# UNIVERSITY OF LIVERPOOL

| Module Specification<br>CSCK506 – Deep Learning |
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## Contents

## 1.    Module Details

| Module Title: | Deep Learning |
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| Short Title: | Deep Learning |
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| Module Code: | CSCK506 |
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| Marketing Module Synopsis: | Deep learning, a sub branch of the broader domain of machine learning founded on the concept of neural networks, is much in the news. Deep learning has provided remarkable benefits in the context of applications such as computer vision, image analysis and natural language processing, facilitated by recent advances in computing power. The module in deep learning provides students with a critical and systematic insight into the operation of a range of deep learning approaches using software libraries of the form that will be encountered in the modern work place operating using a cloud platform. The module will feature a particular focus on the practical application of deep learning approaches. On completion of the module students will be able to put what they have learnt into immediate effect in their place of work. |
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| Credits: | 15 |
| :--- | :--- |

| Level: | Level 7 |
|---|---|

| Delivery Location(s) | Online |
|---|---|

| Semester: | Whole Session |
|---|---|

| Academic Year: | 2021-22 |
|---|---|

| Faculty: | Faculty of Science and Engineering |
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| School/Institute (Level 2): | School of Electrical Engineering, Electronics and Computer Science |
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| Curriculum Board (level 1): | Computer Science PGT |
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| Module Coordinator: | Frans Coenen |
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| Other staff: | Helen Mattocks |
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| External Examiner(s): | Neil Gordon, Dan Neagu |
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| Pre-requisites: | N/A |
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| Co-requisites: | N/A |
|---|---|

| Barred Combinations: | N/A |
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| CE/CPD Provision: | No |
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| Overview: | The potential of deep learning, a sub branch of the broader domain of machine learning, is much in the news. Deep learning is founded on the concept of neural networks whilst at the same time harnessing the processing power that is now available to commercial enterprises of all kinds. The module in Deep Learning is designed to provide students with a critical and systematic insight into the operation of a range of deep learning approaches using software libraries of the |
|---|---|

| | form that will be encountered in the work place, typically operating using a cloud platform. The module will feature a particular focus on the practical application of deep learning approaches. On completion of the module students will be able to put what they have learnt into immediate effect in their place of work. |
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| Notes: | 21/22 Modification is minor and needs no further scrutiny.<br><br>20/21 Online module provided in collaboration with Kaplan Open Learning. |
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| Maximum Places: | 250 |
|---|---|

| Subject: | |
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| HESA Cost Centre(s): | MUST BE COMPLETED FOR APPROVAL |
|---|---|

| Status: | Modification Approval |
|---|---|

**The table below is automatically completed from programme data held in Curriculum Manager; during 2019/20 it is likely to have no data or incomplete data until all programme records are in Curriculum Manager.**

| In Programmes: | Programme Validation Status | Module Status: | Programme Stage / Group / / Sub-group |
|---|---|---|---|
| Cyber Security Master of Science (MSc) 2020-21 | Validated | Optional | Online Flexible Learning Y2<br><br>Online Flexible Learning Y2 Required module 7 |
| Data Science and Artificial Intelligence Master of Science (MSc) 2020-21 | Validated | Optional | Online Flexible Learning Y2 |

| In Programmes: | Programme Validation Status | Module Status: | Programme Stage / Group / / Sub-group |
|---|---|---|---|
| Artificial Intelligence Master of Science (MSc) 2020-21 | Validated | Required | Online Flexible Learning Y2<br><br>Online Flexible Learning Y2 Required Module 6 |

**The table below must be completed for module approval, including confirmation that there are zero costs to the student.**

| Student Cost(s) | | | | | |
|---|---|---|---|---|---|
| | | | | Costs range: | |
| Cost Type: | Description: | Value type (exact, approximate or max/min range): | Cost (exact or approximate): | Minimum Cost: | Maximum Cost: |
| Student Cost | Over the anticipated 8 week module period, an estimated average cost of £12.50 per week for internet access and contribution to the cost of a personal computer (global variations may apply). | Approximate | 100.00 | | |

## 2.    Aims and Content

**Educational Aims:**

1. To provide a theoretical understanding of modern deep learning.
2. To provide a critical understanding of the practical application of deep learning in the modern workplace.
3. To provide a deep insight into the usage of current deep learning libraries.

