation certification is part of the EXIN BCS Artificial Intelligence qualification program.



## Target Group

The EXIN BCS Artificial Intelligence Foundation certification is focused on individuals with an interest in, (or need to implement) AI in an organization, especially those working in areas such as science, engineering, knowledge engineering, finance, education or IT services.

The following roles could be interested:

- Engineers
- Scientists
- Professional Research Managers
- Chief Technical Officers
- Chief Information Officers
- Organizational Change Practitioners and Managers
- Business Change Practitioners and Managers
- Service Architects and Managers
- Program and Planning Managers
- Service Provider Portfolio Strategists / Leads
- Process Architects and Managers
- Business Strategists and Consultants
- Web Page Developers

## Requirements for Certification

- Successful completion of the EXIN BCS Artificial Intelligence Foundation exam.

## Examination Details

Examination type:	Multiple-choice questions
Number of questions:	40
Pass mark:	65%
Open book/notes:	No
Electronic equipment/aides permitted:	No
Exam duration:	60 minutes

The Rules and Regulations for EXIN's examinations apply to this exam.

## Bloom level

The EXIN BCS Artificial Intelligence Foundation certification tests candidates at Bloom Level 1 and 2 according to Bloom's Revised Taxonomy:

- Bloom Level 1: Remembering – relies on recall of information. Candidates will need to absorb, remember, recognize and recall.
- Bloom Level 2: Understanding – a step beyond remembering. Understanding shows that candidates comprehend what is presented and can evaluate how the learning material may be applied in their own environment. This type of questions aims to demonstrate that the candidate is able to organize, compare, interpret and choose the correct description of facts and ideas.

## Training

### Contact hours

The recommended number of contact hours for this training course is 18. This includes group assignments, exam preparation and short breaks. This number of hours does not include lunch breaks, homework and the exam.

### Indication Study Effort

60 hours, depending on existing knowledge.

### Training Organization

You can find a list of our Accredited Training Organizations at [www.exin.com](http://www.exin.com).

## 2. Exam Requirements

The exam requirements are specified in the exam specifications. The following table lists the topics of the module (exam requirements) and the subtopics (exam specifications).

Exam Requirements	Exam Specifications	Weight
<b>1. Ethical and Sustainable Human and Artificial Intelligence (AI)</b>		<b>20%</b>
	1.1 Recall the General Definition of Human and Artificial Intelligence (AI)	
	1.2 Describe what are Ethics and Trustworthy Artificial Intelligence (AI)	
	1.3 Describe the Three Fundamental Areas of Sustainability and the United Nation's Seventeen Sustainability Goals	
	1.4 Describe how Artificial Intelligence (AI) is Part of 'Universal Design,' and 'The Fourth Industrial Revolution'	
	1.5 Understand that Machine Learning (ML) is a Significant Contribution to the Growth of Artificial Intelligence (AI)	
<b>2. Artificial Intelligence (AI) and Robotics</b>		<b>20%</b>
	2.1 Demonstrate Understanding of the Artificial Intelligence (AI) Intelligent Agent Description	
	2.2 Describe what a Robot is	
	2.3 Describe what an Intelligent Robot is	
<b>3. Applying the Benefits of Artificial Intelligence (AI) – Challenges and Risks</b>		<b>15%</b>
	3.1 Describe how Sustainability Relates to Human-Centric Ethical Artificial Intelligence (AI) and how our Values will Drive our use of Artificial Intelligence (AI) and will Change Humans, Society and Organizations	
	3.2 Explain the Benefits of Artificial Intelligence (AI)	
	3.3 Describe the Challenges of Artificial Intelligence (AI)	
	3.4 Demonstrate Understanding of the Risks of Artificial Intelligence (AI) Projects	
	3.5 List Opportunities for Artificial Intelligence (AI)	
	3.6 Identify a Typical Funding Source for Artificial Intelligence (AI) Projects and Relate to the NASA Technology Readiness Levels (TRLs)	
<b>4. Starting Artificial Intelligence (AI): how to Build a Machine Learning (ML) Toolbox – Theory and Practice</b>		<b>30%</b>
	4.1 Describe how we Learn from Data – Functionality, Software and Hardware	
	4.2 Recall which Typical, Narrow Artificial Intelligence (AI) Capability is Useful in Machine Learning (ML) and Artificial Intelligence (AI) Agents' Functionality	
<b>5. The Management, Roles and Responsibilities of Humans and Machines</b>		<b>15%</b>
	5.1 Demonstrate an Understanding that Artificial Intelligence (AI) (in Particular, Machine Learning (ML)) will Drive Humans and Machines to Work Together	
	5.2 List Future Directions of Humans and Machines Working Together	
	5.3 Describe a 'Learning from Experience' Agile Approach to Projects	
<b>Total</b>		<b>100%</b>

