ATHE qualification specification for:

ATHE Level 5 Certificate in Artificial Intelligence

610/6116/5

ATHE Level 5 Diploma in Computing and Advanced Statistics

610/6117/7

ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence

610/6118/9

Specification Version 1.0: Valid from July 2025

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About ATHE

Awards for Training and Higher Education (ATHE) is a global awarding organisation regulated by Ofqual and other United Kingdom and international regulators. We provide centres with a wide variety of qualifications including, but not limited to business and management, accounting, law, computing, health and social care and religious studies.

For the full list please visit our website: www.athe.co.uk

ATHE has also developed a range of bespoke qualifications for clients.

The ATHE mission is to provide outstanding qualifications, customer service and support, enabling centres to thrive and their learners to achieve and progress. We will support this mission by:

- providing qualifications which enable learners to fulfil their potential and make a positive contribution to society both socially and economically
- delivering the highest standards of customer service
- delivering support and guidance which meet the needs of all centres and enable them to improve performance
- upholding and maintaining the quality and standards of qualifications and assessments
- having a commitment to lifelong learning and development

Our Qualifications

Our qualifications are the culmination of expert input from colleges, industry professionals, higher education providers and our qualification development team. We have developed a flexible suite of qualifications that offer progression across many of the RQF levels.

Support for Centres

We are committed to supporting our centres and offer a range of training, support and consultancy services including:

- a comprehensive guide for centres on delivering ATHE qualifications
- qualification guidance, assessor guidance, suggested resources and sample assignments for all units which have been written and verified by experienced practitioners
- verification and guidance with internally devised assignments
- guidance on how to deliver, assess and quality assure the qualifications
- an ATHE centre support officer who guides centres through the recognition process, learner registration and learner results submission
- health check visits to highlight areas of good practice and any areas for development
- an allocated member of our team who can work with centres to support further improvements in the quality of teaching, learning and assessment
- the services of a team of experienced external quality assurers
- opportunities for training and staff development
- access to free webinars to support delivery, assessment and QA processes
- support for business development.

ATHE Qualifications at Level 5 in this Specification

This document provides key information on the ATHE Level 5 qualifications in Artificial Intelligence, including the rules of combination, the content of all the units and guidance on assessment and curriculum planning. It should be used in conjunction with the ATHE handbook “Delivering ATHE

Qualifications". Further guidance and supporting documentation on curriculum planning, internal verification and assessment is provided separately in the Delivering ATHE Qualifications Guide and via the ATHE website.

These qualifications are regulated by Ofqual and are listed on Ofqual's Register of Regulated Qualifications. Each qualification has a Qualification Number (QN). This number will appear on the learner's final certification documentation. Each unit within a qualification also has a Unit Reference Number.

The QN number for this qualification is as follows**:**

ATHE Level 5 Certificate in Artificial Intelligence	**610/6116/5**
ATHE Level 5 Diploma in Computing and Advanced Statistics	**610/6117/7**
ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence	**610/6118/9**

Regulation Dates

This qualification is regulated from July 2025 and its operational start date in centres is August 2025.

Availability

This qualification is available to learners who are registered at a recognised ATHE centre which is based in England, Wales or internationally, outside of the United Kingdom.

Introduction to the Level 5 Qualifications in Artificial Intellgence

Aims of the Qualifications

These qualifications have been developed to conform to the requirements of the RQF, to meet the requirements of higher education and employers and to meet the needs of learners.

Learners looking to achieve a Level 5 qualification should be advised of all the opportunities available at this level (eg Higher Apprenticeships, Higher Technical Qualifications, Undergraduate Degree programmes) and the possible funding (ie loan opportunities) available for these.

Where relevant, the units build on IfATE standards at Level 4 and are based on industry-recognised BoK (Body of Knowledge) for Data Management.

The aim of each qualification is as follows:

Introduction to the ATHE Level 5 Certificate in Artificial Intelligence

This two-unit, 30-credit qualification builds on the Level 4 Award and extends specific Artificial Intelligence knowledge and skills by requiring learners to get to grips with underpinning advanced statistics and natural language processing. This qualification would be particularly suited to learners with a background in maths and computing looking to upskill their knowledge and skills in this specific area.

Introduction to the ATHE Level 5 Diploma in Computing and Advanced Statistics

This 60-credit qualification is aimed at learners looking to move on from foundational topics at Level 4, within the context of the Advanced Statistics necessary for understanding Artificial Intelligence. The qualification covers key underpinning computing content at Level 5: digital transformation, professional development, business communication and information systems, and looks to build on Level 4 maths and statistics topics to develop understanding in statistical modelling. This maths understanding is the

basis for the AI units in the Level 5 Extended Diploma. The qualification is suited to learners with a background in maths.

Introduction to the ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence

This qualification is a 120-credit qualification aimed at learners building on Level 4 and pursuing a data analysis and Artificial Intelligence route through computing. Level 5 topics grow from Level 4 topics, and Level 5 Advanced Statistics and Artificial Intelligence units enable the learner to fully explore their AI interests. The Advanced Statistics unit underpins two units exploring natural language processing and machine learning algorithms.

General Qualification Features

Unit content and skill areas are explored systematically. Learners are expected to demonstrate both what they know and understand of the unit content, and how they apply it to a practical problem or situation. Learners will have the opportunity to develop their practical computing skills across a number of related Computing skill areas.

The qualifications also have a synoptic focus. Unit 9 is a synoptic project (taken as a part of the Extended Diploma) that requires that learners utilise the skills and knowledge that they have learnt in previous units. Each unit has signposting to synoptic learning and assessment opportunities across the entire suite of units, ensuring that learning and assessment is connected and holistic. Learners and tutors can see and understand the relationship between aspects of unit content clearly and easily.

The qualifications also focus on the development of those study and transferable skills necessary for learners to develop and grow both personally and in the working environment. Each unit is signposted to Study Skills and Employability Skills opportunities derived from ATHE's standards. This ensures that learners and tutors have the opportunity to relate aspects of learning to broader study and work-related skills.

The qualification is, therefore, designed to provide a strong base for continued learning and a desire to constantly develop as an individual, further improving knowledge, understanding and skills.

The qualification is suitable for learners to study both in college/classroom settings and as distance learning programmes. Each unit is supported by an ATHE assignment which, requires the learner to complete a small number of focussed tasks designed to demonstrate relevant applied knowledge and skill.

Entry Requirements

These qualifications are designed for learners who are typically aged 18+.

ATHE's policy regarding access to our qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from any barriers that restrict access and progression
- there should be equal opportunities for all those wishing to access the qualifications

Centres should review the prior qualifications and experience of each learner and consider whether they provide the necessary foundations to undertake the programme of study at Level 5. If there are exceptional entrants, centres are advised to contact ATHE. For learners with disabilities and other specific needs, this review will need to take account of the support available to the learner during teaching and assessment of the qualification.

The entry profile for learners is likely to include at least one of the following:

- prior study in computing or related subjects at Level 4 or above, or a Level 4 qualification, for example, an ATHE Level 4 Diploma/Extended Diploma in Computing; a Higher Technical Qualification (HTQ) in a computing-related subject
- other equivalent international qualifications

Mature learners may present a more varied profile of achievement that is likely to include relevant work experience (paid and/or unpaid) with levels of responsibility, participation and/or achievement of relevant professional qualifications. This may be used for recognition of prior learning (RPL). Learners may also hold RQF qualifications which will enable them to claim an exemption from part of the qualification.

Learners must also have an appropriate standard of English to enable them to access relevant resources and complete the unit assignments. For those whom English is not their first language we recommend the following standards of proficiency in English language skills or an approved equivalent for this qualification:

- IELTs 5.5
- Common European Framework of Reference (CEFR) B2
- Cambridge English Advanced (CAE) 162 or above
- Pearson Test of English (PTE) Academic 42-49

Centres are required to recruit learners to qualifications with integrity. Centres must carry out robust initial assessment to ensure that learners, who undertake qualifications have the necessary background knowledge, understanding and skills to undertake the learning and assessment at Level 5. This assessment should take account of any support available to the learner within the centre during the programme of study and any support that may be required to allow the learner to access the assessment for the units within the qualification.

ATHE will review centre recruitment policies as part of the monitoring processes.

Reasonable Adjustments and Special Considerations

ATHE's policy on reasonable adjustments and special consideration aims to enhance access to the qualifications for learners with disabilities and other difficulties (as defined by the Equality Act 2010) without compromising the assessment of skills, knowledge and understanding. Where the learner has been awarded a Reasonable Adjustment or Special Consideration, this must be recorded on the assessment sheet and the learner record. External Quality Assurers will take account of this information at the external quality assurance of learner work. Further details on Reasonable Adjustments and Special Considerations are provided in the policy document, which can be found on our website. Please contact ATHE if you uncertain about adjustments for certain learners.

Progression

On successful completion of these qualifications, learners will have a number of progression options. Learners may progress to:

- employment in a computing role or have increased opportunities for progression in their current role
- larger qualifications at the same level e.g. from a Diploma to the Extended Diploma in Computing / Computing and Artificial Intelligence
- a Level 6/7 ATHE qualification such as the ATHE Level 7 Extended Diploma in Computing
- the final year of degree programmes at universities supporting the ATHE progression route (see HE Progression Routes on the ATHE website)

ATHE Recognition of Prior Learning (RPL)

There will be occasions where learners wish to claim recognition of prior learning that has not been formally assessed and accredited. ATHE has provided detailed guidance on RPL which is available for centres on the ATHE website. Centres may also contact ATHE directly to obtain further clarification or discuss the requirements for RPL.

Resources Required by Centres

ATHE expects centres to provide the right human and physical resources needed to ensure the quality of the learner experience. Centres must ensure that staff have the appropriate level of subject knowledge and are normally qualified to at least a degree standard. It is desirable that staff have a teaching and/or assessing qualification and practical experience of this sector.

The physical resources required will vary depending on the style of delivery. ATHE expects centres to have appropriate learning support materials, infrastructure and technology in place to meet student needs.

This information will be checked by External Quality Assurers on their visits to centres.

Modes of Delivery

Subject to checks by external verifiers centres can deliver this qualification using the following modes of delivery in order to meet the needs of their learners.

This can include:

- full time
- part-time
- blended learning
- distance learning

Qualification Size

The size of a qualification is expressed in **Total Qualification Time (TQT)**

Total Qualification Time – TQT

TQT is the total amount of time, in hours, expected to be spent by a student to achieve a qualification.

TQT is comprised of:

1. Guided Learning Hours (GLH)
2. Additional non-supervised learning

Guided Learning Hours – GLH

This is the amount of time the average student is expected to spend in lectures and other tutor-supervised learning and activities, including induction, face to face training, e-learning with the co-presence of learner and tutor, invigilated exams.

Guided Learning Hours (GLH) are an estimate of the amount of time, on average, that a lecturer, supervisor, tutor or other appropriate provider of education or training, **will immediately guide or supervise** the learner to complete the learning outcomes of a unit to the appropriate standard. GLH are intended to provide guidance for centres on the amount of time required to deliver the programme and support learners.

Additional non-supervised learning

This is an estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike Guided Learning, not under the Immediate Guidance or Supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

These activities may include webinars, podcasts, research, work-based learning, private and online study, compilation of a portfolio of evidence and non-invigilated assessment.

How TQT is calculated

Values for Total Qualification Time, Guided Learning Hours and Credit, are calculated by considering the different activities that a learner would typically complete in order to achieve the learning outcomes of a qualification at the standards provided.

The needs of individual learners and the differing teaching styles used mean there will be variation in the actual time taken to complete a qualification.

Values for Total Qualification Time, Guided Learning Hours and Credit are estimates.

Credit

Each ATHE qualification has a Credit value. Credit is calculated by dividing the TQT by ten. For example, a qualification with a TQT of 120 hours would have a credit value of 12.

Level

The level is an indication of relative demand, complexity and depth of achievement and autonomy. This qualification has been designed to suit learners working towards a Level 5 qualification. Level descriptors are divided into two categories:

I. Knowledge and understanding
II. Skills

There is a knowledge descriptor and a skills descriptor for each Level within the Regulated Qualifications Framework (RQF). The descriptors set out the generic knowledge and skills associated with the typical holder of a qualification at that Level. The Knowledge and Skills for Level 5 are:

Knowledge descriptor (the holder….)

- Has practical, theoretical or technological knowledge and understanding of a subject or field of work to find ways forward in broadly defined, complex contexts.
- Can analyse, interpret and evaluate relevant information, concepts and ideas.
- Is aware of the nature and scope of the area of study or work.
- Understands different perspectives, approaches or schools of thought and the reasoning behind them

Skills descriptor (the holder can….)