**Outline Syllabus:**

Week 1: Foundations.
Introduction to deep learning, historical context, application context, available libraries and tool kits, practical aspects of Deep Learning, formulating a deep learning problem, case studies.

Week 2: Cloud computing.
The theory and operation of cloud computing, cloud security, introduction to a common cloud platform to support deep learning, setting up a cloud-based deep learning application.

Week 3: Neural Networks (NN):
Background, perceptrons, multi-layer neural networks, propagation, designing a neural network architectures.

Week 4: Regularization and optimizations.
Hyperparameter tuning, batch normalization, regularisation, optimization algorithms.

Week 5: Convolutional Neural Networks (CNNs)
Theoretical underpinning, convolution, pooling, applications of CNNs in image analysis, implementing a CNN using a popular deep learning library.

Week 6: Recurrent Neural Networks (RNNs)
Theoretical underpinning, applications of RNNs of language modelling, implementing a CNN using a popular deep learning library.

Week 7: Generative Adversarial Networks (GANs)
Theoretical underpinning, generators and discriminators, loss functions and optimizers, implementing a GAN using a popular deep learning library.

Week 8: Deep Reinforcement Learning.
Comparison with other forms of machine learning, the reward concept, the reinforcement learning process, deep learning for reinforcement learning, implementing reinforecment learning using a popular deep learning library.

**Reading lists and resources:**

| Type | Category | Title | Description |
|------|----------|-------|-------------|

## 3. Module Outcomes (learning outcomes, skills and other attributes)

| Ref No. | Learning Outcome / Skill: | Category: |
|---|---|---|
| M1 | A comprehensive understanding of the nature of deep learning in the context of modern computing capabilities. | Learning Outcomes: Master's |
| M2 | A systematic understanding of mathematical foundations and algorithmic principles of deep learning. | Learning Outcomes: Master's |
| M3 | A critical understanding of the process of deploying deep learning systems and the limitations involved. | Learning Outcomes: Master's |
| M4 | A practical ability to apply the techniques of deep learning using current deep learning libraries. | Learning Outcomes: Master's |
| S1 | Communication skills in electronic as well as written form. | Skills |
| S2 | Self-direction and originality in tackling and solving problems. | Skills |
| S3 | An ability to act autonomously and professionally when planning and implementing solutions to computer science problems. | Skills |
| S4 | Experience of working in development teams, respecting others, co-operating, negotiating/persuading, awareness of interdependence with others. | Skills |

## 4. Assessments

| Assessment Strategy: |
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| The module features two broad categories of assessment: discussion questions and practical assessments. The first has a focus on moderated active learning, where the faculty member responsible for the module posts discussion questions to which students respond individually and then consider each other's responses. Each discussion question runs over a three-week period. At the end of the first week each student posts a 500 word "initial response". During the second week each student selects two or three responses, made by other students in the first week, and writes a 500 word "follow-up" response. In the third week each student reviews the initial and follow-up responses from the previous two weeks and submits a 500 word executive critical summary with respect to the main themes identified by the responses. Practical assessment adopts the principle of authentic assessment where the assessment tasks to be undertaken are aligned with the kinds of task that students would be expected to undertake in a professional setting.<br><br>1. Due to nature of the on-line mode of instruction work is not marked anonymously. |