## Exam Specifications

### 1 Ethical and Sustainable Human and Artificial Intelligence (AI)

- 1.1 Recall the General Definition of Human and Artificial Intelligence (AI)  
The candidate can...
  - 1.1.1 describe the concept of intelligent agents.
  - 1.1.2 describe a modern approach to Human logical levels of thinking using Robert Dilt's Model.
- 1.2 Describe what are Ethics and Trustworthy Artificial Intelligence (AI), in Particular:  
The candidate can...
  - 1.2.1 recall the general definition of Ethics.
  - 1.2.2 recall that a Human Centric Ethical Purpose respects fundamental rights, principles and values.
  - 1.2.3 recall that Ethical Purpose AI is delivered using Trustworthy Artificial Intelligence (AI) that is technically robust.
  - 1.2.4 recall that the Human Centric Ethical Purpose Trustworthy Artificial Intelligence (AI) is continually assessed and monitored.
- 1.3 Describe the Three Fundamental Areas of Sustainability and the United Nation's Seventeen Sustainability Goals
- 1.4 Describe how Artificial Intelligence (AI) is Part of 'Universal Design,' and 'The Fourth Industrial Revolution'
- 1.5 Understand that Machine Learning (ML) is a Significant Contribution to the Growth of Artificial Intelligence (AI)  
The candidate can...
  - 1.5.1 describe 'learning from experience' and how it relates to Machine Learning (ML) (Tom Mitchell's explicit definition).

### 2 Artificial Intelligence (AI) and Robotics

- 2.1 Demonstrate Understanding of the Artificial Intelligence (AI) Intelligent Agent Description, and:  
The candidate can...
  - 2.1.1 list the four rational agent dependencies.
  - 2.1.2 describe agents in terms of performance measure, environment, actuators and sensors.
  - 2.1.3 describe four types of agent: reflex, model-based reflex, goal-based and utility-based.
  - 2.1.4 identify the relationship of Artificial Intelligence (AI) agents with Machine Learning (ML).
- 2.2 Describe what a Robot is and:  
The candidate can...
  - 2.2.1 describe robotic paradigms
- 2.3 Describe what an Intelligent Robot is and:  
The candidate can...
  - 2.3.1 relate intelligent robotics to intelligent agents.

### 3 Applying the Benefits of Artificial Intelligence (AI) – Challenges and Risks

- 3.1 Describe how Sustainability Relates to Human-Centric Ethical Artificial Intelligence (AI) and how our Values will Drive our use of Artificial Intelligence (AI) and will Change Humans, Society and Organizations
- 3.2 Explain the Benefits of Artificial Intelligence (AI) by:  
The candidate can...
  - 3.2.1 list advantages of machine and human and machine systems.



- 3.3 Describe the Challenges of Artificial Intelligence (AI), and:  
The candidate can...
  - 3.3.1 give examples of general ethical challenges Artificial Intelligence (AI) raises.
  - 3.3.2 give general examples of the limitations of Artificial Intelligence (AI) systems compared to human systems.
- 3.4 Demonstrate Understanding of the Risks of Artificial Intelligence (AI) Projects, and:  
The candidate can...
  - 3.4.1 give at least one a general example of the risks of Artificial Intelligence (AI).
  - 3.4.2 describe a typical Artificial Intelligence (AI) project team in particular.
  - 3.4.3 describe a domain expert.
  - 3.4.4 describe what is 'fit-of-purpose'.
  - 3.4.5 describe the difference between waterfall and agile projects.
- 3.5 List Opportunities for Artificial Intelligence (AI)
- 3.6 Identify a Typical Funding Source for Artificial Intelligence (AI) Projects and Relate to the NASA Technology Readiness Levels (TRLs)

#### **4 Starting Artificial Intelligence (AI): how to Build a Machine Learning (ML) Toolbox – Theory and Practice**

- 4.1 Describe how we Learn from Data – Functionality, Software and Hardware  
The candidate can...
  - 4.1.1 list common open source machine learning functionality, software and hardware.
  - 4.1.2 describe introductory theory of Machine Learning (ML).
  - 4.1.3 describe typical tasks in the preparation of data.
  - 4.1.4 describe typical types of Machine Learning (ML) Algorithms.
  - 4.1.5 describe the typical methods of visualizing data.
- 4.2 Recall which Typical, Narrow Artificial Intelligence (AI) Capability is Useful in Machine Learning (ML) and Artificial Intelligence (AI) Agents' Functionality