- Determine, adapt and use appropriate methods, cognitive and practical skills to address broadly defined, complex problems.
- Use relevant research or development to inform actions.
- Evaluate actions, methods and results.

Rules of Combination

Each qualification has agreed rules of combination which indicates the number of credits to be achieved, and the units that are required. The rules of combination for these qualifications are given below.

Qualification Structure: ATHE Level 5 Certificate in Artificial Intelligence

The ATHE Level 5 Certificate in Artificial Intelligence is a two-unit 30-credit qualification. Learners are required to achieve both mandatory units.

The Total Qualification Time is 300 Hours
The Total Guided Learning Hours is 120
The Total Credit value is 30

Unit Codes	Unit Title	Level	Credit	GLH
	Mandatory Units			
A/651/7143	Unit 3 Advanced Statistics for Data Science	5	15	60
D/651/7144	Unit 7 Foundations of Artificial Intelligence for Data and Language	5	15	60

Qualification Structure: ATHE Level 5 Diploma in Computing and Advanced Statistics

The ATHE Level 5 Diploma in Computing and Advanced Statistics is a 60-credit qualification. Learners are required to achieve all four units.

The Total Qualification Time is 600 Hours
The Total Guided Learning Hours is 240
The Total Credit value is 60

Unit Codes	Unit Title	Level	Credit	GLH
	Mandatory Units			
F/651/0150	Unit 1 Computing Projects for Digital Transformation	5	15	60
H/651/0151	Unit 2 Professional Development and Business Communication	5	15	60
A/651/7143	Unit 3 Advanced Statistics for Data Science	5	15	60
K/651/0153	Unit 4 Information Systems	5	15	60

Qualification Structure: ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence

The ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence is a 120-credit qualification. Learners are required to achieve all five mandatory units plus at least three units from units 5 – 8.

The Total Qualification Time is 1200 Hours
The Total Guided Learning Hours is 480
The Total Credit value is 120

Unit Codes	Unit Title	Level	Credit	GLH
	Mandatory Units			
F/651/0150	Unit 1 Computing Projects for Digital Transformation	5	15	60
H/651/0151	Unit 2 Professional Development and Business Communication	5	15	60
A/651/7143	Unit 3 Advanced Statistics for Data Science	5	15	60
K/651/0153	Unit 4 Information Systems	5	15	60
T/651/0166	Unit 9 Advanced Project	5	15	60
	Optional Units			
L/651/0154	Unit 5 Advanced Database Practice	5	15	60
M/651/0155	Unit 6 Programming for Data Engineering	5	15	60
D/651/7144	Unit 7 Foundations of Artificial Intelligence for Data and Language	5	15	60
F/651/7145	Unit 8 Machine Learning in Practice: Structure, Strategy, and Evaluation	5	15	60

Guidance on Assessment and Grading

Assessment

Assessment for each unit is completed based on achievement of the Learning Outcome at the standards set by the Assessment Criteria for that unit. The learner can therefore achieve a Pass, Merit, Distinction or Fail for each unit based on the quality of the work submitted and the assessor's judgements made against the criteria provided.

The assessment of each of Level 5 qualification is completed through the submission of internally assessed learner work.

To achieve a pass for a unit, a learner must have successfully achieved the learning outcomes at the pass standard set by the assessment criteria for that unit. To achieve merit or distinction, the learner must demonstrate that they have achieved the criteria set for these grades. Learners cannot omit completing work to meet the pass standard and simply work to the higher grades, as this would put a pass for the unit in jeopardy. Similarly, learners cannot complete work to meet the criteria for distinction in the anticipation that this will also meet the criteria for merit. However, where work for the pass standard is marginal, assessors can take into account any extension work completed as this may support achievement of the pass standard.

ATHE will provide an assignment for each unit which can be used as the assessment for the unit. These assignments have extension activities, which enable the learners to provide additional evidence to show that the criteria for the higher grades have been met. The assessor therefore must judge the grade for the work submitted on the basis of whether the LO has been met at the standard, specified for the pass, merit or distinction grade for that LO. In making their judgements assessors will continue to check whether the command verbs stated in the AC have been delivered. There is no requirement for learners to produce the additional work required for the higher grades and the tutor may advise the learner to work to the pass standard, where this is appropriate.

The assessor should record their judgements on the ATHE template, stating what grade the learner has achieved and providing evidence for the judgements. The internal verifier can also use the ATHE IV template but the feedback to the assessor must show whether the assessor has made valid judgements for all the learner work, including any extension activities which met the standard for merit and distinction

grades. Assessment judgements always require care to ensure that they are reliable and that there is sufficient and specific feedback to the learner to show whether he or she has demonstrated achievement of the LO at the specified standard. The additional grades mean that assessors must take even greater care to assure the validity of their judgements.

We welcome centres developing their own assessment strategies, so you can put assignments in a context that is appropriate for your learners. Any assignments that you devise independently will need to be submitted to ATHE for approval before delivery of the programme. Centres can submit assignments for approval using the 'Centre-Devised Assignment' template documentation available on the ATHE centre portal.

An assignment can relate to a single unit, or an integrated assignment can incorporate more than one unit. Any assignment must show which learning outcomes and assessment criteria from which unit(s) are being covered.

Assignment Marking Guidance

Each ATHE assignment has marking guidance produced with it so that assessors can better understand the requirements for the satisfaction of assessment criteria/learning outcomes. For tutors, it is worthwhile reading and understanding this marking guidance before learners are asked to commence an assignment. It is also worthwhile tutors bringing this marking guidance to the attention of learners before they embark on an assignment. As the marking guidance often captures the expected level of detail of a learner response, it contains additional information that can help learners and tutors better understand the kind of response to a task that best meets the requirements.

Key command verbs from the assessment criteria have also been emboldened in the marking guidance so that tutors and learners can clearly understand the level of response that is expected.

Recording Assessment Judgements

Assessors are required to record assessment judgements for each student by unit. ATHE has provided a template for centres to use to record their judgements and this form should be used. The form enables the centre to record any adjustments due to special considerations or reasonable adjustments. Any adjustments following appeals should also be recorded. These records must be retained as they will be checked at external verification visits. All learner work must be retained for a minimum of 4 years after certification has taken place.

Putting an Assessment Strategy in Place

You will need to demonstrate to your External Quality Assurer that you have a clear assessment strategy supported by robust quality assurance to meet the ATHE requirements for registering learners for a qualification. In devising your assessment strategy, you will need to ensure that:

- Learners are well-briefed on the requirements of the unit and what they must do to meet them.
- Assessors are well-trained and familiar with the content of the unit/s they are assessing.
- There is an internal verification process in place to ensure consistency and standardisation of assessment across the qualification.
- Assessment decisions are clearly explained and justified through the provision of feedback to the learner.
- Work submitted can be authenticated as the learner's own work and that there is clear guidance and implementation of the centre's Malpractice Policy.

- There is an assessment plan in place identifying dates for summative assessment of each unit and indicating when external quality assurance will be needed.
- Enough time is included in the assessment planning to allow the learners time for any necessary remedial work that may be needed prior to certification.

Grading

Grading system

The grading algorithms and overall grade thresholds published in any ATHE specification may be subject to change where this is necessary to maintain standards.

This qualification involves assessment using judgements against 'Pass', 'Merit' and 'Distinction' Assessment Criteria to make a decision about whether a learner has met the required standard. Our grading system is straightforward and we do not currently envisage the need to change this. However, should a change become necessary, the change would be published in an updated version of the specification with a clearly revised version number and a new 'valid from' date on the front cover. We will write to all centres in good time to inform them of this change so that plans for any changes can be made to your programme delivery, internal assessment and quality assurance arrangements.

The ATHE grading system where a qualification result can be either Pass, Merit, Distinction or Fail is as currently follows and we plan to maintain this system for the foreseeable future:

- Learner meets all Learning Outcomes at Pass standards stated in the assessment criteria in a unit > Learner gains a Pass for the unit
- Learner meets all Learning Outcomes at Pass standards stated in the assessment criteria, and where available also at Merit standard in a unit > Learner gains a Merit for the unit
- Learner meets all Learning Outcomes at Pass standards, and where available also at Merit and Distinction standards stated in the assessment criteria in a unit > Learner gains a Distinction for the unit
- Learner does not meet all Learning Outcomes at Pass standards stated in the assessment criteria in a unit > Learner gains a Fail for the unit
- Learner meets the rules of combination in a qualification and points for achieving units are added up > points are converted to an overall qualification grade > learner meets minimum number of points required > learner achieves a Pass, Merit or Distinction for the qualification
- Learner does not meet rules of combination > learner achieves a Fail for the qualification but may receive unit credit certification for those units achieving a Pass.

Qualification Grading Structure

Determining the Overall Qualification Grade

Each unit is graded pass, merit or distinction. As well as receiving a grade for each individual unit learners will receive an overall grade for the qualification. Each unit is equally weighted. The formula for establishing the overall grade is as follows.

Points for each 15-credit unit are allocated as follows:

Pass (achieves Learning Outcomes at the standards stated in pass assessment criteria) – **45 points**
Merit (achieves Learning Outcomes at the standards stated in pass and all merit assessment criteria) – **60 points**
Distinction (achieves Learning Outcomes at the standards stated in pass, all merit and all distinction Assessment Criteria) – **75 points**

Total points required for each grade:

ATHE Level 5 Certificate in Artificial Intelligence (30 credits)
Pass 90 - 107
Merit 108 - 134
Distinction 135

ATHE Level 5 Diploma in Computing and Advanced Statistics (60 credits)
Pass 180 - 215
Merit 216 - 269
Distinction 270

ATHE Level 5 Extended Diploma in Computing and Artificial Intelligence (120 credits)
Pass 360 - 431
Merit 432 - 539
Distinction 540

Quality Assurance of Centres

Centres delivering ATHE Qualifications must be committed to ensuring the quality of the units and qualifications they deliver, through effective standardisation of assessors and verification of assessor decisions. ATHE will rigorously monitor the application of quality assurance processes in centres.

ATHE's quality assurance processes will include:

- centre approval for those centres who are not already recognised to deliver ATHE qualifications
- approval to offer ATHE qualifications
- monitoring visits to ensure the centre is continuing to work to the required standards
- moderation of centre-marked work submitted for results.

Centres will be required to undertake training and standardisation activities as agreed with ATHE. Details of ATHE's quality assurance processes are provided in the ATHE Guide: "Delivering ATHE Qualifications" which is available on our website.

Malpractice

Centres must have a robust Malpractice Policy in place, with a clear procedure for implementation. Centres must ensure that any work submitted for verification can be authenticated as the learner's own. Any instance of plagiarism detected by the External Quality Assurer during sampling, will be investigated and could lead to sanctions against the centre.

Centres should refer to the Delivering ATHE Qualifications Guide and the ATHE Malpractice and Maladministration Policy on the ATHE website.

Guidance for Teaching and Learning

Learners normally improve their understanding when they are actively involved in the learning process. We would encourage practitioners delivering our qualifications to use a range of teaching methods and classroom-based activities to ensure learners are engaged in the learning, as this facilitates understanding and progress. Learners should be encouraged to take responsibility for their learning and should be able to demonstrate a high degree of independence in applying the skills of research and evaluation. You can facilitate this by using engaging methods of delivery that involve active learning rather than relying on traditional methods of lecture delivery to impart knowledge.

Your approach to delivery should give the learners sufficient structure and information on which to build without you doing the work for them. In achieving the right balance, you will need to produce well-planned sessions that follow a logical sequence.

Top Tips for Delivery

- Adopt a range of teaching and learning methods, including active learning.
- Plan sessions well to ensure a logical sequence of skills development.
- Include study skills aspects, e.g. how to construct a report or Harvard Referencing.
- Build time into your scheme of work and session plans to integrate study skills teaching.
- Set structured additional reading and homework tasks to be discussed in class.
- Elicit feedback from learners. Get them to identify where the work they've done meets the assessment criteria.
- Contextualise your activities, e.g. using real case studies as a theme through the sessions.
- Take an integrated approach to teaching topics across units, where appropriate, rather than always taking a unit-by-unit approach. In this way, learners will be able to see the links between the content of the different units.

There is further guidance on teaching and learning in the Delivering ATHE Qualifications Guide.

Unit Specifications

Unit Format
Each unit is presented in a standard format. This format provides guidance on the requirements of the unit for learners, tutors, assessors and External Quality Assurers.

Each unit has the following sections:

Unit Title
The unit title reflects the content of the unit. The title of each unit completed will appear on a learner's statement of results.

Unit Aims
The unit aims section summarises the content of the unit.

Unit Code
Each unit is assigned a unit code that will appear on the qualification certificate

Level
All units and qualifications have a level assigned to them which represents the level of achievement. The level of each unit is informed by the level descriptors. The level descriptors are available on the ATHE website.

