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| **MODULE TITLE:** | **Cloud Computing for AI and Data Science** |
| **MODULE CODE:** | IPLDSAM03 |
| **LEVEL:** | 7 |
| **MODULE LEADER:** | Dr Kakia (Aikaterini) Chatsiou |

**RATIONALE**

The on-demand delivery of compute, database, storage, applications and IT resources through cloud computing has enabled many organisations to deliver innovative solutions without upfront capital investment. Cloud computing ecosystems provide a variety of scalable AI and machine learning solutions. This module provides a comprehensive grounding in cloud computing concepts and solutions, buttressed with extensive practicals to build experience in individual services and architectural designs. As the University of Suffolk is an AWS Academy partner institution, the module will make extensive use of AWS, but will not be exclusively focused on AWS.

**AIMS**

Through the completion of this module students will:

1. Gain a comprehensive understanding of cloud computing concepts, economics, services and architectures
2. Gain experience in actual commercial cloud services
3. Be able to design a cloud solution using commercial cloud services

**LEARNING OUTCOMES**

On successful completion of this module, a student will be able to:

1. Evaluate the technical dimensions of AI and data science architectures and solutions with specific emphasis on cloud approaches
2. Combine theory, research and practice at forefront of the discipline and use it to guide the development of robust and high-quality cloud solutions and architectures
3. Critically review cloud solutions and tools for AI and data science problems
4. Demonstrate system-level competencies in assessing, understanding, creating and improving cloud-based architectural solutions

**ASSESSMENT**

Formative assessment will be undertaken through cloud practicals, architectural and costing analyses, and architectural design exercises.

The summative assignment will be to develop a cloud-based robust architectural solution for a specific scenario. The assignment will allow for an assessment and critical reflection on the solution. The scenario may be a set scenario for the entire cohort or individual to the student, and may be proposed by an industrial or organisational partner of the programme.

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| **Component number** | **Form of assessment** | **Assessment size** | **Weighting (%)** | **Learning outcomes assessed** | **Late Sub** | **Core or non-core** |
| 1 | Scenario-based Assignment | 5,000 words equivalent | 100% | ALL | Yes | Core |

**Assessment: Scenario-based Assignment Overview**

In this assignment, students will be asked to take up the role of a cloud data expert working closely with an organisation who would like to move parts of their operations in the cloud. Students will have at their disposal a list of scenarios with their requirements following an initial meeting with the client, or they could suggest a scenario of their own if they so desire (will need to confirm with the lecturer if this is the case by the end of Lecture 6 if this is the case).

The objective of the report is to research the organisational requirements (what the client thinks they need), as well as other requirements of other companies that have migrated recently in the cloud in the same sector (what the sector does) and suggest some options of cloud services that the client should consider. Students may also choose to implement an example of these technologies for the client to see how it would work in their case.

Here is how you could tackle this report:

1. Go through the user cases provided (or the one that you have chosen) and identify the requirements listed. Define the problem and the needs of the organisation.
2. Research what others are doing in the sector and what the typical needs of the sector are when it comes to cloud computing. Consider cloud economies and different cloud payment models.
3. Review the industry and academic literature on aspects of cloud computing offerings (AWS, Google Cloud, Microsoft Azure) that would be relevant for the client’s requirements
4. Design and draw cloud architecture diagrammes for the current and proposed systems and information architecture.
5. Discuss your findings and make recommendations on next steps the client needs to take for successful migration to the cloud and possibilities for growth and innovation using cloud technologies.

Note that whilst you will need to be as thorough in terms of your research as with any academic piece, the target reader of this report is a chief executive or manager of the company, so remember to adjust your tone accordingly.

The report is worth 100% of the overall mark for this module. It will be marked on clarity and readability of the sections below, as well as on the variety of recommendations and ability to critically review all the information you will have available to you at the time of writing the report and make recommendations. Here are some suggested sections of the report and their allocated marks:

**Executive summary (10 points)**

This is where you will summarise the main requirements, scope of the report, findings and recommendations. This part should be clear and self-contained and should include everything the busy executive needs to know about your report.

**Introduction (5 points)**

Introducing the report’s scope and aims, the challenges the organisation faces as included in the requirements and a brief overview of the structure of the report.