#### **5 The Management, Roles and Responsibilities of Humans and Machines**

- 5.1 Demonstrate an Understanding that Artificial Intelligence (AI) (in Particular, Machine Learning (ML)) will Drive Humans and Machines to Work Together
- 5.2 List Future Directions of Humans and Machines Working Together
- 5.3 Describe a 'Learning from Experience' Agile Approach to Projects  
The candidate can...
  - 5.3.1 describe the type of team members needed for an Agile project.

### 3. List of Basic Concepts

This chapter contains terms and abbreviations which can be used for reference.

Abbreviation	Meaning
AI	Artificial Intelligence
IoT	Internet of Things
ANN	Artificial Neural Network
NN	Neural Network
CNN	Convolution Neural Network
ML	Machine Learning
OCR	Optical Character Recognition
NLP	Natural Language Processing
DL	Deep Learning
DNN	Deep Neural Networks
AGI	Artificial General Intelligent
CPU	Central Processing Unit
GPU	Graphical Processing Unit
RPA	Robotic Process Automation
CART	Classification and Regression Trees
IT	Information Technology
IQ	Intelligence Quotient
EQ	Emotional Quotient

Term	Description or Definition	Reference
Activation Function	The activation function defines the output of a node given an input or set of inputs.	<a href="https://en.wikipedia.org/wiki/Activation_function">https://en.wikipedia.org/wiki/Activation_function</a>
Agent Modelling	An intelligent agent (IA) is autonomous, observes through sensors and acts on its environment using actuators.	<a href="https://en.wikipedia.org/wiki/Intelligent_agent">https://en.wikipedia.org/wiki/Intelligent_agent</a>
Algorithm	An algorithm is an unambiguous specification of how to solve a class of problems.	<a href="https://en.wikipedia.org/wiki/Algorithm">https://en.wikipedia.org/wiki/Algorithm</a>
Artificial Intelligence (AI)	A branch of computer science dealing with the simulation of intelligent behavior in computers.	<a href="https://www.merriam-webster.com/dictionary/artificial%20intelligence">https://www.merriam-webster.com/dictionary/artificial%20intelligence</a>
Automation	Automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor.	<a href="https://www.merriam-webster.com/dictionary/automation">https://www.merriam-webster.com/dictionary/automation</a>
Autonomous	Undertaken or carried on without outside control	<a href="https://www.merriam-webster.com/dictionary/autonomous">https://www.merriam-webster.com/dictionary/autonomous</a>
Axon	An axon is a long, slender projection of a nerve cell, or neuron, that typically conducts electrical impulses.	<a href="https://en.wikipedia.org/wiki/Axon">https://en.wikipedia.org/wiki/Axon</a>

Term	Description or Definition	Reference
Axon Terminals	Axon terminals are terminations of the telodendria (branches) of an axon.	<a href="https://en.wikipedia.org/wiki/Axon_terminal">https://en.wikipedia.org/wiki/Axon_terminal</a>
Back-propagation	A method used in artificial neural networks to calculate a gradient required in the calculation of the weights to be used in the network.	<a href="https://en.wikipedia.org/wiki/Back_propagation">https://en.wikipedia.org/wiki/Back_propagation</a>
Bayesian Network	A Bayesian network or belief network is a probabilistic graphical model that represents a set of variables and their conditional dependencies.	<a href="https://en.wikipedia.org/wiki/Bayesian_network">https://en.wikipedia.org/wiki/Bayesian_network</a>
Bias	Deviation of the expected value of a statistical estimate from the quantity it estimates.	<a href="https://www.merriam-webster.com/dictionary/bias">https://www.merriam-webster.com/dictionary/bias</a>
Big Data	Big data is data sets that are so big and complex that traditional data-processing application software are inadequate to deal with them.	<a href="https://en.wikipedia.org/wiki/Big_data">https://en.wikipedia.org/wiki/Big_data</a>
Boosting	Boosting is an ensemble meta-algorithm for reducing bias, and also variance in supervised learning and a family of algorithms that convert weak learners to strong ones.	<a href="https://en.wikipedia.org/wiki/Boosting_%28machine_learning%29">https://en.wikipedia.org/wiki/Boosting_%28machine_learning%29</a>
Bootstrap Aggregating – Bagging	Bootstrap aggregating, is an ensemble meta-algorithm used in statistical classification and regression.	<a href="https://en.wikipedia.org/wiki/Bootstrap_aggregating">https://en.wikipedia.org/wiki/Bootstrap_aggregating</a>
Chatbot	A chatbot is an artificial intelligence program that conducts a conversation via auditory or textual methods.	<a href="https://en.wikipedia.org/wiki/Computer_program">https://en.wikipedia.org/wiki/Computer_program</a>
Classification	Classification is the problem of identifying to which of a set of classes a new observation belongs.	<a href="https://en.wikipedia.org/wiki/Statistical_classification">https://en.wikipedia.org/wiki/Statistical_classification</a>
Clustering	Clustering groups a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups.	<a href="https://en.wikipedia.org/wiki/Cluster_analysis">https://en.wikipedia.org/wiki/Cluster_analysis</a>
Cognitive Simulation	Cognitive simulation uses computers that test how the human mind works.	<a href="http://www.alanturing.net/turing_archive/pages/Reference%20Articles/what_is_AI/What%20is%20AI02.html">http://www.alanturing.net/turing_archive/pages/Reference%20Articles/what_is_AI/What%20is%20AI02.html</a>
Combinatorial Complexity	The exponential growth in computer power required to solve a problem that has many combinations with increasing complexity.	<a href="https://www.frontiersin.org/article/10.3389/fnbot.2013.00023/full">https://www.frontiersin.org/article/10.3389/fnbot.2013.00023/full</a>

