THE UNIVERSITY of EDINBURGH
College of Science & Engineering

Proposal for BSc Honours in Data Science (Graduate Apprenticeship)

Stage 2

Contents

THE UNIVERSITY OF EDINBURGH

PROGRAMME SPECIFICATION FOR BSc Honours in Data Science (Graduate Apprenticeship)[1]

PROGRAMME SPECIFICATION

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OVERVIEW	
Awarding Institution	University of Edinburgh
Teaching Institution	University of Edinburgh
Programme accredited by	n/a
Final Award	BSc Honours in Data Science (Graduate Apprenticeship)
Programme Title	BSc Honours in Data Science (Graduate Apprenticeship)
UCAS Code	?
Relevant QAA Subject Benchmarking Group(s)	**Computing, Mathematics, Statistics and Operations Research**
Postholder with overall responsibility for QA	John Longley
Date of Production/revision	12 July 2018

[1] The information contained in this Programme Specification should be used as a guide to the content of a degree programme and should not be interpreted as a contract.

EXTERNAL SUMMARY

Data Science arises from the synergy between the statistical and mathematical analysis of collections of data with the capabilities of modern computers. In a world where there is almost unlimited capability to gather data on activities, data science has become the key discipline in analysing and using data to inform and improve almost any activity. Edinburgh University has a long tradition in Data Science with strong research interests in the area. This has informed the development of a wide range of both practical and theoretical courses that provide a leading educational resource in the area. With the advent of the Data Driven Innovation initiative and the Edinburgh City Deal this provides a strong context for the application of these techniques in business. This programme seeks to combine a thorough grounding in the theory and practice of data science with experience of the application of these techniques in a business context. The programme aims to provide students with a strong grounding in statistical and mathematical analysis of data including Machine Learning and AI decision support techniques together with experience of the deployment of these techniques in the workplace and ow these techniques can provide unique insight into the operation of an enterprise and can be used to transform the business models of an enterprise. The programme is a joint collaborative programme delivered between the School of Informatics and the School of Mathematics, with Informatics as the lead.

The programme will commence with a cohort from PWC in September 2018. This will be expanded for September 2019 to include several more industry partners, several of which have given written commitment with others in discussion.

EDUCATIONAL AIMS OF THE PROGRAMME

The University of Edinburgh Graduate Apprenticeship in Data Science and Innovation programme aims to:

- Develop graduate apprentices possessing a thorough understanding of Data Science and its application in a business context, including statistical modelling, machine learning, programming and the management of data;
- Equip graduate apprentices with advanced skills in statistical modelling and machine learning;
- Offer the benefits of a research-led environment where students are exposed to new thinking in the field;
- Enable students to develop communication skills, initiative, professionalism and the ability to work independently as well as with others; and
- Provide graduate apprentices with the knowledge and skills necessary for professional careers in data science.

PROGRAMME OUTCOMES

Knowledge and Understanding	Understand and be able to apply the:

	• Main current statistical models used in data science. • Process of building computational systems for data science in all its stages and be able to demonstrate this understanding in supervised system building efforts. • Business contexts for the use of Data Science • Limitations of particular models in practical settings. • Mathematics underpinning Data Science.
Graduate Attributes: Skills and abilities in Research and Enquiry	• Undertake a literature review and develop analysis skills. • Research a business question and identify the relevant background literature and potential solutions. • Deploy logical, analytical, and problem-solving skills and to synthesise solutions. • Undertake a substantive data science related business project (3-4 months) on a proposed topic • Develop skills needed for undertaking projects, including reviews, time management and writing extended reports.
Graduate Attributes: Skills and abilities in Personal and Intellectual Autonomy	• Show self-direction and time management skills when working independently. • Make effective use of learning materials and to acquire and apply knowledge from a variety of sources. • Work to strict deadlines and employ effective time management. • Reflect on personal practice and identify areas for development • Understand a business context in terms of the available data and how that might be modelled and analysed.
Graduate Attributes: Skills and abilities in Communication	• Communicate effectively on Data Science and its contribution to business with a diverse business audience. • Communicate effectively through a variety of media including oral, written, diagrammatic and on-line
Graduate Attributes: Skills and abilities in Personal Effectiveness	• Work effectively as a team member with people from different cultural and business contexts. • Develop awareness of the professional context and the legal and ethical limits on the deployment of Data Science in a business context

Technical/practical skills	• Develop technical programming skills in the systematic development, documentation and management of programming codes. • Develop skills in data management that enable the effective use of multiple sources of data in support of data science projects.

PROGRAMME STRUCTURE AND FEATURES

An overview of the programme structure is given in the following table and is fully articulated in the attached DPT structure. The only new courses that need to be developed are the Data Science Work-Based Learning courses that will be undertaken in the workplace.

