EXIN BCS Artificial Intelligence

ESSENTIALS

Certified by EXIN

Preparation Guide

Edition 201905

Content

1. Overview

EXIN BCS Artificial Intelligence Essentials (AIE.EN)

Scope

Candidates should be able to demonstrate a basic knowledge and understanding of general concepts in the following areas:

- Human and Artificial Intelligence
- The Machine Learning process
- The benefits, challenges and risks of a Machine Learning project
- The future of humans and machines in Work

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 Essentials exam tests a candidate's knowledge and understanding of the terminology and the general principles. This syllabus covers the potential benefits; types of Artificial Intelligence; the basic process of Machine Learning (ML); the challenges and risks associated with an AI project, and the future of AI and Humans in work.

Context

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

Target Group

The Artificial Intelligence Essentials certificate 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, 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 Essentials exam.

Examination Details

Examination type:	Multiple-choice Questions
Number of questions:	20
Pass mark:	65% (13 / 20 questions)
Open book/notes:	No
Electronic equipment/aides permitted:	No
Exam duration:	30 minutes

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

Bloom level

The EXIN BCS Artificial Intelligence Essentials 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 6. 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

30 hours, depending on existing knowledge.

Training Organization

You can find a list of our Accredited Training Organizations at 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
1. Artificial and Human Intelligence: An Introduction and History		**25%**
	1.1 Recall the general definition of human and Artificial Intelligence (AI)	
	1.2 Describe 'learning from experience' and how it relates to Machine Learning (ML) (Tom Mitchell's explicit definition)	
	1.3Understand that ML is a significant contribution to the growth of Artificial Intelligence	
	1.4Describe how AI is part of 'Universal Design,' and 'The Fourth Industrial Revolution'	
2. Examples of AI: Benefits, Challenges and Risks		**30%**
	2.1 Explain the benefits of Artificial Intelligence	
	2.2 Describe the challenges of Artificial Intelligence	
	2.3 Demonstrate understanding of the risks of Artificial Intelligence	
	2.4 Identify a typical funding source for AI projects	
	2.5 List opportunities for AI	
3. An introduction to Machine Learning		**35%**
	3.1 Demonstrate understanding of the AI intelligent agent description	
	3.2 Give typical examples of Machine Learning	
	3.3 Recall which typical, narrow AI capability is useful in ML and AI agents' functionality	
	3.4 Describe and give examples of forms of ML	
	3.5 Describe the basic schematic of a neutral network	
4. The Future of Artificial Intelligence – Human and Machine Together		**10%**
	4.1 Demonstrate an understanding that Artificial Intelligence (in particular Machine Learning) will drive humans and machines to work together	
	4.2 List future directions of humans and machines working together	
	Total	**100%**

Exam Specifications

1. **Artificial and Human Intelligence: An Introduction and History**
   The candidate can…
   - 1.1 recall the general definition of human and Artificial Intelligence (AI).
   - 1.2 describe 'learning from experience' and how it relates to Machine Learning (ML) (Tom Mitchell's explicit definition).
   - 1.3 understand that ML is a significant contribution to the growth of Artificial Intelligence.
   - 1.4 describe how AI is part of 'Universal Design,' and 'The Fourth Industrial Revolution'.

2. **Examples of AI: Benefits, Challenges and Risks**
   The candidate can…
   - 2.1 explain the benefits of Artificial Intelligence, and
     - 2.1.1 list advantages of machine and human and machine systems;
   - 2.2 describe the challenges of Artificial Intelligence, and give:
     - 2.2.1 general examples of the limitations of AI compared to human systems,
     - 2.2.2 general ethical challenges AI raises.
   - 2.3 demonstrate understanding of the risks of Artificial Intelligence, and
     - 2.3.1 give at least one a general example of the risks of AI;
   - 2.4 identify a typical funding source for AI projects;
   - 2.5 list opportunities for AI.

3. **An introduction to Machine Learning**
   The candidate can…
   - 3.1 demonstrate understanding of the AI intelligent agent description, and:
     - 3.1.1 identify the differences with Machine Learning (ML), and:
     - 3.1.2 list the four rational agent dependencies,
     - 3.1.3 describe agents in terms of performance measure, environment, actuators and sensors,
     - 3.1.4 describe four types of agent: reflex, model-based reflex, goal-based and utility-based.
   - 3.2 give typical examples of Machine Learning in the following contexts:
     - 3.2.1 business,
     - 3.2.2 social (media, entertainment),
     - 3.2.3 science.
   - 3.3 recall which typical, narrow AI capability is useful in ML and AI agents' functionality;
   - 3.4 describe and give examples of the following forms of ML:
     - 3.4.1 supervised,
     - 3.4.2 unsupervised,
     - 3.4.3 reinforcement.
   - 3.5 describe the basic schematic of a neutral network.