Term	Description or Definition	Reference
Combinatorial Explosion	A combinatorial explosion is the rapid growth of the complexity of a problem due to the combinations of the problem's input parameters.	<a href="https://en.wikipedia.org/wiki/Combinatorial_explosion">https://en.wikipedia.org/wiki/Combinatorial_explosion</a>
Connectionist	Cognitive science that hopes to explain intellectual abilities using artificial neural networks.	<a href="https://plato.stanford.edu/entries/connectionism/">https://plato.stanford.edu/entries/connectionism/</a>
Data Analytics	The discovery, interpretation, and communication of meaningful patterns in data.	<a href="https://en.wikipedia.org/wiki/Analytics">https://en.wikipedia.org/wiki/Analytics</a>
Data Cleaning	Data cleaning detects and corrects (or removes) corrupt or inaccurate records from a record set, table, or database and refers to identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the dirty or coarse data.	<a href="https://en.wikipedia.org/wiki/Data_cleansing">https://en.wikipedia.org/wiki/Data_cleansing</a>
Data Mining	The process of discovering patterns in large data sets.	<a href="https://en.wikipedia.org/wiki/Data_mining">https://en.wikipedia.org/wiki/Data_mining</a>
Data Science	Data science uses scientific methods, processes, algorithms and systems to understand data.	<a href="https://en.wikipedia.org/wiki/Data_science">https://en.wikipedia.org/wiki/Data_science</a>
Data Scrubbing	See data cleaning.	
Decisions Trees	A decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences.	<a href="https://en.wikipedia.org/wiki/Decision_tree">https://en.wikipedia.org/wiki/Decision_tree</a>
Deep Learning	Deep learning is a class of algorithms that use a cascade of multiple layers for feature extraction and transformation. Each successive layer uses the output from the previous layer as input.	<a href="https://en.wikipedia.org/wiki/Deep_learning">https://en.wikipedia.org/wiki/Deep_learning</a>
Dendrites	Dendrites are branched extensions of a nerve cell that propagate the electrochemical stimulation.	<a href="https://en.wikipedia.org/wiki/Dendrite">https://en.wikipedia.org/wiki/Dendrite</a>
Edges	Edges are the machine learning name for the brain's axons	<a href="https://en.wikipedia.org/wiki/Artificial_neural_network">https://en.wikipedia.org/wiki/Artificial_neural_network</a>
Ensemble	Ensemble methods use multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent learning algorithms alone.	<a href="https://en.wikipedia.org/wiki/Ensemble_learning">https://en.wikipedia.org/wiki/Ensemble_learning</a>
Expert Systems	An expert system is a computer system that emulates the decision-making ability of a human expert.	<a href="https://en.wikipedia.org/wiki/Expert_system">https://en.wikipedia.org/wiki/Expert_system</a>
Feedforward Neural Network	A feedforward neural network is an artificial neural network wherein connections between the nodes do not form a cycle.	<a href="https://en.wikipedia.org/wiki/Feedforward_neural_network">https://en.wikipedia.org/wiki/Feedforward_neural_network</a>