Guided Learning Hours (GLH)
Guided learning hours is an estimate of the amount of time, on average, that a tutor, trainer, workshop facilitator etc., will work with a learner, to enable the learner to complete the learning outcomes of a unit to the appropriate standard.

Total Qualification Time (TQT)
TQT represents the total time required for a learner to complete a qualification.

Credit Value
The credit value specifies the number of credits that will be awarded to a learner who has achieved the learning outcomes of a unit at the specified standard.

Learning Outcomes
The learning outcomes set out what a learner is expected to know, understand or be able to do as the result of the learning process.

Assessment Criteria
The assessment criteria describe the requirements a learner is expected to meet in order to demonstrate that the learning outcome has been achieved. Command verbs reflect the level of the qualification e.g. at Level 5 you would see words such as analyse, evaluate, synthesise.

Unit Indicative Content
The unit indicative content section provides details of the range of subject material for the programme of learning for the unit.

Opportunities for Synoptic Teaching and Learning

This section identifies the links between the unit's learning outcomes and other unit learning outcomes and assessment criteria within the qualification that are thematically related. This enables learners and tutors the opportunity to connect learning across the qualification to ensure that learners have a joined-up experience of each unit.

Opportunities for Synoptic Assessment
This section identifies the way in which a unit's assessment links internally different parts of a unit or links more broadly to other parts of the overall qualification. In each unit, there are shared Merit and Distinction AC which draw together different but related learning from different LOs. These are labelled throughout each unit:

Eg, Unit 1 LOs 2 and 3 3D1 Evaluate how the identification and mitigation of risk increases the likelihood of success in a digital transformation

For certain units, eg Unit 9 Advanced Project, these represent larger opportunities for assessment to be informed by knowledge and understanding developed in previous units.

Opportunities for Skills Development

This section contains two important elements of signposting: signposting to ATHE Study Skills and signposting to ATHE Employability Skills. These enable learners and tutors the opportunity to see where each unit's LO/AC link into underpinning Study Skills and Employability Skills categories, eg Digital Skills, Thinking Skills etc, and to promote possible programme/curriculum opportunities for the development of these skills. The ATHE Study Skills and Employability Skills are drawn from the standards documents for each skill. These standards documents are on the ATHE Centre Portal.

Guidance on appropriate software

The indicative contents in the units of the qualification are based on Python programming with emphasis on the Pandas and Scikit Learn module. Python is one of the most popular languages because it is so versatile and it is often used when working with statistics and AI, both in academic and in commercial organisations. Pandas and Scikit Learn are some of the most widespread packages used for developing algorithmic models in Python, although others do exist and are gaining popularity.

Learners could use other programming languages, such as C#, C++, or Java, alternative Python packages, or other algorithmic programs if they wish. However, if proprietary packages, such as SAS Viya or Matlab, are used, agreement should be sought from ATHE to ensure that External Quality Assurers (EQAs) have appropriate access to learner evidence.

It is assumed that the centre has already ensured that the learners have access to computing devices with appropriate analytical software installed prior to attempting this assignment, as such software is essential for teaching and undertaking the contents of the units.

Guidance on expected submissions for practical activities

Where the assessment activity calls actions to be performed in Python (e.g. “carry out […] in Python using scikit learn”) there might be some limited data preparation activities included. These are likely to include loading the data into a suitable dataframe, basic data transformations, and listings of columns names, rows count, or rudimentary graphs.

The submission for such activities should include files containing the Python script that has been developed. This would typically consist of the following parts:

- A copy of the data used, or, if the data is freely available to download, a hyperlink to where it can be accessed
- Data investigation and preparation
- Model Training
- Model Fitting
- Results Evaluation

This could be submitted in one Python script file, or as separate files. If there are multiple files it should be clear in the submission document what order they should be executed.

The submission should also contain a brief document with description of the major sections of code, the significant decisions made, and, where this is required in the activity, an evaluation of the model outcome.

Multiple files could be compressed into one file with the use of standard compression software, such as WinZip, 7Zip or similar.

Qualification units

Unit 1 Computing Projects for Digital Transformation	
Unit aims	This unit enables learners to begin to think about how digital transformation may benefit their organisation, their job role, or the day-to-day activities within their organisation or their team. This understanding should be digital pathway neutral as learners at Level 5 will be expected to understand and contribute to plans for a digital transformation, regardless of their role.
Unit level	5
Unit code	F/651/0150
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	There are no special software requirements to support the delivery or assessment of this unit. Learners should, however, have access to the internet. You could find a range of local and global examples of how digital transformation has benefitted organisations and individuals. In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand opportunities and drivers for digital transformation	1.1 Identify and explain a range of opportunities for digital transformation 1.2 Give examples of how digital transformation can enable organisations to reduce their carbon footprint 1.3 Explain the benefits of digital transformation to a non-technical audience	1M1 Recommend digital assets to support a digital transformation	1D1 Evaluate your choice of digital assets to support a digital transformation

2. Understand risks associated with digital transformation	2.1 Identify and explain the skills needed to support a digital transformation 2.2 Explain the costs associated with digital transformation 2.3 Explain why staff can be resistant to change	2M1 Analyse the importance of realistic timescales in the implementation of a digital transformation	3D1 Evaluate how the identification and mitigation of risk increases the likelihood of success in a digital transformation
3. Understand how risks associated with digital transformation are mitigated	3.1 Explain the role that communication plays in managing how staff perceive change resulting from digital transformation 3.2 Explain the importance of ROI (return on investment) and why ROI might not be immediate 3.3 Describe how data will need to be prepared to accommodate digital transformation	3M1 Analyse how a range of risks associated with digital transformation can be mitigated	

Indicative Content

1 Understand opportunities and drivers for digital transformation

- Opportunities for digital transformation
    - Automation
        - e.g., industrial machinery, home automation, vehicle automation and logistics, programmed kitchen appliances and consumer electronics, agricultural processes such as automated ploughing, irrigation systems and harvesting
    - Development of products
        - e.g., technology used in design, prototyping, simulation
    - Accessing new markets and customers
        - e.g., building or re-energising a brand
    - Taking advantage of emerging technologies
        - e.g., having an awareness of emerging technologies and their capabilities and how these could be used by organisations
    - Futureproofing (upskilling staff and developing a staff base that is ready for the future demands of the organisation)
    - Leveraging connected technologies
        - e.g., automated social media posting, personalised marketing, using assistive devices to generate sales (such as re-ordering reminders)
    - Modernising IT infrastructure

        - e.g. what are the benefits of modernisation such as scalability, responsiveness, greater capacity
    - Modernising operational practices
        - e.g. simplification, improved workflow, improved capabilities (the ability to do more)
    - Digitising documentation
        - e.g., better storage, better organisation, improved access, more availability for analysis to support decision making
    - Improvement in the customer experience
        - e.g., more responsive to customer needs, use of chatbots, remote patient or customer management, online help
    - Re-engagement of staff
        - e.g., improved communication and information sharing, better collaboration across teams, provides wider access to resources, potential for remote working, better work-life balance, developing a digital culture that is recognised and appreciated
    - Becoming greener
        - e.g., embracing sustainability, reduction of carbon footprint, better relationships with local community
    - Accessibility to education and training
        - e.g., more efficient access to education and training (access to remote learning and training), greater choice of training and educational programmes
    - Enhanced collaboration with external partners
        - e.g., easier access to meetings without excessive travel
- Drivers for digital transformation
    - Regulatory compliance and ethical responsibility
        - e.g., using technology to help organisations meet legislative requirements and demonstrate ethical responsibility
    - Cost reduction
        - e.g., this does not necessarily mean reducing staff, it could be using satellite technologies to find better delivery routes, online meetings to avoid attending in person
    - Improved efficiency
        - e.g., improved workflow, creating an organisation that can respond to continuous change, reduction in process bottlenecks
    - Meeting evolving customer expectations
        - e.g., responsiveness, accountability, agility
    - Obsolescence of existing technology
        - e.g., technology for which parts are no longer available, software is no longer supported or updated (causing an operational and security risk)
    - To drive innovation
        - e.g., support initiatives for growth, access to data for research and development
    - Greater access to a wider talent pool
        - e.g., using digital technologies to enable a wider pool of skills and abilities to be available for work (such as carers and those who are housebound), being able to outsource to reduce costs by employing less expensive labour.
    - Maintain competitiveness
        - e.g., having access to more information about competitors and their activities

2 Understand risks associated with digital transformation

- Lack of appropriate skills in existing workforce to support a digital transformation
    - technical skills
    - people management skills

    - project management
- Costs
    - initial outlay for hardware and software upgrades
    - hidden costs (such as the costs of training, downtime when staff are being trained)
    - ongoing maintenance costs
    - ongoing support costs
    - ROI (return on investment)
    - costs of software licenses
    - managing cost increases caused by scope creep
- Lack of real understanding about the technologies being implemented
    - what the technology can do
    - what the technology cannot do
    - over-promising what digital transformation can offer
    - lack of appreciation about the extent of change and what will really be impacted
- Risks to staff
    - staff burnout due to
        - expectation that staff can manage more work
        - expectation that staff can work more quickly
        - staff can feel that there is a greater expectation that they are accessible 24/7
    - isolation during long periods where they are working from home
- Staff fear of change and resistance to change
    - fears, including job loss, requirements to do more work or to work more quickly
    - assumption that staff will buy in to transformation
    - staff who lack understanding
- Managing large volumes of digital data
    - many organisations work with multiple systems which often means data duplication
    - data may need to be cleaned and prepared
    - data may need to be kept within certain locations due to security concerns or legislation
- Timescales
    - digital transformation should be carefully planned
    - underestimating the impact from the changeover from one way of working to another
    - adopting new technologies without sufficient testing
        - high volumes of users
        - wireless capacity (number of connected users)
    - underestimating problems that could emerge during transformation
        - costs over-running
        - scope creep
- New cyber security risks
    - the introduction of new digital assets that need to be risk assessed and managed before being added to the existing infrastructure
- Disaster recovery
    - updated policies for disaster management to reflect digital transformation
    - updated policies for business recovery to reflect digital transformation

3 Understand how risks associated with digital transformation are mitigated

- Managing change and the risks associated with digital transformation
    - Upskilling
        - providing necessary training
        - buying in expertise (which increases costs)
    - Costs
        - finding project capital
        - creating a budget for operational and support costs

        - calculating ROI (return on investment)
    - Lack of real understanding about the technologies being implemented
        - be clear about what will and will not be possible after digital transformation
        - share the facts with staff so that they feel informed
        - ask staff to contribute to the estimates of how the transformation will impact on their ability to work
        - keep staff informed about how the transformation will affect them
    - Risks to staff
        - create operational policies and set out expectations of staff
        - ensure that remote staff have regular contact with their manager and team
    - Staff fear of change and resistance to change
        - assumption that staff will buy in to transformation
        - staff who lack understanding of technology
    - Managing large volumes of digital data
        - many organisations work with multiple systems which often means data duplication
        - data may need to be cleaned and prepared (e.g. removal of duplicated data, data may need to be reorganised)
        - requirements in relation to data sovereignty should be observed
    - Timescales
        - should be realistic
        - should be agreed with staff
        - should be shared with all stakeholders
    - New cyber security risks
        - cyber specialists should be involved in the selection and preparation of technologies
    - Importance of taking stakeholders with you on a digital transformation journey

Suggested Resources

Lardi, K., 2022, The Human Side of Digital Business Transformation, Wiley

Weiss, A., 2022, The Practical Guide to Digital Transformation: Quickly Master the Essentials with Tips, Case Studies and Actionable Advice, Kogan Page

Porter, M.E., et al., 2021, HBR's 10 Must Reads on Leading Digital Transformation (with bonus article "How Apple Is Organized for Innovation" by Joel M. Podolny and Morten T. Hansen), Harvard Business Review Press

Rogers, D., 2023, The Digital Transformation Roadmap: Rebuild Your Organization for Continuous Change, Columbia University Press

Websites

www.skillsyouneed.com
www.coursera.org
Digital Transformation: What is it? 10 Successful Big Brand Examples
What is digital transformation? (IBM)
What is digital transformation? (McKinsey & Company)
The Essential Components of Digital Transformation
13 Benefits of Digital Transformation to Inspire You

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand opportunities and drivers for digital transformation.	It is clear that to understand how new and emerging technologies can be used in digital transformation, it is essential to understand not only what these technologies and connected devices are, but also how they impact on organisations, individuals, the IT sector and society as a whole. This is examined in **U3 LO1**, **U3 LO2**, and **U3 LO3.** It is also likely that developments in information systems (links with **U4 LO1**, **U4 LO2**, **U4 LO3**) and the growth and developments in AI and machine learning (**U7 and 8**) will also drive digital transformation as outlined in this unit.
LO2 Understand risks associated with digital transformation. **LO3** Understand how risks associated with digital transformation are mitigated.	Barriers to communication are one of the key risks associated with digital transformation. If a practitioner cannot successfully take customers and users on their journey, then the transformation may fail. For this reason, practitioners should understand the importance of communication at the right level to suit the target audience and know how to overcome any communication barriers to sure that users as customers are supported. **U1 LO2** and **U1 LO3** therefore link directly with **U2 LO4**. Whereas **Unit 1 LO2** looks at the risks of digital transformations, when transformations have a significant data element, they often include performance evaluations of algorithmic models which is covered in **Unit 3 LO1**.
Opportunities for Synoptic Assessment	
Some of the Distinction criteria require knowledge from one or more of the LOs. In this unit, **AC 3D1** includes assessment across **LO2** and **LO3**. In addition, Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Problem-solving – Understanding how and why digital transformation benefits an organisation, a team or an individual in their job role (LO1). Learners will also need to identify risks associated with a digital transformation in a given context (LO2), and explain how to overcome the risks by suggesting suitable mitigations (LO3). **Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO1). **Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3). **Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research to support argument, presenting data) (LO1, LO2, LO3).	**Using sources of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3). **Reading Skills** – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3). **Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3). **Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).