4. **The Future of Artificial Intelligence – Human and Machine Together**
   The candidate can…
   - 4.1 demonstrate an understanding that Artificial Intelligence (in particular Machine Learning) will drive humans and machines to work together;
   - 4.2 list future directions of humans and machines working together.

3. List of Basic Concepts

Abbreviations

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

Glossary of Terms

Term	Description or Definition
Activation Function	The activation function defines the output of a node given an input or set of inputs.
Agent Modelling	An intelligent agent (IA) is autonomous, observes through sensors and acts on its environment using actuators.
Algorithm	An algorithm is an unambiguous specification of how to solve a class of problems.
Artificial Intelligence (AI)	A branch of computer science dealing with the simulation of intelligent behavior in computers.
Automation	Automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor.
Autonomous	Undertaken or carried on without outside control
Axon	An axon is a long, slender projection of a nerve cell, or neuron, that typically conducts electrical impulses.
Axon Terminals	Axon terminals are terminations of the telodendria (branches) of an axon.
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.
Bayesian Network	A Bayesian network or belief network is a probabilistic graphical model that represents a set of variables and their conditional dependencies.
Bias	Deviation of the expected value of a statistical estimate from the quantity it estimates.

Term	Description or Definition
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.
Boosting	Boosting is an ensemble meta-algorithm for reducing bias, and also variance in supervised learning and family algorithms that convert weak learners to strong ones.
Bootstrap Aggregating – Bagging	Bootstrap aggregating, is an ensemble meta-algorithm used in statistical classification and regression.
Chatbot	A chatbot is an artificial intelligence program that conducts a conversation via auditory or textual methods.
Classification	Classification is the problem of identifying to which of a set of classes a new observation belongs.
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.
Cognitive Simulation	Cognitive simulation uses computers that test how the human mind works.
Combinatorial Complexity	Is the exponential growth in computer power required to solve a problem that has many combinations with increasing complexity.
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.
Connectionist	Cognitive science that hopes to explain intellectual abilities using artificial neural networks.
Data Analytics	The discovery, interpretation, and communication of meaningful patterns in data.
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.
Data Mining	The process of discovering patterns in large data sets.
Data Science	Data science uses scientific methods, processes, algorithms and systems to understand data.
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.
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.
Dendrites	Dendrites are branched extensions of a nerve cell that propagate the electrochemical stimulation.
Edges	Edges are the machine learning name for the brain's axons
Emotional Intelligence or Emotional Quotient (EQ)	The understanding of our emotions and the emotions of others.
Ensemble	Ensemble methods use multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent learning algorithms alone.
Expert Systems	An expert system is a computer system that emulates the decision-making ability of a human expert.
Feedforward Neural Network	A feedforward neural network is an artificial neural network wherein connections between the nodes do not form a cycle.

Term	Description or Definition
Functionality	The tasks that a computer software program can do
Genetic Algorithms	a genetic algorithm (GA) is an algorithm inspired by the process of natural selection.
Hardware	Hardware are the physical parts or components of a computer.
Heuristic	Heuristic is a strategy derived from previous experiences with similar problems.
High Performance Computing – Super Computing	HPC or Supercomputing is a computer with a high level of performance compared to a general-purpose computer.
Hyper-parameters	A hyperparameter is a parameter whose value is set before the learning process begins.
Inductive Reasoning	Inductive reasoning makes broad generalizations from specific observations.
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.
Intelligent Quotient (IQ)	Is a standard test of intelligence.
k-Means	k-Means is a clustering algorithm that partitions observations into k clusters, where each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster.
k-Nearest Neighbors	The simplest clustering algorithm used to classify new data points based on the relationship to nearby data points.
Layers	Neural networks are organized into layers and a layer is a set of interconnected nodes.
Linear Algebra	Linear algebra is the branch of mathematics concerning linear equations and functions and their representations through matrices and vector spaces.
Logistic Regression	Logistic Regression is used in binary classification to predict two discrete classes.
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.
Model Optimization	The improvement of the output of a machine learning algorithm (e.g. adjusting hyper parameters).
Natural Language Processing (NLP)	Natural Language Processing (NLP) is an area of artificial intelligence concerned with the interactions between computers and human (natural) languages, and how these happen.
Natural Language Understanding (NLU)	Natural Language Understanding is the term used to describe machine reading comprehension.
Nearest Neighbor Algorithm	The Nearest Neighbor Algorithm was one of the first algorithms used to determine a solution to the travelling salesman problem.
Neural Network (NN)	A Machine Learning Algorithm that is based on a mathematical model of the biological brain.
Nodes	Nodes represent neurons (biological brain) and are interconnected to form a neural network.
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.
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.
Optical Character Recognition (OCR)	Optical Character Recognition is the conversion of images of typed, handwritten or printed text into machine-encoded text.