Term	Description or Definition	Reference
Functionality	The tasks that a computer software program is able to do.	<a href="https://dictionary.cambridge.org/dictionary/english/functionality">https://dictionary.cambridge.org/dictionary/english/functionality</a>
Genetic Algorithms	A genetic algorithm (GA) is an algorithm inspired by the process of natural selection.	<a href="https://en.wikipedia.org/wiki/Genetic_algorithm">https://en.wikipedia.org/wiki/Genetic_algorithm</a>
Hardware	Hardware are the physical parts or components of a computer.	<a href="https://en.wikipedia.org/wiki/Computer_hardware">https://en.wikipedia.org/wiki/Computer_hardware</a>
Heuristic	Heuristic is a strategy derived from previous experiences with similar problems.	<a href="https://en.wikipedia.org/wiki/Heuristic">https://en.wikipedia.org/wiki/Heuristic</a>
High Performance Computing – Super Computing	HPC or Supercomputing is a computer with a high level of performance compared to a general-purpose computer	<a href="https://en.wikipedia.org/wiki/Supercomputer">https://en.wikipedia.org/wiki/Supercomputer</a>
Hyper-parameters	A hyperparameter is a parameter whose value is set before the learning process begins.	<a href="https://en.wikipedia.org/wiki/Hyperparameter_(machine_learning)">https://en.wikipedia.org/wiki/Hyperparameter_(machine_learning)</a>
Inductive Reasoning	Inductive reasoning makes broad generalizations from specific observations.	<a href="https://www.livescience.com/21569-deduction-vs-induction.html">https://www.livescience.com/21569-deduction-vs-induction.html</a>
Internet of Things (IoT)	The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data.	<a href="https://en.wikipedia.org/wiki/Internet_of_things">https://en.wikipedia.org/wiki/Internet_of_things</a>
k-Means	k-means is a clustering algorithm that partitions observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster.	<a href="https://en.wikipedia.org/wiki/K-means_clustering">https://en.wikipedia.org/wiki/K-means_clustering</a>
k-Nearest Neighbors	The simplest clustering algorithm used to classify new data points based on the relationship to nearby data points.	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.
Layers	Neural networks are organized into layers and a layer a set of interconnected nodes.	<a href="http://pages.cs.wisc.edu/~bolo/shipyard/neural/local.html">http://pages.cs.wisc.edu/~bolo/shipyard/neural/local.html</a>
Linear Algebra	Linear algebra is the branch of mathematics concerning linear equations and functions and their representations through matrices and vector spaces. $(x_1, \dots, x_n) \mapsto a_1x_1 + \dots + a_nx_n$	<a href="https://en.wikipedia.org/wiki/Linear_algebra">https://en.wikipedia.org/wiki/Linear_algebra</a>
Logistic Regression	Logistic Regression is used in binary classification to predict two discrete classes.	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.