Unit 2 Professional Development and Business Communication	
Unit aims	This unit builds on the professional practice content first introduced in Level 4's Unit 11 (Synoptic Project and Professional Best Practice) where learners considered team behaviours that contribute to effective working, written and oral communication and wider considerations such as ethical practice and an understanding of relevant legislation. Because the IT industry is fast moving, practitioners should understand that working in this sector will necessitate continuous professional development (CPD), often including the updating of technical skills as well as the development of professional skills as practitioners are promoted.
Unit level	5
Unit code	H/651/0151
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	There are no special software requirements to support the delivery or assessment of this unit. Learners should, however, have access to the internet. Learners should be encouraged to watch professional development videos on streaming services such as YouTube that relate to their preferred pathway. In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand the role of Continuous Professional Development (CPD) in the professional development of IT practitioners	1.1 Explain the purpose and importance of CPD 1.2 Describe the types of CPD and a range of typical activities that contribute to CPD 1.3 Explain the importance of formally recording CPD activity		

2. Understand the factors that contribute to different types of communication and the reputational impact of good business communication	2.1 Explain a range of factors that contribute to successful business communication 2.2 Explain how the way you communicate impacts on how others perceive you, your department and your organisation 2.3 Describe, with examples, how organisations should use different communication channels	2M1 Analyse the importance of understanding the reputational impact of different communication methods	2D1 Justify a chosen approach to business communication in a given context
3. Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management	3.1 Describe the importance of identifying and understanding a target audience 3.2 Explain how you could better prepare to facilitate good communication 3.3 Explain why SLAs are necessary to manage expectations within organisations	3M1 Differentiate between the differing needs of internal and external audiences	4D1 Evaluate the success of a business communication and identify CPD tasks you could undertake to improve your business communication
4. Understand how barriers to communication can be overcome to support users as customers	4.1 Explain barriers to communication 4.2 Describe how barriers to communication can be overcome	4M1 Analyse how fear of change becomes a barrier to communication	

Indicative Content

1 Understand the role of Continuous Professional Development (CPD) in the professional development of IT practitioners

- Purpose of CPD (e.g. short, medium and long term career planning)
- Types of CPD (e.g. structured activity, formal unstructured activity, informal unstructured activity, reflective practice)
- Activities that contribute to CPD (e.g. certificated courses, in-house training, job shadowing, workshops and seminars, online learning, networking events and conferences)
- CPD process (e.g. performance review: analysing personal contributions over period being reviewed, identifying job and personal goals, target setting)
- Formally recording CPD (e.g. CPD log, copies of certificates, feedback from informal training)
- Importance of CPD (e.g. preparing to meet the needs of the organisation, meeting the needs and aspirations of the practitioner)

2 Understand the factors that contribute to different types of communication and the reputational impact of good business communication

- Types of communication (e.g. verbal, written)
- Factors that contribute to business communication (e.g. body language, facial expressions, tone of voice, use of technical jargon, use of listening skills, use of appropriate images: awareness of image copyright)
- Reputational impact (e.g. understanding that in a business context practitioners are representing themselves, their departments, and their organisations)
- Appropriate use of communication channels (e.g. social media, email, verbal communication channels like Microsoft Teams, presentations, written reports)
- Public and private communication channels (e.g. when to use)

3 Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management

- Types of target audience (e.g. technical, non-technical)
- Internal audience (e.g. colleagues, subordinates, senior managers)
- The importance of understanding internal users of IT services as customers (e.g. why it is necessary to have SLAs (Service Level Agreements) and why it is necessary to set and manage expectations)
- External audience (e.g. customers, suppliers, stakeholders, business partners)
- Target audience differentiators (e.g. lifestyle, attitudes and beliefs, gender, ethnicity, culture or sub-culture, specific age-groups, needs and motivations, aspirations, location, economic group, seniority (particularly in a business context), level of education, occupation, technical proficiency)
- Importance of understanding different audiences so that you speak their language, not IT e.g.
    - to enable you to find common ground between you and your audience
    - to enable you to adapt your message to suit their needs
    - to enable your audience to engage
    - to avoid the potential for miscommunication
    - to help you build a business relationship
- How to understand your audience:
    - Spend time trying to get to know your audience (e.g. with customers – what do they usually buy and how often, whether they are buying from your competitors and what your competitors offer; with senior managers – understand their role within the organisation and the needs of their area of responsibility; with subordinates – know how the message you are sharing will impact them and their day to day activities)

4 Understand how barriers to communication can be overcome to support users as customers

- Technical (e.g. having no understanding of computing, IT or individual technologies and relevant terminology, having no understanding of the time that may be needed to investigate and correct faults in systems and devices or time needed to develop a solution)
    - How to overcome: use simple language, avoid using technical terminology and try to only explain the key points that customers need to know, be realistic about time needed to develop systems or solutions, or to investigate and correct faults.
- Physical (e.g. distance, time zones, technical issues, noise and other distractions)
    - How to overcome: leverage technology, be prepared to be flexible, plan ahead and find a suitable time, test technology in advance, find a quiet environment
- Language (e.g. different languages, specialised language and technical jargon, regional dialects, colloquialisms)
    - How to overcome: use simple language, where possible avoid jargon, limit the amount of information being shared, be unambiguous, spend as much time listening as talking
- Culture (e.g. social customs, cultural norms and values, values and belief systems, stereotypes)
    - How to overcome: learn about other cultures, ask questions if unsure, demonstrate respect, be positive
- Physiological (e.g. physical disability that prevents travel, visual impairment, hearing impairment, dyslexia)
    - How to overcome: where practitioners are aware of a physiological challenge they should make suitable adjustments, organisations should also help employees make adjustments
- Psychological (e.g. fear of change creates a psychological barrier, due to: personal insecurity, lack of trust in management, assumption that change will be bad, fear of job loss, fear of loss of control, previous experience of change)
    - How to overcome:
        - share the nature of change, timescales and the expected benefits
        - give an audience time to absorb the information and ask questions
        - demonstrate emotional intelligence, do not assume everyone will be on your page

Suggested Resources

Fishpool, Bernie and Fishpool, Mark, 2022, Software Development in Practice, BCS (The Chartered Institute for IT)

Heller, Daniel, 2020, Building a Career in Software Development: A comprehensive Guide to Success in the Software Industry, Apress

Edited by Rasmussen, Rune, 2019, Data Analyst: Careers in Data Analysis, BCS (The Chartered Institute for IT)

Barker, Jessica, 2020, Confident Cyber Security: How to Get Started in Cyber Security and Futureproof Your Career (Kogan Page)

Pontus, M.J., 2021, Management for Beginners: The Ultimate Guide for First Time Managers, Self-published

Websites

www.lucidchart.com/blog/communicate-with-senior-management
www.prnewsonline.com/water-cooler/2015/02/27/10-tips-for-smart-communications-with-upper-management
www.grammarly.com/business/learn/types-of-business-communication/

www.highspeedtraining.co.uk/hub/what-is-cpd/
www.makingbusinessmatter.co.uk/barriers-to-effective-communication/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand the role of Continuous Professional Development (CPD) in the professional development of IT practitioners	All of the units contribute towards CPD as the learners (and then learners as employees) come across new technologies, approaches, methodologies and technologies when in the world of work. There is a good opportunity here as part of teaching this outcome to ask learners to consider why academic/vocational computing/IT qualifications and professional qualifications and certificates are updated regularly. You should also explain the importance of documenting CPD activities to ensure that evidence is available for formal personal reviews. **All units/LOs**.
LO2 Understand the factors that contribute to different types of communication and the reputational impact of good business communication	Summaries of numerical data and data visualisations as laid out in **U6 LO3** are regularly used to communicate information. In this unit, the importance of accurate data is stressed because of the potential reputational impact of misinformation.
LO3 Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management	As stated above, summaries of numerical data and data visualisations as laid out in **U6 LO3** are regularly used to communicate information. In this unit, the importance of accurate data is stressed because of the potential reputational impact of misinformation.
LO4 Understand how barriers to communication can be overcome to support users as customers	Communication as a barrier to digital transformation, as outlined in **U1 LO2** and **U1 LO3**, is the most important risk in relation to any IT related activity in all pathways. Practitioners should develop negotiation techniques and strategies to overcome any negative or uncooperative attitudes demonstrated by stakeholders in a project, transition or transformation activity, or even in day-to-day interactions with non-technical users.
Opportunities for Synoptic Assessment	
Some of the Distinction criteria require knowledge from one or more of the LOs. In this unit, **AC 4D1** includes assessment across **LO3** and **LO4**. In addition, Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Problem-solving – Understanding why continuous professional development is essential for the IT practitioner in their job role (LO1). Learners must understand that their demonstrated behaviour impacts on how their organisation, their department and how they themselves are perceived (LO2). **Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO1). **Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3, LO4). **Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research to support argument, presenting data) (LO1, LO2, LO3, LO4).	**Using sources of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3, LO4). **Reading Skills** – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3, LO4). **Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3, LO4). **Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3, LO4).

Unit 3 Advanced Statistics for Data Science	
Unit aims	This unit introduces statistical and probability concepts for understanding statistical models. It enables learners to numerically evaluate the performance of algorithmic models and equips them with practical knowledge of statistical modelling techniques such as regression, Bayes classifiers and support vector machines. The learners will undertake a practical activity in applying one of these algorithms to data.
Unit level	5
Unit code	A/651/7143
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand ways to evaluate the performance of algorithmic models	1.1 Explain why and how to use separate training and validation datasets 1.2 Explain how a confusion matrix is constructed and what information it shows	1M1 Discuss the dangers of overfitting an algorithmic model	1D1 Evaluate how numeric performance metrics can enable automatic selection of algorithmic models amongst multiple candidates
2. Understand statistical prediction and regression	2.1 Explain how multiple linear regression can be used for forecasting 2.2 Explain the assumptions and limitations of linear regression, and how visual plots can be used to validate the assumptions and point out the existence of limitations 2.3 Carry out appropriate training, fitting, and evaluation of a linear	2M1 Discuss different ways to choose an appropriate set of explanatory variables	

	regression model in Python using scikit learn		
3. Understand and can apply traditional statistical machine learning algorithms	3.1 Explain how a naïve Bayes model can be used for predicting the category of unknown observations 3.2 Carry out appropriate training, fitting, and evaluation of a naïve Bayes classifier model in Python using scikit learn 3.3 Carry out appropriate training, fitting, and evaluation of a support vector machine model in Python using scikit learn	3M1 Explain the limitations and assumptions of a naïve Bayes classifier model	3D1 Compare the benefits of using naïve Bayes models vs support vector machines for classification problems

Indicative Content

1 Understand ways to evaluate the performance of models

- The importance of splitting input data or using separate data sets for:
    - Training data
    - Testing data
    - Validation data
- The importance of evaluating individual algorithmic models
- Simple graphs of algorithmic model output
- Bias vs variance
    - Underfitting; imposing inappropriate restrictions on underlying data structures
    - Overfitting; not appropriately restricting the model complexity
- Regression accuracy
    - Residual error graphs; independent and identically distributed
    - Explained variance, mean squared error, R squared
- Classification and prediction accuracy
    - True positive, true negative, type I error, type II error
    - Specificity and sensitivity
    - Accuracy, precision and recall, ROC curve and Gini coefficient
    - Confusion matrixes for models with more than 2 target classes
    - Chi-squared test

