Knowledge-Based Systems

BCS Foundation Award

The Chartered Institute for IT

September 2020 v1.0

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Document Change History

Any changes made to the syllabus shall be clearly documented with a change history log. This shall include the latest version number, date of the amendment and changes made. The purpose is to identify quickly what changes have been made.

Version Number	Changes Made
V1.0	Document Creation

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Introduction

The BCS Foundation Award in Knowledge-Based Systems is designed for anyone wishing to gain an understanding of the principles of Knowledge-Based Systems and how they can be used to complement other AI technologies such as Machine Learning.

Knowledge-Based Systems are designed to capture human expertise in order to enable AI applications to make intelligent decisions. Through completion of this award candidates will have the ability to recognise Knowledge-Based Systems, gain an understanding of how they work, and consider how they can add value to an organisation. This award will also enable candidates to understand the concept of Uncertainty and Fuzzy Logic, and how Knowledge-Based Systems can be used to help organisations to make decisions and act where there is higher level of uncertainty.

Qualification Suitability and Overview

There are no specific entry requirements for this award. However, some professional experience in a business or IT environment may be advantageous.

The BCS Foundation Award in Knowledge-Based Systems has been designed for individuals interested in furthering their understanding of the more technical aspects of AI, and how knowledge-based intelligence can be used to compliment more modern AI techniques such as Machine Learning.

This award has been created alongside a selection of other awards in the AI space which offer candidates a clear pathway of progression into other disciplines of IT along with a broader knowledge of AI in the workplace. This makes it ideally suited for those looking for a change in career, an upskilling workforce, sustainable employers and individuals with a background in: science, engineering, knowledge engineering, finance, education or IT services.

This award represents 5 credits that can count towards the credits required for a BCS Foundation Certificate or Diploma in a relevant discipline.

Candidates can study for this award by attending a training course provided by a BCS accredited Training Provider or through self study.

Total Qualification Time	Guided Learning Hours	Independent Learning	Assessment Qualification Time	Credits
50 hours	16 hours	33.5 hours	0.5 hours	5

*Examples of Independent Learning include reading of articles or books, watching videos, attendance of other types of training or work shadowing.

Trainer Criteria

It is recommended that to effectively deliver this award, trainers should possess:

- BCS Foundation Certificate in Artificial Intelligence or a similar qualification.
- A minimum of 2 years' training experience or a recognised training qualification.

SFIA Levels

This award provides candidates with the level of knowledge highlighted within the table, enabling candidates to develop the skills to operate successfully at the levels of responsibility indicated.

Level	Levels of Knowledge	Levels of Skill and Responsibility (SFIA)
K7		Set strategy, inspire and mobilise
K6	Evaluate	Initiate and influence
K5	Synthesise	Ensure and advise
K4	Analyse	Enable
K3	Apply	**Apply**
K2	**Understand**	**Assist**
K1	**Remember**	**Follow**

SFIA Plus

This syllabus has been linked to the SFIA knowledge skills and behaviours required of an individual working at level 3;

KSD43

Methods and techniques for ensuring valid results are obtained by means of sampling.

KSC86

Analytical, statistical and machine learning tools appropriate to the organisational environment. Able to apply these tools and techniques to meet the requirements of stakeholders. Examples, but not limited to: search routines and completion algorithms.

Further detail around the SFIA Levels can be found at www.bcs.org/levels.

Learning Outcomes

Upon completion of the award, candidates will be able to demonstrate:

1. An understanding of Knowledge-Based Systems and their role within AI.
2. An understanding of the use of rules within a Knowledge-Based System.
3. An understanding of the principles of case-based reasoning.
4. An understanding of uncertainty and the use of fuzzy logic.
5. An understanding of the role of the inference engine.

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Syllabus

1. Introduction to Knowledge-Based Systems (20%) K1/K2

Candidates will be able to:

1.1 Describe how a Knowledge-Based System works and its role within an AI solution.

Indicative content

a. What is a Knowledge-Based System?
b. Capturing human expertise
c. Knowledge base
d. Inference engine

Guidance

The aim is for learners is to understand that a Knowledge-Based System (KBS) is a form of Artificial Intelligence designed to capture human expertise (knowledge) to enable an AI application to make decisions. A KBS consists of a knowledge base and an inference engine which work together to enable the system to problem solve.