Term	Description or Definition	Reference
Machine Learning (ML)	Machine learning is a subset of artificial intelligence in the field of computer science that gives computers the ability to learn from data.	<a href="https://en.wikipedia.org/wiki/Machine_learning">https://en.wikipedia.org/wiki/Machine_learning</a>
Model Optimization	The improvement of the output of a machine learning algorithm (e.g. adjusting hyper parameters)	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.
Natural Language Processing (NLP)	Natural language processing (NLP) is an area of artificial intelligence concerned with the interactions between computers and human (natural) languages, in particular how.	<a href="https://en.wikipedia.org/wiki/Natural_language_processing">https://en.wikipedia.org/wiki/Natural_language_processing</a>
Natural Language Understanding (NLU)	Natural language understanding is term used to describe machine reading comprehension	<a href="https://en.wikipedia.org/wiki/Natural_language_understanding">https://en.wikipedia.org/wiki/Natural_language_understanding</a>
Nearest Neighbor Algorithm	The nearest neighbor algorithm was one of the first algorithms used to determine a solution to the travelling salesman problem.	<a href="https://en.wikipedia.org/wiki/Nearest_neighbour_algorithm">https://en.wikipedia.org/wiki/Nearest_neighbour_algorithm</a>
Neural Network (NN)	A Machine Learning Algorithm that is based on a mathematical model of the biological brain	<a href="https://en.wikipedia.org/wiki/Artificial_neural_network">https://en.wikipedia.org/wiki/Artificial_neural_network</a>
Nodes	Nodes represent neurons (biological brain) and are interconnected to form a neural network.	<a href="https://en.wikipedia.org/wiki/Artificial_neural_network">https://en.wikipedia.org/wiki/Artificial_neural_network</a>
One-hot Encoding	Transforms text-based features into a numerical form, e.g. false is given the number zero and true is given the number 1.	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.
Ontology	Ontology is the philosophical study of the nature of being, becoming, existence, or reality, as well as the basic categories of being and their relations.	<a href="https://en.wikipedia.org/wiki/Ontology">https://en.wikipedia.org/wiki/Ontology</a>
Optical Character Recognition (OCR)	Optical character recognition is the conversion of images of typed, handwritten or printed text into machine-encoded text.	<a href="https://en.wikipedia.org/wiki/Optical_character_recognition">https://en.wikipedia.org/wiki/Optical_character_recognition</a>
Over-fitting or Over-training	Overfitting is a machine learning model that is too complex, has high variance and low bias. It is the opposite of Under-fitting or Under-training.	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.
Probabilistic Inference	Probabilistic Inference uses simple statistical data to build nets for simulation and models.	
Probability	Probability is the measure of the likelihood that an event will occur.	<a href="https://en.wikipedia.org/wiki/Probability">https://en.wikipedia.org/wiki/Probability</a>
Pruning	Pruning reduces the size of decision trees.	<a href="https://en.wikipedia.org/wiki/Decision_tree_learning">https://en.wikipedia.org/wiki/Decision_tree_learning</a>
Python	A programming language popular in machine learning	<a href="https://pythonprogramming.net">https://pythonprogramming.net</a>

Term	Description or Definition	Reference
Random Decision Forests	Random decision forests are an ensemble learning method for classification, regression and other tasks.	<a href="https://en.wikipedia.org/wiki/Random_forest">https://en.wikipedia.org/wiki/Random_forest</a>
Random Forests	Random forests are an ensemble learning method or classification, regression and other tasks, that operate by constructing a multitude of decision trees at training time.	<a href="https://en.wikipedia.org/wiki/Random_forest">https://en.wikipedia.org/wiki/Random_forest</a>
Regression Analysis	In machine learning, regression analysis is a simple supervised learning technique used to find a trendline to describe the data.	Machine Learning for Absolute Beginners, Second Edition, ISBN 9781549617218, Oliver Theobald.
Reinforcement Machine Learning	Reinforcement learning (RL) uses software agents that take actions in an environment so as to maximize some notion of cumulative reward.	<a href="https://en.wikipedia.org/wiki/Reinforcement_learning">https://en.wikipedia.org/wiki/Reinforcement_learning</a>
Robotics	Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing.	<a href="https://en.wikipedia.org/wiki/Robotics">https://en.wikipedia.org/wiki/Robotics</a>
Robotic Process Automation (RPA)	Robotic process automation is a business process automation technology based on the notion of software robots or artificial intelligence workers.	<a href="https://en.wikipedia.org/wiki/Business_process_automation">https://en.wikipedia.org/wiki/Business_process_automation</a>
Scripting	Scripting are programs written for a special run-time environment that automate the execution of tasks that could alternatively be executed one-by-one by a human operator.	<a href="https://en.wikipedia.org/wiki/Scripting_language">https://en.wikipedia.org/wiki/Scripting_language</a>
Search	The use of machine learning in search problems, e.g. shortest path	
Semi-supervised Machine Learning	Machine learning that uses labelled and unlabeled data for training.	<a href="https://en.wikipedia.org/wiki/Semi-supervised_learning">https://en.wikipedia.org/wiki/Semi-supervised_learning</a>
Sigmoid Equation	A sigmoid function is a mathematical function having a characteristic "S"-shaped curve or sigmoid curve.	<a href="https://en.wikipedia.org/wiki/Sigmoid_function">https://en.wikipedia.org/wiki/Sigmoid_function</a>
Software	Software is a generic term that refers to a collection of data and computer instructions that tell the computer how to work.	<a href="https://en.wikipedia.org/wiki/Software">https://en.wikipedia.org/wiki/Software</a>
Software Robots	A software robot replaces a function that a human would otherwise do.	<a href="https://en.wikipedia.org/wiki/Robotic_automation_software">https://en.wikipedia.org/wiki/Robotic_automation_software</a>