2 Understand statistical regression and prediction

- Linear Regression
    - Simple linear regression, best fitting line
        - Use of appropriate software to calculate, e.g. spreadsheets or Python
    - Multiple linear regression for multivariate data

        - Use appropriate software to calculate, e.g. spreadsheets or Python
    - Assumptions and sensitivities of linear regression
        - Linear relationships
        - Homoscedasticity
        - Error normality
        - No multicollinearity
        - No autocorrelations
        - Sensitivity to outliers
        - Use of suitable plots for inspection of linearity, homoscedasticity, error normality
        - Use of suitable plots for inspection of outliers
    - Formula and components
        - Intercept, coefficients
        - Independent variables, dependent variable
    - Linear Regression Forecasting
        - Interpolation vs extrapolation
        - Interpretation of accuracy, e.g. mean squared error, R squared
        - Producing formulae, tables and suitable plots
    - Choosing explanatory variables
        - All possible combinations of independent variables
        - Forward selection of variables
        - Backwards elimination of variables
    - Use appropriate software to train, apply and evaluate a model, e.g. spreadsheets or Python

3 Understand and apply traditional statistical machine learning algorithms

- Bayes theorem
    - Conditional Probability
        - Notation
    - Elements of the equation
        - Posterior probability
        - Prior probability
        - Likelihood
        - Marginal probability
    - Simple Binary Classifier given estimates of prior, likelihood and marginal probability
        - Calculation of posterior probability
    - Naïve Bayes Classifiers based on training and test data samples
        - Assumptions of independence and gaussian distribution
        - Calculation of stratified training sample means and variances
        - Calculation of posterior numerator by group
- Support vector machines
    - Non-linearly separable observations
    - Separation of observations and label classification
    - Input space
        - Feature count, aka multidimensional space
        - Coordinates, aka support vectors
    - Transformations and feature space
    - Cost function, e.g. mean squared error
    - Maximal margin hyperplane
    - Common Kernel functions
        - Linear
        - Polynomial
        - Radial Basis Function
        - Sigmoid
    - Evaluating the model
    - Turning appropriate kernel function

    - Use appropriate software to train, apply and evaluate a model, e.g. spreadsheets or Python
- Naïve Bayes classifiers vs support vector machines
    - Requirement for linear relationships
    - Sensitivity to outliers
    - Speed and efficiency
    - Need for tuning parameters, e.g. kernel functions and prior probabilities

Suggested Resources

Bruce, P., Bruce, B., Gedeck, P. (2020) *Practical Statistics for Data Scientists*, O'Reilly

Müller, A., Massaron, L. (2023) *Python for Data Science for Dummies*, Wiley

Müller, A., Guido, S. (2016) *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly

Montgomery, D. C., Peck, E. A., Vining, G. G. (2021) *Introduction to Linear Regression Analysis*, 6th Edition, Wiley

Boyle, J. (2024) *Understanding Linear Regression with Python*

Downey, A. B. (2021) *Think Bayes: Bayesian Statistics in Python*, O'Reilly

Websites

https://www.comet.com/site/blog/introduction-to-machine-learning-model-evaluation/

https://medium.com/@asmello/introduction-to-model-evaluation-part-1-regression-and-classification-metrics-e75179d01db

https://machinelearningmastery.com/a-gentle-introduction-to-bayesian-statistics/

https://www.open.edu/openlearn/science-maths-technology/bayesian-statistics/content-section-0

https://www.ibm.com/think/topics/support-vector-machine

https://www.kdnuggets.com/2023/07/gentle-introduction-support-vector-machines.html

https://www.spiceworks.com/tech/big-data/articles/what-is-support-vector-machine/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand ways to evaluate the performance of algorithmic models	Performance evaluation is key to understand and mitigate the risk associated with data driven digital transformations, which is a key subject covered in **Unit 1**, particularly in **LO2**. The evaluation techniques covered in this unit should also be used in **Unit 7** and **Unit 8** when implementing machine learning algorithms
LO2 Understand statistical prediction and regression	The practical task of how to produce visual plots is covered in **Unit 6 LO3**, whereas this unit covers why these plots are

LO3 Understand and apply traditional statistical machine learning algorithms	important and one purpose they can serve in understanding numerical data is covered in this unit. Whereas this unit covers traditional statistical models and their implementation, **Unit 7** and **Unit 8** similarly cover the implementations of machine learning algorithms. Expanded and combined with practical skills covered in other units, a statistical machine learning implementation could form the basis for a larger practical project for the advanced project in **Unit 9**.
Opportunities for Synoptic Assessment	
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Working independently - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3). **Communication Skills** - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO1, LO2). **Leadership** - Leadership is the skill of motivating a group of people to act towards achieving a common goal. In organisations, this means directing workers and colleagues with a strategy to meet the organisation's needs (LO2). **Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO2, LO3).	**Self-organisation** - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO1, LO2, LO3) **Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3). **Using source of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3). **Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3). **Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2).

	Thinking Skills – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO1, LO2, LO3).

Unit 4 Information Systems	
Unit aims	When working in industry, IT practitioners must be able to see the bigger picture, drawing on all of their knowledge and previous experiences to find the best and most viable solutions to the problem. This is particularly important when working with non-technical managers who may not understand the technologies that they need to be able to perform their role. Practitioners must be able to share their knowledge and understanding in an appropriate way to promote the use of data and information systems to support modern business and enterprise. This unit enables learners to examine a wide range of information systems that they will find in industry.
Unit level	5
Unit code	K/651/0153
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	No specialist resources are needed to deliver and assess this unit. In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand different types of information systems that are used in an organisation	1.1 Explain different types of information system with examples of their application 1.2 Describe the components of an information system 1.3 Explain the characteristics of information systems	1M1 Choose and recommend an information system in a business context	1D1 Justify your choice of information systems in a business context
2. Understand the principal uses, advantages and disadvantages of information systems	2.1 Explain the principal uses of information systems 2.2 Describe the advantages of information systems and how they can be		

	used by organisations 2.3 Describe the reasons why information systems can fail		3D1 Evaluate the importance of testing different scenarios by changing variables within projection models
3. Understand how organisations use information systems to support strategic and operational decisions	3.1 Examine, with examples, how information systems are used to support strategic decisions 3.2 Examine, with examples, how information systems are used to support operational decisions 3.3 Present your arguments to a non-technical audience	3M1 Analyse the key benefits of information systems in how they are used to support strategic and operational decision making, ensuring that data is used ethically and within regulatory and legislative constraints	

Indicative Content

1 Understand different types of information systems that are used in an organisation

- Types of information systems:
  - Expert Systems (ES) (e.g. used in health, science, engineering)
  - Knowledge Systems (KS) (e.g. helpdesk and support systems)
  - Knowledge Work Systems (KWS) (e.g. Computer Aided Design (CAD), Virtual Reality (VR))
  - Transaction Processing Systems (TPS) (e.g. payroll, booking, stock control, point of sale (POS), supply chain management, automated ordering)
  - Management information (MIS) (e.g. Human Resource (HR), budgeting, sales management, customer relationship management systems (CRM), crime and fraud detection, terrorism detection using Artificial Intelligence (AI))
  - Decision support (DSS) (e.g. financial planning systems, logistics and transportation systems)
  - Executive support systems (ESS) (drawing data from DSS and MIS systems)
  - Online Analytical Processing (OLAP) (e.g. used in marketing, forecasting, process management)
  - Office Automation Systems (OAS) (e.g. word processing, email)
  - Process control (PCS) (e.g. used in water purification, desalination plants, sewage management, food manufacturing and processing, chemical processing and refining, vehicle manufacturing, nuclear power)

- Components of information systems:
  - Sources of data
  - Databases
  - Data Warehouses
  - Hardware (input and output devices)
  - Software
  - Networks
  - Human resources
  - Defined policies and procedures

- Characteristics of information systems:
  - Collecting data
  - Processing data
  - Storing data
  - Distributing information

2 Understand the principal uses, advantages and disadvantages of information systems

- Principle uses of information systems:
  - Automate operational processes
  - Production of information that is reliable and up to date
  - Manage internal data
  - Organise data
  - Manage change
  - Control organisational activities

- Advantages of information systems
  - Reduction in time taken to achieve routine tasks
  - Reduced labour costs
  - Finding ways to realise competitive advantage
  - Finding ways to make optimal use of organisational resources
  - Production of real time data
  - Reduction of errors
  - Faster response
  - Greater variety of ways to present information

- Disadvantages of information systems
  - Poor initial design
  - Incorrect setup (GIGO principles – Garbage In, Garbage Out)
  - Systems can fail (e.g. data loss, processing errors, hardware failure, software fault, poser outages, disaster including sabotage, natural disaster, user error due to poor training

3 Understand how organisations use information systems to support strategic and operational decisions

- Applications of information systems – strategic
  - Analysis of trends
  - Analysis of competitors
  - Carry out cost-benefit analysis
  - Financial forecasting
  - Set and manage future budgets
  - Reduction of costs
  - Create competitive advantage
  - Create new products
  - Improve products
  - Improve services
  - Establish future goals and aspirations
  - Planning improvements
  - Key benefits of information systems in supporting strategic decision making:
    - having the right information to support long-term decision making
    - having the ability to test different scenarios by changing variables within projection models

- Applications of information systems – operational
  - Day to day management of staff
  - Day to day management of resources
  - Production planning
  - Logistics planning
  - Providing e-learning/training
  - Booking management
  - Communication (e.g. video conferencing, Teams channels, remote working)
  - Key benefits of information systems in supporting operational decision making:
    - faster responses
    - better customer service
    - better control of resources

- Identifying business objectives and aligning a data strategy to support objectives (e.g. data in the right format, unbiased data, sufficient data)

- Identifying long-term strategic objectives and planning a data strategy to support objectives

- Ensuring that data is used in a way that is ethical and is within relevant regulatory and legislative constraints

Suggested Resources

Benyon-Davies, Paul, (2019), Business Information Systems, Red Globe Press

Stair, Ralph et al., (2020), Principles of Business Information Systems, Cengage Learning EMEA

Cadle, James, (2014), Developing Information Systems: Practical guidance for IT

Peppard, Joe et al., (2016), The Strategic Management of Information Systems: Building a Digital Strategy

Laudon, Kenneth and Jane, (2021), Management Information Systems: Managing the Digital Firm

Websites

https://opentextbook.site/informationsystems2019/chapter/chapter-1-what-is-an-information-system-information-systems-introduction/
https://www.britannica.com/topic/information-system
www.umn.ac.id/en/information-system-applications-in-daily-life/
https://au.indeed.com/career-advice/career-development/examples-of-information-management-systems

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand different types of information systems that are used in an organisation	From a generic perspective, **Unit 4** has a direct link with **U1 LO1** as the underpinning concept for understanding opportunities and drivers for digital transformation. In addition, this unit is particularly relevant for data analytics where there are strong links with **U5 LO1** advanced relational database concepts.
LO2 Understand the principal uses, advantages and disadvantages of information systems	
LO3 Understand how organisations use information systems to support strategic and operational decisions	
Opportunities for Synoptic Assessment	
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Problem-solving – Whether working in a technical role, development or data role, practitioners must understand the concept of information systems and how different information systems are built on the same principles but with completely different applications. The practitioner must be able to select and justify the use of specific information systems to solve a problem (LO1, LO2, LO3). **Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats. **Working independently** - Using own initiative, self-organisation, maintaining	**Using sources of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3). **Reading Skills** – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3). **Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3). **Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).

motivation/focus, managing tasks (LO1, LO2, LO3). **Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research to support argument, presenting data) (LO1, LO2, LO3).	