2. Reassessment opportunities offered in line with Code of Practice on Assessment.

3. Penalties for late submission will be in line with Code of Practice on Assessment.

**All fields in the table below must be completed for module approval.**

| Method | Description | Type | Units of Length | Length | Min | Max | Description (re length) | Weighting | Assessment period(s) | Group Work | Must Pass | Final Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project | Report: Deep learning group project resulting in a demonstrable system and a group report describing and analysing the system. | Summative | Words | N/A | 2000 | 2500 | Software Solution and Presentation | 30 % | Wk08 | Yes | No | Yes |
| Coursework | Discussion Question 1: Participate actively in an online discussion concerning the background to deep learning, demonstrating an understanding of the key issues and showing original thought. | Summative | Words | N/A | 1000 | 1500 | N/A | 20 % | Wk03 | No | No | No |
| Coursework | Discussion question 2: Actively participate in online discussion on a specific topic related to deep learning, | Summative | Words | N/A | 1000 | 1500 | N/A | 20 % | Wk07 | No | No | No |

| Method | Description | Type | Units of Length | Length | Min | Max | Description (re length) | Weighting | Assessment period(s) | Group Work | Must Pass | Final Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | demonstrating an understanding of the key issues and showing original thought | | | | | | | | | | | |
| Coursework | Programming: Individual software deep learning challenge resulting in a demonstrable system and supporting analysis in the form of a brief report (500 words) | Summative | Hours | 12 | N/A | N/A | Software solution and report | 30 % | Wk05 | No | No | No |

*Please see Appendix 1 for details of the outcomes tested by the above assessments.*

## Module Specification Appendix 1: Assessments and the Outcomes Tested

| Module Title | Deep Learning |
|---|---|
| Module Code | CSCK506 |

In the table below, all fields should be completed for approval, except for the **Weighting** field for a **Formative Type** assessment method.

| Assessment Method | Type | Weighting | Marked out of | Pass Mark | Learning Outcomes / Skills Tested |
|---|---|---|---|---|---|
| Project | Summative | 30 % | 100 | 50 | M4, S1, S4 |
| Coursework | Summative | 20 % | 100 | 50 | M1, S1 |

| Assessment Method | Type | Weighting | Marked out of | Pass Mark | Learning Outcomes / Skills Tested |
|---|---|---|---|---|---|
| Coursework | Summative | 20 % | 100 | 50 | M2, S2 |
| Coursework | Summative | 30 % | 100 | 50 | M3, S2, S3 |

## 5. Learning and Teaching Methods

| Summary of Learning and Teaching Methods: |
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| The mode of delivery is by online learning, facilitated by a Virtual Learning Environment (VLE). This mode of study enables students to pursue modules via home study while continuing in employment. Module delivery involves the establishment of a virtual classroom in which a relatively small group of students (usually 10-25) work under the direction of a faculty member. Module delivery proceeds via a series of eight one-week online sessions, each of which comprises an online lecture, supported by other eLearning activities, posted electronically to a public folder in the virtual classroom. The mode of learning includes a range of required and optional eLearning activities, including but not limited to: lecture casts, live seminars, self-assessment opportunities, and required and suggested further reading and try-for-yourself activities. Communication within the virtual classroom is asynchronous, preserving the requirement that students are able to pursue the module in their own time, within the weekly time-frame of each online session. An important element of the module provision is active learning through collaborative, cohort-based, learning using discussion fora where the students engage in assessed discussions facilitated by the faculty member responsible for the module. This in turn encourages both confidence and global citizenship (given the international nature of the online student body). |

**The following table must be completed for module approval, accounting for all hours associated with the credit value of the module, e.g. for 15 credits there should be 150 hours of learning and teaching activity, including independent learning.**

| Learning and Teaching Method: | Length (Minutes): | Times per Week (if applicable): | Number of Weeks (if applicable): | Calculated Hours (if applicable): | Hours: |
|---|---|---|---|---|---|
| Self-Directed Learning | N/A | N/A | N/A | N/A | 62 |
| Assignment | N/A | N/A | N/A | N/A | 40 |
| E-lecture | N/A | N/A | N/A | N/A | 24 |

| Learning and Teaching Method: | Length (Minutes): | Times per Week (if applicable): | Number of Weeks (if applicable): | Calculated Hours (if applicable): | Hours: |
|---|---|---|---|---|---|
| Online Discussions | N/A | N/A | N/A | N/A | 24 |

## 6. Supplementary Information

| If a risk assessment is required for this module for students under 18, please record a summary of the risks: | N/A |
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