Term	Description or Definition	Reference
Strong AI or Artificial General Intelligence	Strong AI's goal is the development of artificial intelligence to the point where the machine's intellectual capability is functionally equal to a human's.	<a href="https://www.ocf.berkeley.edu/~arihuang/academic/research/strongai3.html">https://www.ocf.berkeley.edu/~arihuang/academic/research/strongai3.html</a>
Supervised Machine Learning	Supervised machine learning is the task of learning a function that maps an input to an output based on example input-output pairs.	<a href="https://en.wikipedia.org/wiki/Supervised_learning">https://en.wikipedia.org/wiki/Supervised_learning</a>
Support Vector Machine	A support vector machine constructs a hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks like outlier detection.	<a href="https://en.wikipedia.org/wiki/Support_vector_machine#Definition">https://en.wikipedia.org/wiki/Support_vector_machine#Definition</a>
Swarm-intelligence	Swarm intelligence is the collective behavior of decentralized, self-organized systems, natural or artificial	<a href="https://en.wikipedia.org/wiki/Swarm_intelligence">https://en.wikipedia.org/wiki/Swarm_intelligence</a>
Symbolic	Symbolic artificial intelligence is the term for the collection of all methods in artificial intelligence research that are based on high-level "symbolic" (human-readable) representations of problems, logic and search.	<a href="https://en.wikipedia.org/wiki/Symbolic_artificial_intelligence">https://en.wikipedia.org/wiki/Symbolic_artificial_intelligence</a>
System	A regularly interacting or interdependent group of items forming a unified whole.	<a href="https://www.merriam-webster.com/dictionary/system">https://www.merriam-webster.com/dictionary/system</a>
The Fourth Industrial Revolution	The Fourth Industrial Revolution builds on the Digital Revolution, representing new ways in which technology becomes embedded within societies and even the human body.	<a href="https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution">https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution</a>
Turing Machine	A Turing machine is a mathematical model of computation.	<a href="https://en.wikipedia.org/wiki/Turing_machine">https://en.wikipedia.org/wiki/Turing_machine</a>
Un-supervised Machine Learning	Unsupervised machine learning infers a function that describes the structure of unlabeled" data.	<a href="https://en.wikipedia.org/wiki/Unsupervised_learning">https://en.wikipedia.org/wiki/Unsupervised_learning</a>
Under-fitting	Underfitting is when the machine learning model has low variance and high bias. It is the opposite of Over-fitting or Over-training.	<a href="https://en.wikipedia.org/wiki/Overfitting#Underfitting">https://en.wikipedia.org/wiki/Overfitting#Underfitting</a>
Universal Design	Universal design (close relation to inclusive design) refers to broad-spectrum ideas meant to produce buildings, products and environments that are inherently accessible to older people, people without disabilities, and people with disabilities.	<a href="https://en.wikipedia.org/wiki/Universal_design">https://en.wikipedia.org/wiki/Universal_design</a>



Term	Description or Definition	Reference
Validation Data	A set of data used to test the output of a machine learning model that is not used to train the model.	Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurélien Géron, O'Reilly, 2017, ISBN 1491962291.
Variance	Variance is the expectation of the squared deviation of a random variable from its mean.	<a href="https://en.wikipedia.org/wiki/Variance">https://en.wikipedia.org/wiki/Variance</a>
Visualization	Visualization is any technique for creating images, diagrams, or animations to communicate a message.	<a href="https://en.wikipedia.org/wiki/Visualization_(graphics)">https://en.wikipedia.org/wiki/Visualization_(graphics)</a>
Weak AI or Narrow AI	Weak artificial intelligence (weak AI), also known as narrow AI, is artificial intelligence that is focused on one narrow task. It is the contrast of Strong AI.	<a href="https://en.wikipedia.org/wiki/Weak_AI">https://en.wikipedia.org/wiki/Weak_AI</a>
Weights	A weight function is a mathematical device used when performing a sum, integral, or average to give some elements more "weight" or influence on the result than other elements in the same set.	<a href="https://en.wikipedia.org/wiki/Weight_function">https://en.wikipedia.org/wiki/Weight_function</a>

## 4. Levels of Knowledge / SFIA Levels

This syllabus will provide candidates with the levels of difficulty highlighted within the following table, also enabling them to develop the skills to operate at the highlighted level of responsibility (as defined within the SFIA framework) within their workplace. The levels of knowledge and SFIA levels are further explained on [certifications.bcs.org](https://certifications.bcs.org).