Unit 5 Advanced Database Practice	
Unit aims	This unit will teach the learners relational theory concepts such as normalisation, foreign keys, ensuring consistency, three value logic, indexes for efficiency, database optimisation etc. As an advanced course, it will presume that the learners have some familiarity with basic SQL extraction and manipulation techniques, such as those taught in L4 Unit 8. It will teach how to create various database objects and their benefits, e.g. tables, dynamic/materialised views, triggers, stored procedures, user defined functions etc.
Unit level	5
Unit code	L/651/0154
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand advanced relational database concepts	1.1 Discuss how SQL implements relational set theory and the relational model 1.2 Explain why the SQL standard is not Turing Complete and the consequences 1.3 Describe why data should be normalised and carry out normalisation of tables	1M1 Compare the relational set operators, such as the relation operators, set operators and relational joins, to the SQL operators	1D1 Evaluate the importance of ensuring ACID properties and how it can be achieved
2. Understand and carry out definition and manipulation of database objects	2.1 Carry out the creation of tables as SELECT statements and by column definitions 2.2 Carry out the creation, amendment and deletion of databases, views, indexes, functions and stored procedures	2M1 Apply an appropriate SQL index to a table, and justify the choice of table and index configuration	

3. Understand the structure and function of database objects	3.1 Explain the advantages and types of views 3.2 Explain how functions and stored procedures are used 3.3 Explain what triggers are used for	3M1 Compare materialised and non-materialised views	3D1 Evaluate the ways views can improve query performance and the trade-offs this can have

Indicative Content

1. Understand advanced relational database concepts

- Relational Set Theory
  - Entities and classes
  - Tuples, relations, and predicates
  - Relation operators: e.g. projections, selection, rename
  - Set operators: e.g. union, difference and cartesian products
  - Relation joins: e.g. natural, theta, semi, anti and division
  - How SQL implements the mathematical theory
  - Relational Set Theory and standard SQL are not Turing complete
- The Relational Model
  - Relations; heading and body, collection of tuples
  - Attribute; values and names, domains
  - Tuples; unordered collection of attributes
  - Relationship to tables, keys, and relationships
  - Arity and cardinality
  - The practical use in relational database design
  - Data schema definitions by SQL DDL
- Normalisation
  - Reasons for normalisation, e.g. reuse, integrity and reduce redundancy
  - First, Second, Third, Boyce-Codd, Fourth, Fifth normal forms
  - Unique rows, no duplicate rows
  - Scalar vs composite values, noncompound values
  - Candidate and primary keys
  - Functional dependency
  - Transitive dependency
  - Superkeys
  - Multivalued dependency
  - Detection and treatment of anomalous data updates, inserts or deletions
  - Drawbacks of normalisation / reasons for denormalization
- Ensuring data integrity
  - Database transactions ACID properties
    - Atomicity; all or nothing transaction
    - Consistency; constrains on acceptable data
    - Isolation; single unit of work
    - Durability; system failure
  - How a RDBMS ensure data integrity with locking and transactions
  - Commit and rollback commands
  - Problems with locking, e.g. race conditions
  - Referential integrity; dangling foreign keys, propagation

- Data Models
    - Abstract representations, focus on static properties not behaviours
    - Conceptual Models; what is in the system, business description
    - Logical Models; the implementation; business analysts and architects
    - Physical models; the specifics of the system, database administrators

2. Understand and carrying out definition and manipulation of database objects

- Databases
    - CREATE database
    - USE database
    - DROP database
- Tables
    - CREATE table as SELECT statement
        - CREATE temporary table
    - CREATE table with column definitions, primary key and constraints
        - Column names
        - Data types specifications, null/not null
    - RENAME table
    - ALTER table
        - ADD column
        - DROP column
    - DELETE table
        - With WHERE CLAUSE
        - TRUNCATE table
    - DROP table
- Views
    - CREATE view
    - RENAME view
    - UPDATE view
    - DROP view
- Index
    - CREATE index, unique and non-unique
    - DROP index
    - ALTER index
- Stored procedures and triggers
    - CREATE procedure
    - DROP procedure
    - CREATE trigger
        - Before or after
        - Insert, update or delete; referential integrity
    - ALTER trigger
    - DROP trigger
    - DISABLE trigger

3. Understand the structure and function of database objects

- Views
    - Advantages: simplify/customise access, enabling security, providing interface etc.
    - Materialised vs non-materialised
    - Dynamic updating
- User Defined Functions & Stored procedures
    - Advantages: enabling security, reduced IO, providing interfaces, improving code reuse and maintenance etc.

    - Functions vs stored procedures
    - Input parameters and return types
- Triggers
    - Advantages: constraint management, security logging, etc.
    - Events types
- Indexes
    - Types of indexes; e.g. SQL server: clustered, non-clustered, column, filtered, hash and unique
    - Advantages; query optimisation, central logic etc.
    - Disadvantages, space requirements, slower insert, update and delete etc.

Suggested Resources

Forta, B., (2022), *SQL in 10 Minutes a Day*, 5th Edition, Sams Publishing

Nield, T., (2016), *Getting Started with SQL: A Hands-On Approach for Beginners*, O'Reilly

Bush, J., (2020), *Learn SQL Database Programming*, Packt Publishing

Date, C.J., (2009), *SQL and Relational Theory*, O'Reilly

Warner, S., (2019), *Set Theory for Beginners*, Get 800

Websites

https://www.w3schools.com/sql/
https://www.codecademy.com/learn/learn-sql
https://medium.com/visionnlp/fundamentals-of-sql-deep-dive-into-sql-theory-304fadf945a3
https://www.sqlshack.com/learn-sql-set-theory/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand advanced relational database concepts	For many organisations, the databases concepts explored in this unit provide the structure and processes needed to manage data generated by day-to-day activities. For this reason, there are strong links with information systems in the **core** programme. **Unit 4** learning outcomes **U4 LO1**, **U4 LO2** and **U4 LO3** examine the database as an information system, particularly examining how and why these systems are used to support strategic and operational decisions.
Opportunities for Synoptic Assessment	
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Working independently- Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3). **Communication Skills -**You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO2, LO3). **Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO1, LO2, LO3). **Digital Skills** - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access and manage information (LO1, LO2, LO3).	**Self-organisation** - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO3). **Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3). **Using sources of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3). **Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3). **Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO2, LO3). **Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it. (LO2, LO3).

Unit 6 Programming for Data Engineering	
Unit aims	This unit introduces various tools and languages used for data engineering. It presumes that the learners have a basic understanding of programming at the level normally taught in L3 or L4 computing programming syllabi. It will use the SciPy ecosystem of module in Python (mostly pandas and matplotlib) to perform efficient programmatic data loading and data manipulation using a variety of functions provided by the modules.
Unit level	5
Unit code	M/651/0155
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand tools and languages used for data engineering	1.1 Explain, with examples, the difference between imperative and declarative programming techniques 1.2 Explain, with examples, the difference between scripted and compiled programming languages 1.3 Discuss why different languages are often used at different stages in the data and development lifecycles	1M1 Analyse the features and paradigms of three programming languages that are used for data engineering	1D1 Evaluate the benefits and drawbacks of proprietary languages used for data engineering
2. Understand data loading and manipulation techniques	2.1 Carry out appropriate data loading in Python using pandas 2.2 Carry out appropriate data manipulation in Python using pandas	2M1 Justify your choice of techniques used in data manipulation and aggregation	2D1 Analyse the benefits of doing the data loading and manipulation in an alternative way or

	2.3 Carry out appropriate aggregations in Python using pandas		using an alternative language
3. Understand data visualisation functions	3.1 Carry out basic data visualisations in Python using pandas and matplotlib 3.2 Apply colour schemes, titles and axis formats to make the data visualisations clear	3M1 Design and create an interactive data visualisation, e.g. an interactive graph	

Indicative Content

1. Understand languages used for data engineering

- Programming paradigms
  - Imperative; procedural and object-oriented
    - E.g. C/C++, Java, C#, JavaScript and Python all support imperative programming
  - Declarative; functional
    - E.g. SQL and Haskell are declarative languages, and Python, R, and many other languages contain declarative features
  - General purpose vs domain specific
    - E.g. C/C++, Java, C#, JavaScript, Python and Haskell are general purpose languages
    - E.g. SQL is a domain specific language (its domain is data definition and manipulation in RDBMS)
  - Scripting vs compiled languages
    - C/C++ code is typically compiled, whereas Python and R code are interpreted (aka. scripted)
  - Proprietary languages
    - Matlab is a proprietary language by MathWorks and C# was a proprietary language by Microsoft until it was defined as an ISO/IEC standard
- Popular languages used in data engineering
  - Why each language is popular
  - The paradigm(s) the languages implement
  - What is each language's role in the data and development lifecycle, e.g.:
    - Websites and mobile apps development
    - Back-end system development
    - Data movement or API development
    - Data organisation and storage management
    - Data analytics and data science

2. Understand data loading and manipulation techniques

The following indicative content is suggested for the Python programming language using the pandas library in an Anaconda/Spyder environment, but if another language, library or IDE is used, then equivalent content should be chosen.

- Learn typical data engineering tasks in Python using pandas.
- Integrated Development Environment

    - New, open and save python scripts
    - Installing packages from PyPI
    - Run file or run line/selection in interactive mode
    - Variable explorer
    - New and restart consoles
- Core Python
    - General purpose language, supports imperative programming paradigms
    - Comments, variables, build-in data types, casting, operators, variable scope
    - User input, print function, string formatting
    - Lists, tuples, sets, dictionaries, arrays
    - If…else, while and for loops
    - Functions, lambda, classes and objects, inheritance, polymorphism
    - Modules; import all or individual objects, using aliases
    - Try…except
    - File handling; reading, creating, appending files
        - Advanced topic: file handling with the os module
- Pandas Data Structures
    - Pandas uses declarative programming in pythons imperative environment
    - Pandas is based on the mathematical numpy module which also supports machine learning algorithms
    - Copy of data structures vs pointers to data structures
    - In-memory storage and processing; benefits and drawbacks
    - DataFrames vs Series
    - Create empty series with/without row index
    - Create empty dataframes with/without column index and/or row index
    - DataFrame; 1st axis and 2nd axis
- Data Loading
    - Loading and exporting from/to csv files, json files, text files, dictionary, lists
    - Loading and exporting from/to databases tables and excel spreadsheets,
        - Advanced topic: reading, writing and manipulating data in an RDBMS' with the pyodbc or sqlite3 module
        - Advanced topic: use sqlite3 to create and manipulate data with SQL in python
    - Pickling and unpickling
- DataFrame Manipulation
    - Inplace manipulation vs new copies
    - View data
        - info, shape, describe, value_counts head and tail functions
        - columns and index attributes
    - Adding and removing columns
    - Selection and slicing
        - Selecting columns by name and index
        - Selecting rows by name and index
        - Selecting rows by filters with one or more conditions; loc, iloc, ix functions
        - The tilde (~) operator
        - Where and filter functions
    - Drop_duplicates; keep first, keep last and drop all
    - Rename; row index or columns
    - Sort_values, sort_index
    - Dropna, fillna, isnull, isna, notnull, notna functions
    - Element wise operations
        - Numerical
        - Comparisons

- Set operations; all, any functions
- Aggregations
  - aggregate, sum, count, abs, mean, min, max etc.
  - cumsum, cummin, cummax etc.
  - groupby aggregations
- Apply functions to all rows in a dataframe
- Pivot, melt, stack, unstack and T functions
- Iteration over rows; iterrows
  - Computationally slow
- Combining DataFrames; join, merge, append and concatenate

3. Understand data visualisation functions

- Display plots directly from DataFrames
  - Histogram, bar chart, pie chart, line plot, scatter plot etc.
  - Changing plot parameters, colours schemes, labels etc.
- Display more complicated plots using matplotlib module
  - Importing matplotlib.pyplot submodule
  - Having multiple subplots
  - Creating plots; histogram, bar chart, pie chart, line plot, scatter plot etc.
    - Markers, line style/color/width etc
    - Plot titles, X and Y labels, annotations etc.
  - Manipulating axes; labels, number formats, ticks etc.
  - Show; will appear in plots pane in Spyder
  - Saving plots to pictures files, such as png
- Interactive data visualisations
  - Investigate more complex and visually appealing graphs with either the bokeh, plotly or seaborn library

Suggested Resources

Jones, C. B., (2021), *Understanding Programming Languages*, Springer

Romano, F. and Kruger, H., (2021), *Learn Python Programming*, Packt

Ramalho, L., (2022), *Fluent Python: Clear, Concise, and Effective Programming*, O'Reilly

Molin, S. and Jee, K., (2021), *Hands-On Data Analysis with Pandas*, Packt

Fischetti, T., (2018), *Data Analysis with R*, Packt

Hubbard, J. R., (2017), *Java Data Analysis*, Packt

Bhatia, A. and Kaluza, B., (2018), *Machine Learning in Java*, Packt

Websites

https://www.geeksforgeeks.org/introduction-of-programming-paradigms/
https://www.freecodecamp.org/news/what-exactly-is-a-programming-paradigm/
https://www.python.org/about/gettingstarted/
https://www.w3schools.com/python/default.asp
https://www.udacity.com/course/introduction-to-python--ud1110
https://www.w3schools.com/r/r_intro.asp
https://www.datacamp.com/courses/free-introduction-to-r
https://towardsdatascience.com/machine-learning-in-java-e335b9d80c14
https://www.springboard.com/blog/data-science/which-is-better-for-ai-java-or-python/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand tools and languages used for data engineering **LO2** Understand data loading and manipulation techniques **LO3** Understand data visualisation functions	**Unit 6** covers general programming concepts which are then expanded upon in the programming for data manipulation tasks in **units 7 and 8**.
Opportunities for Synoptic Assessment	
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Working independently - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3). **Communication Skills** - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO2, LO3). **Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational	**Self-organisation** - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO3) **Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3). **Using sources of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3). **Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different

way to understand connections between ideas/and/or facts (LO1, LO2, LO3). **Digital Skills** - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access and manage information (LO1, LO2, LO3).	purposes to reading and different reading styles (LO1, LO2, LO3). **Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO2, LO3). **Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO2, LO3).