**Literature Review (15 points)**

A critical literature review of both the industry and academic literature supporting your recommendations. Use any search engine to look for cloud computing migration user cases; use the library search pages (<https://libguides.uos.ac.uk/>), the IEEE Xplore pages (<https://ieeexplore.ieee.org/Xplore/home.jsp>), or google scholar and the Connected Papers (<https://www.connectedpapers.com/>) space to explore different academic papers. Remember that the literature review should not just be descriptive but should be critical in nature and should be included in a way that supports your findings and recommendations. Review where cloud computing has benefitted educational institutions, comparison with other platforms

**Cloud Readiness Assessment (20 points) (Proposed cloud architecture)**

Using a cloud readiness assessment framework (such as the AWS Cloud Adoption Framework: <https://aws.amazon.com/professional-services/CAF/>) conduct an audit of existing systems and technologies currently employed in the organisation from different perspectives and stakeholders. This could include consideration of both business capabilities (business, people, governance, data) as well as technical capabilities (platform, security, operations). This will be covered in Lecture 6 in detail. Include and write about AWS architecture diagram

**Findings and Recommendations (25 points)**

In this section, you will combine the findings of the literature review and the cloud readiness assessment and come up with recommendations for the organisation for its next steps to migrate some of all of its technology to the cloud. Remember to critically analyse your findings and come up with recommendations of not just what the client thinks they need, but also what you as a cloud expert think they will need to grow and innovate. Why did I use various AWS componnts, redundancy, security, latency, scalability, elasticity, , how my architecture is fulfilling these principles.

**Roadplan for implementation (15 points)**

Draw a plan for implementation of your recommendations i.e. attach some dates to the actions the organisation needs to take to do their next step. Remember to include costs where possible, even if they are indicative, and consider dependencies such as possible downtime whilst services or data are migrated to the cloud. (Gantt Chart, e.g. 6 month plan, which order to migrate components, Legacy (temporary systems running in parallell

**Conclusion (10 points)**

Summary of what the key takeaway findings were and conclusions. Use this section to also discuss any limitations of the study and future directions. What were the aspects that this report didn’t or couldn’t cover and how could they be included in future assessments?

**SUBMISSION INSTRUCTIONS**

1. The report should be 5000 words max. If your submission exceeds the word count by up to 10% then there will be no penalty applied. Submissions that exceed the word count by more than 10% will be applied a fixed penalty of 5 percentage points (i.e., 5 marks). In all cases, the penalised mark will not be reduced below a pass level, assuming the work merits a pass. Tables, diagrams (including associated legends), appendices, reference lists, tables of contents, footnotes, and endnotes are excluded from the word count however should be used appropriately. It is for the Module Leader to decide if there is an excessive or inappropriate use of components excluded from the word count.
2. Your report could have sub-level or other high level headings, but you are strongly encouraged to keep the structure above. It should use line spacing of at least 1.15 and body font size of at least 11.
3. All bibliographies must be formatted according to the University of Suffolk Harvard Style. More information about citation and referencing is available here: <https://libguides.uos.ac.uk/academic/referencing/Harvard>
4. Ensure that your report is submitted as a single word or pdf document with a filename matching the pattern sXXXXXX.doc or SXXXXXX.pdf where sXXXXXX is your UoS UserID. Ensure that the document is also marked with your UoS UserId. Your name should not appear anywhere in the files.
5. Submit your document to the Brightspace module for ‘Cloud Computing for Data Science and AI’ under ‘Assessment’ > ‘Submission Folder for Technical Report’
6. Cite your references carefully – remember that the University of Suffolk has strict rules dealing with plagiarism and the university reserves the right to call any student to a viva examination of any piece of assessed work.
7. Use of AI

**SUGGESTED READING**

**Essential Resources**

The major cloud platforms (Amazon Web Services, Microsoft Azure, and Google Cloud) are undergoing continuous change and growth in tools and services. The platform providers’ documentation is more comprehensive and current than any textbook in this area.

There are links provided under each unit on Brightspace, that students are expected to have consulted whilst working on their assignment.

**Recommended Resources**

Couloris, G., Dillimore, J., Kindberg, T., and Blair, G. ((2011) *Distributed Systems: Concepts and Design*. 5th edn. Harlow: Pearson Education

Kleppman, M (2016) *Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems*. O’Reilly

Tanenbaum, A.S. and Van Steen, M. (2015) *Distributed Systems: Principles and Paradigms.* 2nd edn. Pearson.

**Further Resources**

Bahga,A.and Madisetti,V. (2013) *Cloud Computing: A Hands-On Approach*. Createspace Independent Pub.

Chopra, R. (2017) *Cloud Computing: An Introduction*. Mercury Learning & Information.

Erl, T., Puttini,R. and Mahmood, Z. (2013) *Cloud Computing: Concepts, Technology & Architecture*. Prentice Hall.

Murugesan, S. and Bojanova, I. (2016) *Encyclopedia of Cloud Computing. Wiley.*

Rittinghouse, J.W. and Ransome, J.F. (2009) *Cloud Computing: Implementation, Management, and Security.* Taylor & Francis Group

Rountree, D. and Castrillo, I. (2013) *The Basics of Cloud Computing: Understanding the Fundamentals of Cloud Computing in Theory and Practice*. Elsevier.

Wang, L., Ranjan,R., Chen, J. and Benatallah, B. (2011) *Cloud Computing : Methodology, Systems, and Applications.* Taylor & Francis Group.

