



ICDL Module Artificial Intelligence

Syllabus Version 1.0

Purpose

This document details the syllabus for the Artificial Intelligence module. The syllabus describes, through learning outcomes, the knowledge and skills that a candidate for the Artificial Intelligence should possess. The syllabus also provides the basis for the theory and practice-based test in this module.

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Artificial Intelligence Module

This module provides a broad understanding of the Artificial Intelligence (AI) fields and the techniques used to understand how AI is applied to different scenarios and problems.

Module Goals

After studying this Module, candidates should be able to:

- Explain "Artificial Intelligence" and how to identify systems using Artificial Intelligence.
- Differentiate among the major types and methodologies used in Artificial Intelligence.
- Explain how Artificial Intelligence enables capabilities that are beyond conventional technology.
- Characterise the goals of AI and the approaches and progress used in achieving these objectives.
- Describe the contributions and applications of artificial intelligence.
- Describe the key components of the artificial intelligence (AI) fields.
- Explain the role of Artificial Intelligence Agents and how they relate to the environment, including the ways to evaluate how agents act by establishing goals.
- Understand the fundamentals of knowledge representation, reasoning techniques, and know how to build simple knowledge-based systems.
- Understand how Artificial Intelligence is implemented in the real world.
- Define what are rule-based systems, statistical inferences, and fuzzy expert systems.
- Be familiar with some of the basic learning algorithms and techniques.
- Understand how Machine Learning (ML) is implemented in the real world.
- Understand the fundamentals of "deep learning" and how it works.
- Understand the role of Artificial Intelligence to analyse "Big data."
- Explain the basics of Artificial Intelligence Platforms and how they are used.

CATEGORY	SKILL SET	REF.	TASK ITEM
1 Fundamental Concepts of Artificial Intelligence	1.1 Introduction to Artificial Intelligence	1.1.1	Recognise the meaning of Artificial Intelligence (AI).
		1.1.2	Define the term "Intelligence" and recognise its components, like reasoning, learning, and problem-solving. Also, be able to identify human intelligence.
		1.1.3	Understand the definitions of Artificial Intelligence, describing its four main categories; reactive machines, limited memory, the theory of mind, and self-awareness.
		1.1.4	Identify the disciplines of Artificial Intelligence such as computer science, philosophy, mathematics, and neuroscience.

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		1.1.5	Outline the history of Artificial Intelligence starting from the gestation of Artificial Intelligence, the birth of AI, followed by early enthusiasm and great expectations, until the present time.
		1.1.6	Identify the main goals of Artificial Intelligence and how they are related to each other, such as reasoning, knowledge representation of data, perception and the ability to move objects. This also includes the ability to plan, learn, and Natural Language Processing.
	<i>1.2 Basic Concepts of Artificial Intelligence</i>	1.2.1	Understand Artificial Intelligence methods as cognitive science, laws of thought, and using the Turing test.
		1.2.2	Recognise the differences between strong, weak, narrow, and broad AI.
		1.2.3	Understand types of Artificial Intelligence algorithms, such as symbolic reasoning, connections modelled on the brain's neurons, Bayesian Inference, and other systems that learn by analogy.
		1.2.4	Outline the major branches of Artificial Intelligence like pattern recognition, knowledge representation, heuristics, and learning.
		1.2.5	Identify the major domain fields of Artificial Intelligence, like machine learning and natural language processing, and the classification of each field. Explain the difference between speech and voice recognition, and present samples of AI field Applications.
		1.2.6	Define the term "Graphics Processing Unit" and Recognise the challenges when AI is applied.
		1.2.7	Outline the most popular AI programming languages and understand the purposes of each language.
	<i>1.3 Agents and Environments</i>	1.3.2	Understand the concepts of rationality and its terminologies Learn and Autonomy.
		1.3.3	Understand environment properties like Observable vs. Partially Observable and define the differences between them.

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2 Expert and Fuzzy Logic Systems	2.1 Introduction to Expert and Fuzzy Logic Systems	1.3.4	Understand the agency types such as Simple Reflex, Model-Based Reflex, Goal-Based and Utility-Based agents. Students should be able to create a model for each type and identify a learning model.
		2.1.1	Understand the base agents that can form representations of a complex world, and identify the meaning of expertise.
		2.1.2	Understand the core of artificial intelligence research and identify an analysis to distinguish between “knowledge-how” and “knowledge-that.” Outline the classifications of the terms Optimal solution, Satisficing solution, and Probable solutions. Understand how to generate conclusions from available knowledge using logical techniques. Recognise how to establish a link between various knowledge representations.
	2.2 Fundamentals of Expert System	2.1.3	Understand the system that provides a methodology for reasoning about information in the knowledge base. Comprehend the hierarchical data structure, and engine strategies “forward chaining” and “backward chaining.”
		2.2.1	Outline and understand the different definitions of an Expert System like functional and structural components; Knowledge Acquisition Subsystem, and Blackboard Structure. Also, understand Subsystem and Knowledge-Refining System.
		2.2.2	Outline and understand the relationship between the typical components of an expert system like Inference Engine, Knowledge Base, and User Interface (Acquisition Module).
		2.2.3	Understand the process of extracting, structuring and organise knowledge from various sources and how to store it in the knowledge base to build a global architecture of an expert system.
		2.2.4	Outline the main capabilities of Expert Systems
		2.2.5	Identify the Characteristics of Expert Systems.
		2.2.6	Distinguish between Conventional Systems and Expert Systems.
		2.2.7	Outline the main advantages and disadvantages of an Expert System, and the best application usages.