Unit 7 Foundations of Artificial Intelligence for Data and Language	
Unit aims	This unit introduces the learners to the processes of how machines learn from data. It covers the basics of natural language processing as well as applying these techniques to a dataset. Learners will also investigate how generative AI models work, their strengths and weaknesses, and how such models can be used as components in computer systems.
Unit level	5
Unit code	D/651/7144
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand how machines learn from data	1.1 Describe the advantages and disadvantages of data mining in modern enterprises 1.2 Describe which types of models are used for different types of data 1.3 Explain why and how data preprocessing is done	1M1 Analyse why models typically require flattened and denormalised data	
2. Understand text mining algorithms	2.1 Describe why and how the typical preprocessing steps used for natural language models are used 2.2 Carry out an investigation, using appropriate displays for frequency analysis, named entity recognition, and a sample piece of text data	2M1 Analyse how lists of prescribed words and phrases can be frustrated by the use of slang, misspellings, symbols etc. in written text, and how can this be remedied	2D1 Discuss the importance of the context when analysing the meaning of words, sentences and texts in analysis of natural languages

	2.2 Carry out sentiment analysis on an appropriate sample set of text messages, and explain the results		
3. Understand the challenges of implementing Generative AI Models	3.1 Explain how LLMs are trained, how they work, and their strength and weaknesses 3.2 Describe correctness problems of prompt-to-image generators and the issues they have with the rights to their training data	3M1 Compare the benefits of using artificial intelligence models to increase productivity with the drawbacks or challenges that will be encountered	3D1 Analyse the security risks to AI models and what can be done to mitigate them

Indicative Content

1 Understand how machines learn from data

- Data mining
  - Extracting information/patterns from large data sets
  - Integrate techniques from database/data warehouse, maths/stats, machine learning/artificial intelligence and many more
  - Statistical methods
    - Based on proven mathematical theory
    - Regression analysis, statistical summaries
  - Machine learning
    - Pragmatic results driven approach
    - Supervised and unsupervised algorithms
    - Reinforcement learning
  - Artificial intelligence
    - Inspired by biological processes, e.g. brain neurons, genetic selection or insect swarms
  - Advantages: better informed business knowledge, finding “golden nuggets” of knowledge, competitive advantage etc.
  - Disadvantages: privacy/safety issues, needing expensive experts, risks of data dredging etc.
- Learning from different types of data
  - Relational data
    - Often requires data to be denormalized
  - Object-oriented data
    - Often requires data to be flattened
  - Transactional and time-series data
  - Speech or text documents
    - Require natural language processing techniques, such as sentiment analysis, named entity recognition, document retrieval/querying, answering questions in natural languages etc.
  - Aggregated data, e.g. data warehouse marts

- Transient/streaming data
- Steps to train models
  - Data preprocessing
    - The need for preprocessing
    - Benefits of using reconciled data (e.g. data warehouses) vs raw data (e.g. data lakes)
    - Descriptive statistics; central tendency, dispersion, graphic displays
    - Data cleaning; missing values and noisy data
    - Data integration and transformation
    - Data reduction; aggregation, attribute selection, dimensionality reduction, sampling
  - Model selection and creation
    - Considering multiple models
  - Model training
  - Model evaluation

2 Understand text mining algorithms

- Natural language processing (NLP)
  - Preprocessing of unstructured data
    - Tokenisation
    - Stemming and lemmatisation
      - Stemming vs lemmatisation; similarities and differences
      - Overstemming vs understemming
    - Part of Speech tagging, aka word tagging/labelling
      - Noun, pronoun, adjective, verb, adverb, interjection etc.
    - Named Entity Recognition (NER)
      - Chunk Patterns
      - Noun phrase: 'NP: {<DT>?<JJ>*<NN>}'
    - Smilies, symbols, misspellings and abbreviations
  - Word lists aka. lexica
    - Stop words
    - Banned words or terms: spam, swear, or offensive
  - Problems languages
    - Non-English texts
    - Mixed language documents
    - Definition of words, sentences etc. in other languages
    - Slang or misspelled words
    - Smilies or symbols
  - Typical use cases for NLP models
    - Sentiment analysis for social media and electronic communications
    - Spam Filtering and automatic moderation
    - Fraud detection and risk assessment
    - Predictive text and autocomplete
  - Sentiment analysis
    - Word polarity
  - Bag-of-Words (BoW) Model
  - Term Frequency – Inverse Document Frequency
  - Investigating text
    - Frequency distribution and plots; nltk.FreqDist
  - Python Natural Language Toolkit (NLTK)
    - How to install the NLTK package

        - Tokenisation
            - nltk.tokenize.word_tokenize
        - POS tagging
            - nltk.pos_tag
            - nltk.help.upenn_tagset()
        - Filtering stop words
            - nltk.corpus.stopwords
        - Stemming and lemmatisation
            - Porter: nltk.stem.PorterStemmer
            - Porter2 aka.Snowball: nltk.stem.SnowballStemmer
            - Lemmatisation: nltk.stem.WordNetLemmatizer
        - Chucking
            - nltk.RegexpParser
            - averaged_perceptron_tagger
            - nltk.pos_tag
        - Named Entity Recognition
            - maxent_ne_chunker
            - nltk.ne_chunk
        - Sentiment analysis
            - nltk.sentiment.vader.SentimentIntensityAnalyzer

3 Understand the challenges of implementing Generative AI Models

- What is Generative AI?
    - Similarities and differences from traditional natural language processing
    - History of conversational language models
        - Chatbots from Elisa to Tay
    - Large language models
        - What they can and can't do
        - Investigate free language models, e.g. ChatGPT, Bard, Microsoft Copilot
    - Image generators
        - How they work
        - Text prompts to image generation
        - Image diffusion
        - Investigate free image generators, e.g. Midjourney and Dall-E
    - How models are trained
        - Training data, learning from human data or from derived AI generated data
        - Human provided labelled data
        - Issues with plagiarism, copyrights, intellectual property etc.
    - Benefits
        - Increased efficiency by automation
            - Reduction in human error
            - Improved safety by data driven decisions
        - Continuous availability
            - Humans need breaks but computers can available always
    - Vulnerabilities and threats
        - Inaccuracy in results
            - Historical images with errors
            - Anatomical errors, e.g. hands, fingers, facial expressions
        - Bias from training data
            - Political correctness, over/under representation of population groups

        - Offensive results, swearing, extremist/fanatical advocacy
    - Misunderstood/missing context
        - Incorrect use of tools, such as
    - Hallucinations
        - Plausible but incorrect results
    - Data poisoning
        - Poisoning the training data, introducing deliberate bias
    - Prompt injections
        - Direct injection, e.g. ignore previous instructions
        - Jailbreaking, forcing safeguards override
    - Ethical and privacy concerns
        - Misuse or nefarious use
    - Explainability/lack of transparency
        - Unfair or harmful results
        - Lack of trust in results
        - Lack of responsibility for results
        - Regulatory compliance
    - Cyber security risks
        - E.g. UK Government AI and Cyber Risk Governance Framework – see suggested websites
    - High implementation cost

Suggested Resources

Raschka, S., Mirjalili, V. (2019) *Python Machine Learning*, 3rd Edition, Packt Publishing

Müller, A., Guido, S. (2016) *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly

Trappenberg, T. P. (Author) (2020) *Fundamentals of Machine Learning*, Oxford University Press

Alpaydin, E. (2020) *Introduction to Machine Learning*, 4th Edition, MIT Press

Lane, H., Howard, C., Hannes, H. M. (2019) *Natural Language Processing in Action: Understanding, analyzing, and generating text with Python*, Manning Publications

Sarkar, D. (2019) *Text Analytics with Python: A Practitioner's Guide to Natural Language Processing*, Apress

Iusztin, P., Labonne, M. (2024) *LLM Engineer's Handbook: Master the art of engineering large language models from concept to production*, Packt Publishing

Kublik, S., Saboo, S. (2022) *GPT-3*, O'Reilly

Websites

https://www.ibm.com/think/topics/machine-learning

https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained

https://conted.ox.ac.uk/courses/artificial-intelligence-introduction-to-machine-learning

https://www.simplilearn.com/10-algorithms-machine-learning-engineers-need-to-know-article

https://www.coursera.org/learn/introduction-to-machine-learning-with-python

https://openlearninglibrary.mit.edu/courses/course-v1:MITx+6.036+1T2019/about

https://www.w3schools.com/python/python_ml_getting_started.asp

https://www.datacamp.com/courses/introduction-to-natural-language-processing-in-python

https://www.databricks.com/resources/learn/training/generative-ai-fundamentals

Websites – UK Government Cyber and AI Risks

https://www.ncsc.gov.uk/guidance/ai-and-cyber-security-what-you-need-to-know

https://www.ncsc.gov.uk/collection/guidelines-secure-ai-system-development

https://www.gov.uk/government/publications/research-on-the-cyber-security-of-ai/cyber-security-risks-to-artificial-intelligence

https://digitaltrade.blog.gov.uk/2024/08/13/how-our-ai-governance-framework-is-enabling-responsible-use-of-ai/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO2 Understand text mining algorithms	This unit requires a significant amount of programming for data manipulation, which is closely related to **Unit 6** where general programming concepts are covered. The learners could also use techniques for the evaluation of models which is introduced in **Unit 3 LO1**. Expanded and combined with practical skills covered in other units, text mining algorithmic implementations could form the basis for a larger practical project for the advanced project in **Unit 9**.
Opportunities for Synoptic Assessment	
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Working independently - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3). **Communication Skills** - You use communication skills when giving and receiving different kinds of information.	**Self-organisation** - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO1, LO2, LO3) **Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are

This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO1, LO2). **Leadership** - Leadership is the skill of motivating a group of people to act towards achieving a common goal. In organisations, this means directing workers and colleagues with a strategy to meet the organisation's needs (LO2). **Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO2, LO3).	broken down into more manageable bite-size tasks (LO1, LO2, LO3). **Using source of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3). **Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3). **Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2). **Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO1, LO2, LO3).

Unit 8 Machine Learning in Practice: Structure, Strategy, and Evaluation	
Unit aims	This unit introduces the learners to a wide range of modern machine learning algorithms as well as applying these techniques to a dataset. The focus is on practical implementations as well as evaluating their performance.
Unit level	5
Unit code	F/651/7145
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand classification and prediction algorithms	1.1 Discuss the advantages and disadvantages that the structure of decision trees brings to machine learning 1.2 Carry out the data preprocessing, training, and evaluation of a decision tree model 1.3 Carry out the data preprocessing, training, and evaluation of a k-nearest neighbours model	1M1 Describe how k-nearest neighbour models achieve separation between groups in multidimensional space	1D1 Discuss the role and importance of distance metric for k-nearest neighbour models
2. Understand multi-layer perceptron classifiers (aka. neural networks)	2.1 Describe the structure of a perceptron and how they are combined into multi-layer neural networks 2.2 Discuss the advantages, disadvantages and common uses of multi-layer	2M1 Analyse why neural networks require large amounts of input data to train such models	2D1 Discuss the parameters and steps that can be used to optimise the training of a multi-layer perceptron network

	perceptron algorithms 2.3 Carry out the data preprocessing, training, and evaluation of a multi-layer perceptron model		
3. Understand genetic algorithms	3.1 Describe the biological evolutionary inspiration and the structure of a genetic algorithm 3.2 Carry out the data preprocessing, training, and evaluation of a genetic algorithm	3M1 Analyse how the learning process of genetic algorithms achieves convergence and how this can result in local maxima	

Indicative Content

1 Understand classification and prediction algorithms

- Decision trees
  - Hierarchical structure, roots, branches, internal and leaf nodes
  - Independent vs dependent variables
  - Algorithms
    - ID3, C4.5
    - CART (only one supported by Scikit-learn)
  - Optimisation
    - Selecting input variables
    - Attribute selection measures
      - Information gain and entropy
      - Gini impurity
    - Maximum depth, samples per leaf
  - Advantages
    - Non-parametric
    - Simple interpretation
    - Reduced data pre-processing
    - Flexibility
  - Disadvantages
    - Risk of overfitting
    - Computationally intensive
    - Sensitive to input data
  - Typical uses: research online
  - Python Scikit-learn libraries
    - sklearn.preprocessing.StandardScaler
    - sklearn.model_selection.train_test_split
    - sklearn.tree.DecisionTreeClassifier
      - parameters, e.g. criterion, splitter, max_depth, min_samples_split
      - functions, e.g. fit() and predict()