**Journals**

* International Journal of Cloud Computing
* International Journal of Cloud Computing and Database Management International Journal of Cloud Computing and Services Science
* International Journal of Computer Science and Information Security
* Internet of Things and Cloud Computing
* Journal of Cloud Computing
* Journal of Cloud Computing: Advances, Systems and Applications
* Journal of Information Technology & Software Engineering

## Level 7 Module Grading Criteria

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| **Level 7** | | | | | | |
| In accordance with the FHEQ, at the end of Level 7 students should have a systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their academic discipline, field of study or area of professional practice. They will be able to demonstrate originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in the discipline. They should have a conceptual understanding that enables them to evaluate critically current research and advanced scholarship in the discipline and to evaluate methodologies and develop critiques of them and, where appropriate, to propose new hypotheses. They will also be able to deal with complex issues both systematically and creatively, make sound judgements in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences. In addition, they will be able to demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level. | | | | | | |
|  | | **Assessment category** | | | | |
| **Coherent and detailed knowledge and understanding of the subject area, at least some of which is informed by the latest research and/or advanced scholarship within the discipline** | **Cognitive and intellectual skills** | **Application of theory to practice (for courses with a professional practice element)** | **Reading and referencing** | **Presentation, style and structure**  Work that significantly exceeds the specified word limit may be penalized |
| **Pass mark, demonstrating achievement of all associated learning outcomes** | **90%-100%** | Exemplary systematic, theoretical and conceptual understanding of knowledge at or informed by the forefront of the field of study, demonstrating highly sophisticated grasp of the subject matter | Exceptional critical evaluation and awareness of current problems, and contemporary issues and debates that draws on new insights or perspectives within the field. Work demonstrates exemplary ability to synthesise current research and advanced scholarship in an original, creative and innovative manner. | Sophisticated, systematic and innovative application of knowledge and theory to professional practice within the discipline. Flawless use of systematically selected literature to justify and express reasoned judgements and decisions in relation to complex issues and problems at a professional level | A very high level of critical engagement across a systematic and fully appropriate range of relevant and current academic, research, policy- and practice-related literature demonstrating deep and selective reading and initiative along with highly consistent accurate referencing | Exemplary presentation of work that is fluent and flawless throughout. |
| **80%-89%** | Excellent systematic, theoretical and conceptual understanding of knowledge at or informed by the forefront of the field of study and showing sophisticated depth, breadth, detail and clarity | Sophisticated critical evaluation and awareness of current problems, and contemporary issues and debates that draws on new insights or perspectives within the field. Work demonstrates a very high level of originality and creativity in the student’s approaches to synthesising current research and advanced scholarship within the subject area | An excellent level of originality and innovation in the application of knowledge and theory to professional practice within the discipline. Demonstration of excellent critical awareness and evaluation and the ability to effectively critique and employ current academic literature in making reasoned judgements and decisions in relation to complex issues and problems at a professional level | A very high level of critical engagement across an extensive range of relevant and current academic, research, policy- and practice-related literature demonstrating deep and appropriate reading and initiative along with highly consistent accurate referencing | Outstanding presentation of work that is logically and coherently structured with a strong or original central argument(s), conveyed with a high level of fluency and eloquently communicates compelling, coherent conclusions to specialist and non-specialist audiences |