Candidates will be able to:

1.2 Explain the difference between knowledge-based intelligence and computational intelligence..

Indicative content

a. Knowledge-based intelligence
b. Computational intelligence

Guidance

Introduce learners to the 3rd industrial revolution and lessons we have learned from this and continue to learn. Introduce learners to the concept of the 4th Industrial revolution (where we are now) and the main issues that relate to it e.g. automation, digital transformation of a business, the need for a business to sustain itself in a competitive market.

Syllabus

1. Introduction to Knowledge-Based Systems (20%) K1/K2

Candidates will be able to:

1.3 Explain how a Knowledge-Based System complements Machine Learning.

Indicative content

a. Neural Networks
b. AI technologies working together
c. Driverless cars

Guidance

Learners should understand how different AI systems can complement each other to make AI work better. For example, a driverless car may use a combination of a Knowledge-Based System and a Neural Network (used in Machine Learning). In this example the Knowledge-Based System would be used to make decisions on what the car should do based on information contained in the knowledge base. The Neural Network would handle the image recognition (using the car's camera) to determine specific actions.

Candidates will be able to:

1.4 List examples of Knowledge-Based Systems.

Indicative content

a. Customer Support
b. Medical diagnosis
c. Production

Guidance

Learners should be encouraged to find and explore examples of Knowledge-Based Systems to understand how they are used. A good example of a Knowledge-Based System is a Customer Support "chat bot" that can provide first-line support to a customer in order to resolve a commonly reported issue without intervention from a human advisor. In this example the system will suggest a possible resolution through comparison of the information provided by the customer to the details of similarly reported issues stored in the knowledge base.

2. Rules (30%) K1/K2

Candidates will be able to:

2.1 Explain the use of rules within a Knowledge-Based System.

Indicative content

a. The use of rules to derive an outcome
b. The basic principles of Logic

Guidance

Learners should have an understanding of how a Knowledge-based system uses a set of rules to derive an outcome based on certain conditions when compared against the knowledge-base. A comparison can be made to the use of Logic in programming and the use of IF and AND statements (logic gates).

Candidates will be able to:

2.2 List examples of statements used within rules.

Indicative content

a. Constructing rules
b. IF, AND, THEN

Guidance

Learners should be able to articulate an example of a set of rules that could be used within a Knowledge-based system. For example, a system used to identify a system fault may use a set of rules such as "IF the pressure is above XX, AND the release valve is closed, THEN the release valve is stuck". By applying these rules to the input, it can determine the problem.

Syllabus

2. Rules (30%) K1/K2

Candidates will be able to:

2.3 Explain the difference between forward chaining and backward chaining.

Indicative content

a. Forward chaining
b. Backward chaining

Guidance

Learners should understand the basic principles of Forward and Backward chaining in rules-based decision making and where both approaches might be useful. Forward chaining starts with the input and rules are applied to then derive an outcome. In Backward chaining we start with the outcome and then work backwards through a logical chain of events that would need to happen in order to reach the outcome.

3. Case-based reasoning (10%) K1/K2

Candidates will be able to:

3.1 Describe the use of case-based reasoning.

Indicative content

a. What is case-based reasoning?
b. Symbolic learning

Guidance

Learners should be encouraged to explore the concept of case-based reasoning where the details relating to a specific situation or "case" are matched to the details of another case in the knowledge base based on their similarity so that the rules that were applied last time can be used again to solve the problem. It may be useful to provide learners with an example to add context.

Where there are no similar cases in the knowledge base, the knowledge base will be updated with new knowledge and new rules. This is similar to the concept of Symbolic Learning where a rule base is updated based on how successfully it is performing.

Candidates will be able to:

3.2 List the stages of case-based reasoning.

Indicative content

a. Retrieve
b. Reuse
c. Revise
d. Retain

Guidance

It is useful to present case-based reasoning as a cycle to illustrate the process, i.e. how a new case is matched to a retrieved case where a suggested solution is proposed or reused. The solution is tested, and a revision made to the knowledge base if required, with the new knowledge or solution retained for further use.