        - sklearn.metrics.accuracy_score()
    - Visualising Trees, research methods online
- k-nearest neighbours (KNN)
    - Multi-dimensional space, groups, decision boundaries
    - Within-group (intragroup) vs between-group variance
    - Normalisation of input variables
    - Input parameters
        - Distance metrics
            - Euclidian
            - Manhattan
            - Hamming
            - Advanced: Cosine
        - Number of neighbours, aka. k value
        - Cross-validation, experimentation
    - Advantages
        - Non-parametric
        - Simple interpretation
        - Few input parameters
    - Disadvantages
        - Risk of overfitting
        - Computationally intensive
        - Curse of dimensionality
    - Typical uses: research online
    - Python Scikit-learn libraries
        - sklearn.preprocessing.StandardScaler
        - sklearn.model_selection.train_test_split
        - sklearn.tree.KNeighborsClassifier
            - parameters, e.g. n_neighbours and metric
            - fit() and predict()
        - sklearn.metrics.accuracy_score()

2 Understand neural networks

- **Perceptrons**
    - Biological inspiration, simple artificial neurons
    - Nodes, input, weights, threshold, activation, output
- **Multi-layer perceptron classifiers**
    - Input layer, hidden layers, output layer
    - Normalisation of input variables
    - Common input parameters
        - Nodes in hidden layers
        - Activation functions
        - Maximum iterations
    - Advantages
        - Non-parametric
        - Handles unorganised data
        - Flexibility and accuracy
        - Continuous learning and adaptive from input
    - Disadvantages
        - Difficult interpretations, aka. black box
        - Computationally expensive training
        - Difficult to train
        - Require large amounts training data
    - Typical uses: research online

- Python Scikit-learn libraries
  - sklearn.preprocessing.StandardScaler
  - sklearn.model_selection.train_test_split
  - sklearn.neural_network.MLPClassifier
    - parameters, e.g. hidden_layer_sizes, activation, max_iter, tol
  - sklearn.metrics.accuracy_score()

3 Understand genetic algorithms

- Genetic algorithms
  - Biological inspiration, evolutionary basis, survival of the fittest
  - Initial population, evolution, fitness, crossover, mutations, generations/iterations
  - Common input parameters
    - Population sizes, aka. generational survivors
    - Number of training generations
    - Crossover and mutation probabilities
  - Advantages
    - Flexibility
    - Less susceptible to local maxima
    - Adaptability
  - Disadvantages
    - Complexity
    - Less understood as limited use
  - Typical uses: research online
  - Python GPLearn & Scikit-learn libraries
    - gplearn.genetic.SymbolicRegressor
      - parameters, e.g. population_size, tournament_size, generations, p_crossover, p_subtree_mutation

Suggested Resources

Raschka, S., Mirjalili, V. (2019) *Python Machine Learning*, 3rd Edition, Packt Publishing

Müller, A., Guido, S. (2016) *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly

Trappenberg, T. P. (Author) (2020) *Fundamentals of Machine Learning*, Oxford University Press

Alpaydin, E. (2020) *Introduction to Machine Learning*, 4th Edition, MIT Press

Klaas, S. (2021) *Neural Network for Beginners: Build Deep Neural Networks and Develop Strong Fundamentals using Python's NumPy, and Matplotlib*, BPB Publications

Buontempo, F. (2019) *Genetic Algorithms and Machine Learning for Programmers: Create AI Models and Evolve Solutions*, O'Reilly

Websites – General

https://www.ibm.com/think/topics/machine-learning

https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained

https://conted.ox.ac.uk/courses/artificial-intelligence-introduction-to-machine-learning

https://www.coursera.org/learn/introduction-to-machine-learning-with-python

https://openlearninglibrary.mit.edu/courses/course-v1:MITx+6.036+1T2019/about

https://www.w3schools.com/python/python_ml_getting_started.asp

Websites – Decision trees

https://www.ibm.com/think/topics/decision-trees
https://scikit-learn.org/stable/modules/tree.html
https://www.datacamp.com/tutorial/decision-tree-classification-python

Websites – k-nearest neighbors

https://www.ibm.com/think/topics/knn
https://scikit-learn.org/stable/modules/generated/sklearn.neighbors.KNeighborsClassifier.html
https://www.datacamp.com/tutorial/k-nearest-neighbor-classification-scikit-learn

Websites – Neural networks

https://www.ibm.com/think/topics/neural-networks
https://www.springboard.com/blog/data-science/beginners-guide-neural-network-in-python-scikit-learn-0-18/
https://carpentries-incubator.github.io/machine-learning-novice-sklearn/07-neural-networks/index.html
https://scikit-learn.org/stable/modules/generated/sklearn.neural_network.MLPClassifier.html

Websites – Genetic Algorithms

https://www.mathworks.com/help/gads/what-is-the-genetic-algorithm.html
http://ftp.demec.ufpr.br/CFD/bibliografia/an_introduction_to_genetic_algorithms_for_scientists_and_engineers_coley.pdf
https://gplearn.readthedocs.io/en/stable/intro.html
https://www.kaggle.com/code/elvenmonk/genetic-programming-sample-gplearn

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand classification and prediction algorithms **LO2** Understand multi-layer perceptron classifiers (aka. neural networks) **LO3** Understand genetic algorithms	This unit requires a significant amount of programming for data manipulation, which is closely related to **Unit 6** where general programming concepts are covered. The learners could also use techniques for the evaluation of models which is introduced in **Unit 3 LO1**. Whereas **Unit 7** deals principally with text and language models, this unit builds on the understanding of the types of machine learning algorithms, how they are used for different types of data, and the need for data preprocessing that is introduced in **Unit 7 LO1**. The contents covered in this learning outcome are directly applicable to the algorithms and practical tasks in this unit. Expanded and combined with practical skills covered in other units, either of the machine learning implementations from this unit could form the basis for a larger practical project for the advanced project in **Unit 9**.

Opportunities for Synoptic Assessment
Unit 9 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned across the qualification to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies.

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Working independently - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3). **Communication Skills** - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO1, LO2). **Leadership** - Leadership is the skill of motivating a group of people to act towards achieving a common goal. In organisations, this means directing workers and colleagues with a strategy to meet the organisation's needs (LO2). **Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO2, LO3).	**Self-organisation** - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO1, LO2, LO3) **Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3). **Using source of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3). **Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3). **Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2). **Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We

	apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO1, LO2, LO3).

Unit 9 Advanced Project	
Unit aims	This unit is designed to enable learners from any pathway to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies. The project should be a suitable match to their study pathway and should make use of the knowledge and skills gained when studying the other units making up their qualification.
Unit level	5
Unit code	T/651/0166
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades. The assessment will be made against the planning of the project, the use of project management tools, including the creation of a risk register, and a plan that outlines how the project should be reviewed so that valuable lessons are learned. Learners may implement their project/solution if they choose. However, the implementation of the project is not required for assessment purposes. This is the synoptic unit for the qualification and should be delivered as the final unit for learners in their qualification.

Learning outcomes The learner will demonstrate that they:	**Assessment criteria** The learner can:		
	Pass	**Merit**	**Distinction**
1. Understand the tools and techniques of IT project management	1.1 Identify and define a problem or opportunity that would benefit from a computing solution, defining its scope and its key stakeholders 1.2 Choose appropriate stakeholder engagement channels and explain the reasons why good stakeholder management is important 1.3 Use project management tools to plan a project	1M1 Justify your choice of stakeholder engagement channels	1D1 Evaluate how stakeholder engagement should be managed

2. Understand risk and risk mitigation in relation to IT projects	2.1 Create a risk register 2.2 Identify the risks associated with the project		2D1 Recommend and justify mitigations to manage the risks identified in the risk register
3. Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice	3.1 Plan a post-project review 3.2 Explain who should be included in the review process and why 3.3 Explain why projects are reviewed and how the outcomes of reviews are used to inform future practice	3M1 Analyse the impact that a lack of involvement and commitment by stakeholders/users will make on the project	

Indicative Content

1. Understand the tools and techniques of IT project management

- Project management tools
  - Project management software
  - Risk register
- Planning and implementing projects (managing workflow)
  - Plan project activities including timescales
  - Plan regular reviews to look at: progress, budget, stakeholder/user feedback
  - Risk register
  - Implementing the project against the plan
- Stakeholder engagement
  - Identifying key stakeholders and key relationships
  - Identifying key messages and ensuring consistency
  - Identifying appropriate communication channels for different types of stakeholders
  - Importance of good stakeholder engagement:
    - Involve stakeholders in the project
    - Manage expectations
    - Set the tone for the project
    - Ensure that stakeholders have a common understanding of the objectives of the project

2. Understand risk and risk mitigation in relation to IT projects

- Components of a risk register and how to use it (RAG rating, Red Amber Green)
- Key risks to IT projects with mitigations:
  - Costs - know your budget and review it regularly
  - Potential scope creep - know the boundaries of the project and be prepared to say no

- Stakeholder/user engagement - know your stakeholders/users and plan the right level of interaction with them; plan when users will be available so that prototypes or completed features or functionality can be shared for feedback
- Data preparation - examine your data needs and any preparation work that must be completed to ensure that the data is in the right format and is available on time
- Deadlines - use software to plan and monitor activity (and make files available to teams); review activity regularly; create an environment where your team will alert you to emerging problems
- Project handover - discuss how the project will be handed over with customers and end users to ensure that their expectations are met
- Testing - ensure that test data is prepared and used, but also that the customer provides enough real data for testing purposes
- The unexpected - try to identify emerging issues quickly; have a disaster recovery plan
- Regulatory/legislative requirements - which regulatory/legislative requirements are relevant
- Ethical considerations - are there any ethical considerations (such as how data is used, how programmed systems are made secure, how the physical systems themselves are protected)

3. Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice

- What to review (e.g.):
  - Each phase of the project lifecycle: feasibility study/systems analysis, design, planning, implementation, testing, handover
  - Involvement and commitment of stakeholders and users
  - Management of timescales
  - Management of costs
- Who to include in a review:
  - Internal: users, teams, departments, business owners, directors, employees, shareholders
  - External: external client or customer and their users, suppliers, the public, government, local community
- Reasons for review:
  - Examining how well project objectives were met
  - Examining any issues such as how well risks were managed
  - Enabling all stakeholders to share their perspectives on the activities and outcomes of a project
  - Identifying good practice so that this can be used in future practice
  - Identifying what went wrong to avoid this happening again
  - Identifying any training or development needs for development and project staff
- Potential impact of stakeholders/users lack of commitment to an IT project (e.g. project delays, product does not have expected functionality, stakeholder/user dissatisfaction in project outcomes, potential litigation for failing to deliver contract)

Suggested Resources

Fishpool, B. and Fishpool, M., 2020, Software Development in Practice, BCS (The Chartered Institute for IT)

Hanke, Daniel, (2022), The 10 most important methods in traditional project management: Rapidly acquire the most important skills to manage your projects successfully, Self-published

Hayden, Jack, 2023, Project Management Mastery: A comprehensive guide to successfully implementing the core principles of project planning and scope management from concept to completion, Self-published

Hughes, Bob, 2019, Project Management for IT-Related Projects: 3rd Edition, BCS (The Chartered Institute for IT)

Websites

https://assets.publishing.service.gov.uk/media/5bc72a97ed915d0ad7db6cd0/Project_Business_Case_2018.pdf
www.capterra.com/resources/mitigate-project-management-risks/
www.asana.com/resources/project-risks
www.stakeholdermap.com/risk/register-common-project-risks.html
www.tractivity.co.uk/blog/managing-stakeholder-relationships
www.consultationmanager.com/7-tactics-to-maintain-positive-stakeholder-relationships/
https://yourprojectmanager.com.au/managing-costs-project-manager/

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	**Teaching and learning links to other unit LO/AC**
LO1 Understand the tools and techniques of IT project management	To complete the project, learners will use appropriate project management tools and techniques to undertake a project in a similar way to that undertaken at Level 4. The difference with this project is that learners will need to place more emphasis on the mitigation of risk and the process of review. The project should potentially access all learning undertaken towards the qualification. This does not imply that the learning must come from all units studied but should draw on content that is appropriate to solve the problem identified.
LO2 Understand risk and risk mitigation in relation to IT projects	
LO3 Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice	

Opportunities for Skills Development within this unit	
Employability Skills	**Study Skills**
Problem Solving – Understanding the need for structured processes to ensure successful projects (LO1, LO2, LO3). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3). **Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). **Working independently -** Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3). **Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).	**Using sources of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3). **Reading Skills –** Identifying different sources of information, reading with a purpose (LO1, LO2, LO3). **Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3). **Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).