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| **Level 7** | | **Coherent and detailed knowledge and understanding** | **Cognitive and intellectual skills** | **Application of theory to practice** | **Reading and referencing** | **Presentation, style and structure** |
| **Pass mark, demonstrating achievement of all associated learning outcomes** | **70% – 79%** | A high level of systematic, theoretical and conceptual understanding of knowledge at or informed by the forefront of the field of study and showing considerable depth, breadth, detail and clarity | A high level of critical evaluation and awareness of current problems, and contemporary issues and debates that draws on new insights or perspectives within the field. Work demonstrates a significant level of originality and creativity in synthesising current research and advanced scholarship within the subject area | A high level of originality and innovation in the application of knowledge and theory to professional practice within the discipline. Demonstration of excellent critical awareness and evaluation and the ability to select and use academic literature in making reasoned judgements and decisions in relation to complex issues and problems at a professional level | A high level of critical engagement across an extensive range of relevant and current literature demonstrating wide and appropriate reading and initiative along with highly consistent accurate referencing | Excellent presentation of work that is logically and coherently structured with a strong or original central argument(s), conveyed with a high level of clarity of expression and which clearly communicates valid, coherent conclusions to specialist and non-specialist audiences |
| **60% – 69%** | An effective, systematic, theoretical and conceptual understanding of knowledge mostly at or informed by the forefront of the field of study and showing good depth, breadth, detail and clarity | An effective level of critical evaluation and awareness of current problems and contemporary issues and debates that draws on new insights or perspectives within the field. Work demonstrates some effective originality and creativity in synthesising current research and scholarship within the subject area | A good level of originality and innovation in the application of knowledge and theory to professional practice. Demonstration of consistently good critical awareness and evaluation and reasonable ability to use the academic literature in making reasoned judgements and decisions in relation to complex issues and problems at a professional level | A good level of critical engagement across a good range of relevant and current academic, research, policy- and practice-related literature demonstrating appropriate reading and some initiative along with consistent accurate referencing | High quality presentation of work that is largely logically and coherently structured with a generally strong central argument conveyed with a clarity of expression and which communicates clear conclusions to specialist and non-specialist audiences |
| **50% – 59%** | A sufficient but limited level of systematic, theoretical and conceptual understanding of knowledge at times at or informed by the forefront of the field of study but showing adequate depth, breadth, detail and clarity | A sufficient but limited level of critical evaluation and awareness of current problems and contemporary issues and debates, with some reference to new insights or perspectives within the field. Limited evidence of originality and creativity in synthesising current research and scholarship within the subject area | A reasonable but limited level of originality and innovation in the application of knowledge and theory to professional practice within the discipline. Demonstration of some good critical awareness and evaluation and some ability to use the academic literature in developing judgements and decisions in relation to complex issues and problems at a professional level | Sufficient critical engagement with a reasonable range of relevant and current academic, research, policy- and practice-related literature demonstrating mainly appropriate reading but limited initiative and/or some minor inconsistencies and inaccuracies in referencing | Generally good presentation of work that is sufficiently logical and coherent in structure with a discernible central argument. May present limited originality and lack some clarity of expression, but an identifiable conclusion reasonably communicated to specialist and non-specialist audiences |

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| **Level 7** | | **Coherent and detailed knowledge and understanding** | **Cognitive and intellectual skills** | **Application of theory to practice** | **Reading and referencing** | **Presentation, style and structure** |
| **Marginal fail** | **45% – 49%** | Knowledge and understanding of the subject matter is incomplete, uninformed or limited in its scholarship within the field of study, or lacking sufficient depth, breadth, detail or clarity | Critical evaluation is limited or lacks awareness of current problems and contemporary issues and debates. Insufficient reference made to new insights or perspectives within the field, or insufficient evidence of originality and creativity in synthesising current research and scholarship within the subject area | Insufficient degree of originality or innovation in the application of knowledge and theory to professional practice within the discipline. Demonstration of poor critical awareness and evaluation or a lack of ability to use the academic literature in developing judgements and decisions in relation to complex issues and problems at a professional level | Insufficient critical engagement with relevant and current academic, research, policy- and practice-related literature. Lack of evidence of wider reading or a lack of initiative or inconsistent and inaccurate referencing | Presentation of work shows insufficient organisation or central argument, and is lacking in logical and coherent structure. Poor clarity of expression weakly communicating to specialist or non-specialist audiences |
| **Fail** | **30% – 44%** | Limited knowledge and understanding of the subject matter shown. Work is not sufficiently informed by scholarship within the field of study and is insufficient in depth, breadth, detail or clarity | Insufficient evidence of critical evaluation and awareness of current problems and contemporary issues and debates. Insufficient reference to new insights or perspectives within the field and lacking in originality and creativity in synthesising current research and scholarship within the subject area | Little evidence of originality and innovation and a significant lack of application of knowledge and theory to professional practice demonstrating little critical awareness and evaluation and a lack of ability to use the academic literature to make judgements and decisions in relation to complex issues and problems at a professional level | Little evidence of critical engagement with relevant and current literature. Poor use of appropriate sources and/or inconsistent and inaccurate referencing | Often poorly presented work that is disorganised, has an ill-formed central argument, and lacks a logical and coherent structure. A lack of clarity of expression or fails to communicate effective conclusions to specialist or non-specialist audiences |
| **< 30%** | Inadequate and limited knowledge and understanding of the subject matter shown. Work is not informed by scholarship within the field of study and significantly lacks depth, breadth, detail or clarity | Descriptive work with little or no evidence of critical evaluation and awareness of current problems and contemporary issues and debates. No evidence of awareness of new insights or perspectives within the field. Little or no synthesis of current research and scholarship within the subject area | No evidence of originality and innovation and little to no application of knowledge and theory to professional practice. Demonstrates no critical awareness and evaluation and a distinct lack of ability to use the academic literature in an effective manner | No evidence of critical engagement with relevant and current literature. Lack of use of appropriate sources and inconsistent and inaccurate referencing | Poorly presented and disorganised work that lacks a logical and coherent structure, lacks a well-formed central argument and shows a significant lack of clarity of expression with very weak or irrelevant conclusions, that may be incoherent to specialist or non-specialist audiences |

\* Work that significantly exceeds the specified word limit may be penalized