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3 Natural Language Processing (NLP)	2.3 Concepts of Fuzzy Logic system	2.2.8	Understand the steps to develop an Expert System.
		2.2.9	Apply an Expert System to classify an unknown animal, based on a question and answer dialogue between the system and the user.
		2.2.1	Understand one of the first Expert Systems to perform at the level of a skilled human expert. Then, provide users with a complete explanation of its logical reasoning, named MYCIN, and Recognise the components to identify bacteria that is causing severe infections.
		2.3.1	Understand a new method (system) of reasoning that resembles human reasoning, based on intermediate possibilities between digital values YES and NO. Identify its main Architecture.
		2.3.2	Recognise the process of changing a real scalar value into a “fuzzy value” and “fuzzy sets” obtained by an inference engine.
		2.3.3	Outline the major advantages and disadvantages of “fuzzy logic.”
	3.1 Understand Natural Language Processing	2.3.4	Outline the major applications and understand how they are implemented in several fields.
		3.1.1	Recognise the first use of computers to manipulate Natural Language Processing (NLP), followed by the development up to the present day.
		3.1.3	Outline the steps and understand with examples, how to programme computers to process and analyse large amounts of natural language data, such as Lexical Analysis, Parsing, and Semantic Analysis.
		3.1.4	Understand the major components of NLP to encompass anything a computer needs to understand natural language (typed or spoken). Also, how to generate the natural language, named Natural Language Processing and Natural Language Generation.
		3.1.5	Outline the major stages to build Natural Language Processing like recognition/ conversion, and segmentation/ parsing.
		3.1.6	Understand the two main tasks of NLP: Text Processing, and Speech Processing. Identify the major tasks of text processing such as Word Analysis, Stemming/Lematisation, and Syntactical Parsing. Outline the Fundamental Tasks of Speech Recognition and Text to Speech.

CATEGORY	SKILL SET	REF.	TASK ITEM
4 Artificial Neural Networks (ANN)	4.1 Introduction to Artificial Neural Networks (ANN)	3.1.7	Outline the strengths and weakness of Natural Language Processing (NLP).
		4.1.1	Recognise the simple biological structure of a neural network and its characteristics. Outline the concepts of Artificial Neural Networks (ANN) related to neural network and distinguish between Biological Neurons and Artificial Neurons.
		4.1.2	Distinguish between Biological Neurons and Artificial Neurons.
	4.2 Basic Concepts of Artificial Neural Networks (ANN)	4.1.3	Outline the Characteristics of an Artificial Neural Network (ANN).
		4.2.1	Understand how several neurons are arranged, or placed, in relation to each other artificially. Understand the concept of layers, and the two topologies named “Feedforward” and “Feedback” to flow information and the connectivity of Neuron.
		4.2.2	Outline the major components of a typical neural network like neurons, connections, weights, biases, propagation function, and a learning rule. Understand how connections established to indicates the pathway for the flow of information, showing the analogy between biological and Artificial Neural Network.
		4.2.3	Outline the reasons why neural networks are used. Recognise different fields ANN can perform that are easy for a human but difficult for a machine.
5 Concepts of Virtual Agents Learning	5.1 Key Elements of Virtual Agents Learning	5.1.1	Define why an agent is favoured to learn.
		5.1.2	Understand the 3 types of data (training, validation, and testing), and the need to a model (Platform) that simulates cognitive functions that human mind perform, like learning, problem-solving and reasoning.
	5.3 Machine Learning (ML) Categories/Types	5.2.1	Understand Reinforcement Learning and how to allow machines and software agents to automatically determine the ideal behaviour within a specific context and Recognise its components.
		5.2.2	Understand another task of learning function that maps an input to an output based on training data (Supervised Learning). Outline the two categories algorithms of supervised learning; Regression and Classification. Identify the procedure where the training set is given as input to the system. Distinguish between Supervised and Reinforcement learning.