Syllabus

4. Uncertainty (20%) K1/K2

Candidates will be able to:

4.1 Explain the concept of uncertainty in Knowledge-Based Systems.

Indicative content	Guidance
a. Uncertainty b. Probability c. Bayesian updating	Learners should understand the principles of Uncertainty in AI, where an agent may encounter uncertainty in decision making where there is incomplete data and therefore probability is used to make a decision. Bayesian updating is used to then update the probability as more information becomes available.

Candidates will be able to:

4.2 Describe the use of Fuzzy Logic.

Indicative content	Guidance
a. The principles of Fuzzy logic b. "Degrees of truth"	Learners should understand the use of fuzzy logic in AI where truth values of variables can be any number between 0 and 1. This allows an AI agent to make decisions where there is a degree of uncertainty.

5. The Inference Engine (20%) K1/K2

Candidates will be able to:

5.1 Explain the role of the Inference Engine.

Indicative content	Guidance
a. Interface b. Inference engine c. Knowledge base	It is useful to illustrate the inference engine as the component in a Knowledge-based system that takes the information entered by the user (interface) and then applies logical rules to the knowledge base to gain insight that is fed back to the user i.e. the solution.

Candidates will be able to:

5.2 Describe how the inference engine uses rules to derive facts.

Indicative content	Guidance
a. Inference b. Application of rules	Learners should understand the meaning of inference being "a conclusion reached on the basis of evidence and reasoning" (Oxford Languages definition).

Candidates will be able to:

5.3 Describe knowledge-based systems in relation to intelligent agents.

Indicative content	Guidance
a. Intelligent agents b. Insight gained to complete tasks	Understanding how intelligent agents may operate and how this can be supported through a knowledge base is useful.

Examination Format

This award is assessed through completion of an invigilated online exam which candidates will only be able to access at the date and time they are registered to attend.

Type	18 Multiple Choice questions, 1 Scenario Based Question
Duration	30 minutes
Supervised	Yes
Open Book	No (no materials can be taken into the examination room)
Passmark	13/20 (65%)
Delivery	Digital format only.

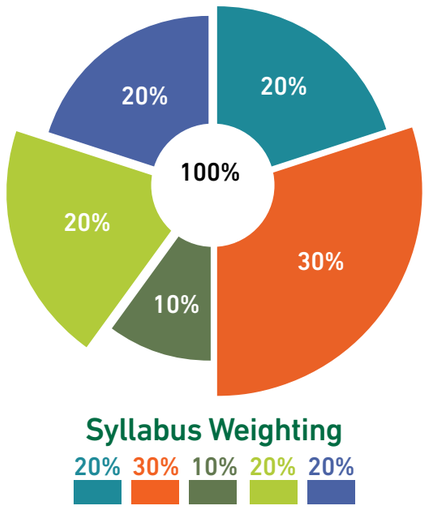
Adjustments and/or additional time can be requested in line with the BCS reasonable adjustments policy for candidates with a disability, or other special considerations including English as a second language.

Question Weighting

Each major subject heading in this syllabus is assigned a percentage weighting. The purpose of this is:

1. Guidance on the proportion of content allocated to each topic area of an accredited course.
2. Guidance on the proportion of questions in the exam.

Syllabus Area	Question type	
1. Introduction to Knowledge-Based Systems	Multiple Choice	**20%**
2. Rules	Scenario Based Multiple Choice	**30%**
3. Case-based reasoning	Multiple Choice	**10%**
4. Uncertainty	Multiple Choice	**20%**
5. The Inference Engine	Multiple Choice	**20%**



Recommended Reading

The following titles are suggested reading for anyone undertaking this award. Candidates should be encouraged to explore other available sources.

Title:	Knowledge-Based Systems
Author:	Rajendra Akerkar, Priti Sajja
Publisher:	Jones & Bartlett Learning, 2010
Publication Date:	30th Aug 2010
ISBN:	0763776475, 9780763776473

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