Level	Levels of Knowledge	Levels of Skill and Responsibility (SFIA)
7		Set strategy, inspire and mobilize
6	Evaluate	Initiate and influence
5	Synthesize	Ensure and advise
4	Analyze	Enable
3	Apply	Apply
2	Understand	Assist
1	Remember	Follow

## 5. e-CF Mapping

The mapping of this exam against the [e-Competence Framework](#).

competence is covered
  partial coverage
  superficial coverage

e-Competence Level		1	2	3	4	5
<b>A.7.</b>	Technology Trend Monitoring					
<b>A.10.</b>	User Experience					
<b>B.4.</b>	Solution Deployment					
<b>B.6.</b>	Systems Engineering					
<b>D.7.</b>	Data Science and Analytics					

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## 6. Literature

### Exam Literature

The knowledge required for the exam is covered in the following literature:

- A. Paul R. Daugherty and H. James Wilson  
**Human + Machine - Reimagining Work in the Age of AI**  
Harvard Business Review Press (2018)  
ISBN: 9781633693869
- B. High-Level Expert Group on Artificial Intelligence  
**Ethics Guidelines for Trustworthy AI**  
European Commission B-1049 Brussels (April 2019)
- C. Stuart Russell and Peter Norvig  
**Artificial Intelligence, A Modern Approach (3rd edition)**  
Pearson (2016)  
ISBN: 9781292153964 (paperback)
- D. Aurélien Géron  
**Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**  
O'Reilly (2017)  
ISBN: 9781491962299
- E. Ray Kurzweil  
**The Singularity is Near**  
Duckworth Overlook (2005)  
ISBN: 9780715635612
- F. Klaus Schwab  
**The Fourth Industrial Revolution**  
Penguin Random House (2016)  
ISBN: 9780241300756

### Additional Literature – Specialist Reference List

- G. Gilbert Strang  
**Linear Algebra and Learning from Data**  
Wellesley-Cambridge Press (1<sup>st</sup> edition, 2019)  
ISBN: 9780692196380
- H. Gilbert Strang  
**An Introduction to Linear Algebra**  
Wellesley-Cambridge Press (5<sup>th</sup> edition, 2016)  
ISBN: 9780980232776

- I. James Lovelock  
**Novacene: The Coming of Age of Hyperintelligence**  
Allen Lane - Penguin (2019)  
ISBN: 9780241399361
  
- J. John R. Searle  
**The Mystery of Consciousness**  
The New York Review of Books (1997)  
ISBN: 9780940322066
  
- K. The Royal Society  
**Machine Learning**  
<https://royalsociety.org/topics-policy/projects/machine-learning/>
  
- L. Tom Mitchell  
**Machine Learning**  
McGraw-Hill (1997)  
ISBN: 9780071154673
  
- M. Max Tegmark  
**Life 3.0**  
Penguin Books (2017)  
ISBN: 9780141981802
  
- N. David Chalmers  
**The Conscious Mind**  
Oxford University Press (1996)  
ISBN: 9780195117899
  
- O. Sir David JC Mackay  
**Sustainable Energy – without hot air**  
UIT Cambridge Ltd. (2009)  
ISBN: 9780954452933
  
- P. Mike Berners-Lee  
**How Bad are Bananas? – The Carbon Footprint of Everything**  
Profile Books Ltd. (2010)  
ISBN: 9781846688911
  
- Q. Kevin P. Murphy  
**Machine Learning – A Probabilistic Perspective**  
MIT (2012)  
ISBN: 9780262018029
  
- R. Malik Ghallab, Dana Nau and Paolo Traverso  
**Automated Planning Theory and Practice**  
Elsevier (2004)  
ISBN: 9781558608566
  
- S. Keith Frankish and William Ramsey  
**The Cambridge Handbook of Artificial Intelligence**  
Cambridge University Press (2014)  
ISBN: 9780521691918

- T. Lasse Rouhiainen  
**Artificial Intelligence: 101 Things You Must Know Today About Our Future**  
CreateSpace Independent Publishing Platform (2018)  
ISBN: 9781982048808
  
- U. Frederick P. Brooks, JR., Addison Wesley  
**The Mythical Man Month**  
Addison-Wesley Longman (1995)  
ISBN: 9780201835953
  
- V. Shai Shalev-Shwartz; Shai Ben-David  
**Understanding Machine Learning: From Theory to Algorithms**  
Cambridge University Press (2014)  
<https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/>  
ISBN: 9781107057135
  
- W. Oliver Theobald  
**Machine Learning for Absolute Beginners: A Plain English Introduction**  
*Independently published* (2<sup>nd</sup> edition, 2017)  
ISBN: 9781549617218

### Comment

Additional literature is for reference and depth of knowledge only.





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