Term	Description or Definition
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.
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.
Pruning	Pruning reduces the size of decision trees.
Python	A programming language popular in machine learning.
Random Decision Forests	Random Decision Forests are an ensemble learning method for classification, regression and other tasks.
Random Forests	Random Forests are an ensemble learning method for classification, regression and other tasks, that operate by constructing a multitude of decision trees at training time.
Regression Analysis	In machine learning, regression analysis is a simple, supervised learning technique used to find a trendline to describe the data.
Reinforcement Machine Learning (RL)	Reinforcement Learning (RL) uses software agents that take actions in an environment to maximize some notion of cumulative reward.
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.
Robotic Process Automation (RPA)	Robotic Process Automation is a business process automation technology based on the notion of software robots or artificial intelligence workers.
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.
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.
Sigmoid Function	A sigmoid function is a mathematical function having a characteristic "S"-shaped curve or sigmoid curve.
Software	Software is a generic term that refers to a collection of data and computer instructions that tell the computer how to work.
Software Robots	A software robot replaces a function that a human would otherwise do.
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.
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.
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.
Swarm Intelligence (SI)	Swarm Intelligence is the collective behavior of decentralized, self-organized systems, natural or artificial

Term	Description or Definition
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.
System	A regularly interacting or interdependent group of items forming a unified whole.
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.
Turing Machine	A Turing machine is a mathematical model of computation.
Unsupervised Machine Learning	Unsupervised Machine Learning infers a function that describes the structure of unlabeled data.
Underfitting	Underfitting is when the machine learning model has low variance and high bias. It is the opposite of Overfitting or Overtraining.
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.
Validation Data	A set of data used to test the output of a machine learning model that is not used to train the model.
Variance	Variance is the expectation of the squared deviation of a random variable from its mean.
Visualization	Visualization is any technique for creating images, diagrams, or animations to communicate a message.
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.
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.

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.

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
A.7.	Technology Trend Monitoring					
A.10.	User Experience					
B.4.	Solution Deployment					
B.6.	Systems Engineering					
D.7.	Data Science and Analytics					

6. Literature

Exam Literature

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

Artificial Intelligence and Consciousness

A. Stuart Russell and Peter Norvig
Artificial Intelligence, A Modern Approach
Pearson (2016, 3rd Edition)
ISBN: 1292153962

B. Keith Frankish and William Ramsey
The Cambridge Handbook of Artificial Intelligence
Cambridge University Press (2014)
ISBN: 978-0-521-69191-8

C. David Chalmers
The Conscious Mind
Oxford University Press (1996)
ISBN: 978-0-19-511789-9

D. Max Tegmark
Life 3.0
Penguin Books (2017)
ISBN: 978-0-141-98180-2

Machine Learning

E. Tom Mitchell
Machine Learning
McGraw-Hill (1997)
ISBN: 0071154671

F. Oliver Theobald
Machine Learning for Absolute Beginners: A Plain English Introduction
Independently Published (2017, 2nd Edition)
ISBN: 1549617214

High Level / Management Consultant View of Machine Learning

G. Klaus Schwab
The Fourth Industrial Revolution
Penguin Random House (2016)
ISBN: 978-0-241-30075-6

H. Paul R. Daugherty and H. James Wilson
Human + Machine - Reimagining Work in the Age of AI
Harvard Business Review Press (2018)
ISBN: 1633693869

High Level / Research and Political View of Machine Learning

I. The Royal Society
Machine Learning
https://royalsociety.org/topics-policy/projects/machine-learning/

Professional Development of Machine Learning Algorithms and Planning

J. Aurélien Géron
Hands-On Machine Learning with -Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems
O'Reilly (2017)
ISBN: 1491962291

K. Kevin P. Murphy
Machine Learning – A Probabilistic Perspective
MIT (2012)
ISBN: 0262018020

Additional Literature

L. Ray Kurzweil
The Singularity is Near
Duckworth Overlook (2005)
ISBN: 978-0715635612

M. Frederick P. Brooks, JR.
The Mythical Man Month
Addison Wesley (1995)
ISBN: 0-201-83595-9

N. Lasse Rouhiainen
Artificial Intelligence: 101 Things You Must Know Today About Our Future
CreateSpace Independent Publishing Platform (2018)
ISBN: 1982048808

Comment

Additional literature is for reference and depth of knowledge only.

Contact EXIN

www.exin.com

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