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6 Deep Learning	5.3 How does Machine Learning (ML) work?	5.2.3	Understand Unsupervised Learning and its two categories of algorithms, named Clustering and Association. Identify the process of Unsupervised Learning, and understand the difference between Supervised and Unsupervised Learning.
		5.2.4	Understand how Decision Tree Induction is implemented as learning by example. Recognise its two parts, named Classification and Regression.
		5.3.1	Outline the Machine Learning (ML) terminology, like model, training, and prediction. List the relation between them. Understand the differences between Machine Learning and Deep Learning.
		5.3.2	Create a model to understand how, in general, Machine Learning works. Outline as a summary Machine Learning types, and the applications.
		5.3.3	Outline the obvious problems that we can face when Machine Learning is implemented, assembled on the basis of the nature of learning and the desired output.
	6.1 The Essentials of Deep Learning	5.3.4	List the differences between Machine Learning and Artificial Intelligence.
		6.1.1	Understand the main concepts of Deep Learning as a subfield of Machine Learning, and when it started. Define the major tasks, with real examples, that Deep Learning supports today and tomorrow, like Virtual Assistants, Translation, and the vision for Driverless, Facial Recognition, Speech Recognition, Instant Visual Translation, etc.
		6.1.2	Create and understand the processing steps of Deep Learning. Identify the training for Neural Network Algorithms, and the sequential approach of Neural Networks.
		6.1.3	Understand in steps of how Deep Learning works by using two cases: Image Recognition and how to Recognise handwriting numbers.
		6.1.4	Identify Tensor Flow as one of the common AI platforms. Tensor Flow uses data flow graphs to build models, which is used for Machine Learning applications, and specifically neural networks. Outline a model as an example using Google Smart Shopping navigator.

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		6.1.5	Understand the major differences between Machine Learning and Deep Learning and Recognise how Deep Learning overcome the limitations of Machine Learning.
		6.1.6	Outline recent examples of how Deep Learning is implemented in practice that will help to visualise its potential such as Automatic Colorisation, Automatic Machine Translation, Automated Video Surveillance, and Marketing.
7 Robotic Process	7.1 Key Concepts of Robotic Process Automation	7.1.1	Understand the term Robotics Process Automation.
		7.1.2	Identify main benefits when using Robotics Process Automation like scalability and resiliency in a cost-effective way.
		7.1.3	Recognise the characteristics of Robotic Process Automation, such as “Emulates humans” and “can be trained.”
		7.1.4	Distinguish between Robot System and Other AI programmes.
		7.1.5	List the major types of Robot like Manipulators, Legged and wheeled Robots.
		7.1.6	Recognise the first robot and when it was created, followed by the improved robots with a focus on Industrial robots.
	7.2 How Does a Robot Work?	7.2.1	Understand the necessary components needed to design and build a robot, such as the locomotion, actuator, sensor, and control system. Create a diagram to show the relationship between all the components.
		7.2.2	Understand the Locomotion mechanism and its various parts like “legged” and “wheeled.” Define the number of movements based on the number of robot legs.
		7.2.3	Define what Robotics need to understand visual information in order to perform a useful function. Including automatically extracting, analysing, and comprehending useful information from a single image or an array of an image.
	7.3 Robotics in Life	7.3.1	Understand the most advanced robots with its body shape built to resemble the human body. Also, human-like information processing and the underlying mechanisms of the human brain in dealing with the real world. Outline the recent names and the functional purposes of each like NAO-Bot, Ocean-One, Sofia, ATLAS, and ARMAR-III.

CATEGORY	SKILL SET	REF.	TASK ITEM
8 Big Data Analytics	8.1 Concepts of Big Data	7.3.2	Define the Robot Processing Automation software categories (Basic, Enchanted and Cognitive automation) and the major domains it uses.
		8.1.1	Understand the term “Big Data,” and define the current volume of data use.
		8.1.2	Understand why “Big Data” has become too complex and too dynamic to be able to process, store, analyse and manage with traditional data tools, due to various types of sources like activity, conversion, social media, video, and sensor data.
		8.1.3	Define and understand in most Big Data circles, the four V's: Volume, Variety, velocity and veracity. Understand why it should turn into value.
		8.1.4	Recognise the two types of Big Data: Structured and Unstructured.
	8.2 Big Data Analytics	8.1.5	Identify the concept of storage repository that holds a vast amount of raw data in its native flat architecture. Outline the main features of “Data Lakes.”
		8.2.1	Understand the term Analytics.
		8.2.2	Understand the four types of data analysis that reveals what actions should be taken: Diagnostic, Descriptive, Predictive and Prescriptive, and define the relationship between them.
	8.3 Overview of Analytics Tools	8.2.3	Outline the critical factors that affect Big Data Analytics, like strong, committed and the right analytics tools.
		8.3.1	Identify the various types of technologies to handle “Big Data” like Map Reduce.
		8.3.2	Recognise the popular framework for storing and processing large amounts of data using distributed computing called Hadoop and define its advantages.
	8.4 The Use of Big Data	8.3.3	Recognise and create layers of analytics.
		8.4.1	Understand why Big Data is a powerful tool that makes things easier in various fields and used in many applications like inferring knowledge, improving health, Security and Law Enforcement and optimising cities and countries.

CATEGORY	SKILL SET	REF.	TASK ITEM
9 Artificial Intelligence (AI) Platforms	9.1 Overview of Platform Types	9.1.1	Identify the meaning of the term Platform.
		9.1.2	Understand the basic architecture of Amazon Web Services (AWS). Identify the capabilities of its Machine Learning Artificial Intelligence Platform and the fields it can use.
		9.1.3	Define the main four parts of Azure Platform that offer largely basic capabilities around flexible computer storage and networking, and AI Services. Understand the capabilities of AI services such as Cognitive, Bot, and Machine Learning services.