	Semester 1	**Semester 2**	**Summer**
Year 1	• Introduction to Computation (INFR08025) (20 credits) • Fundamentals of Algebra and Calculus (MATH07003) (20 credits) or option (20 credits) • Intro to Linear Algebra (MATH08057) (20 credits)	• Informatics 1: Object Oriented Programming (INFR08014) (10 credits) • Informatics 1: Data Analysis (INFR08015) (10 credits) • Proofs and Problem Solving (MATH08059) (20 credits) • Calculus and its application (MATH08058) (20 credits)	• Professional Practice A 10-week work-based (New - INFWBL01*) (continued to year 2)
Year 2	• Informatics 2A: Processing Formal and Natural Languages (INFR08008) (20 credits) • Several Variable Calculus and Differential Equations (MATH08063) (20 credits) • Probability (MATH08066) (10 credits) • Facets of Mathematics (MATH08068) (10 credits) or • Informatics 2C - Introduction to Software Engineering (INFR08019) (10 credits)	• Informatics 2B Algorithms, Data Structures, Learning (INFR08009) (20 credits) • Fundamentals of Pure Mathematics (MATH08064) (20 credits) or Informatics 2D – Reasoning and Agents (INFR08010) (20 credits • Statistics (MATH08051) (10 credits) • Computing and Numerics (MATH08059) (10 credits)	• Professional Practice A 10-week work-based (New - INFWBL01*) (continued from year 1)
Year 3	• Professional Practice A (New - INFWBL01*) (20 credits) final assessment submitted at start of year 3 • Introductory Applied Machine Learning (INFR10069) (20 credits) • Algorithms and Data Structures (INFR10052) (10 credits) • Statistical Methodology (MATH10095) (10 credits) • Hons Differential Equations (MATH10066) (20 credits)	• Professional Practice B 8-month work-based New (INFWBL02*) (40 credits)	
	• Machine Learning Practical (INFR11132) (20 credits)		

Year 4	• Machine Learning and Pattern Recognition (INFR11130) (20 credits) • Multivariate Data Analysis (MATH10064) (10 credits) • Statistical consultancy (MATH10092) (10 credits) • Option: Algorithmic Foundations of Data Science (INFR11156), or Fundamentals of Operational Research (MATH10065) (10 credits)	• Data Mining and Exploration (INFR11007) (10 credits) • Informatics Honours Project (INFR10044) (40 credits) Or • Project in Mathematics (Double) (MATH10031) (40 credits)	

The programme has been designed with some level 11 courses specified in year 4. The current BSc Hons in Computer Science and Mathematics specifies that students Select between 40 and 50 credits of courses that include both level 10 and level 11. In this case we have restricted that choice of available courses to those most relevant to data science. The courses for year 4 have been carefully selected to match the outcomes required to align to the SDS GA framework. There are 50 credits core at level 11 including: Machine Learning and Pattern Recognition (20), Machine Learning Practical (20), Data Mining and Exploration and an additional 10 credits optional (Algorithmic Foundations of Data Science). Whilst these are at SCQF Level 11 these are all designated as Year 4 Undergraduate. The assessment methods include elements of coursework between 20% and 100%.

The entry requirements for the programme are:

Typical offer range

The typical offer is likely to be:

- SQA Highers: AAAA - AABB.
- A Levels: AAA - ABB.
- IB: 37 points with 666 at HL - 32 points with 655 at HL.

Access threshold

The access threshold for a contextual offer is:

- SQA Highers: AABB.
- A Levels: ABB.

- IB: 32 points with 655 at HL.

Detailed requirements for all applicants

To be considered for an offer of a place all applicants must meet the following requirements:

- SQA Highers: AABB by end of S5 or AABBB/AAAB from S4-S6, with a minimum of BBB achieved in one year of S4-S6, to include Mathematics at Grade A. We strongly recommend that you study Advanced Higher Mathematics.
- A Levels: ABB in one sitting, to include Mathematics at Grade A.
- IB: 32 points overall and award of IB Diploma with 655 at HL to include Mathematics at Grade 6.

Direct Entry

Direct entry to second year is feasible. However, all such cases must satisfy that they have appropriate prior experience and would be required to undertake the end of year 1 Professional practice period with their host industrial partner. For direct entry to second year the minimum academic requirements must be exceeded, including the following:

- SQA Advanced Highers: AAA to include Mathematics. Appropriate relevant computing qualifications or experience is required.
- A Levels: A*AA in one sitting, to include Mathematics and Further Mathematics. Appropriate relevant computing qualifications or experience is required.
- IB: 38 points overall and award of IB Diploma with 666 at HL to include Mathematics. The Diploma must include Computer Science.

Progression Requirements

- Academically the progression requirements are standard, namely that the student has satisfied the programme specified in the appropriate DPT.
- All students must pass each of the prescribed courses through the assessment methods specified in them. Should a student fail a course or element of assessment that must be passed then arrangements have been considered and built into the programme (and specifically the work-based professional practice periods) to allow for re-sits to be undertaken during the normal assessment re-sit periods. For graduate apprenticeship programme all students must pass each course assessment either at the first or second attempt. The two work-based professional practice courses have been carefully designed so that the assessment is based upon coursework in the form of a reflective report. All students must undertake the professional practice in order to submit their assessments and will be guided and supported by their professional practice tutor. If a student fails their assessment they will be allowed to submit a second attempt which they must then pass.
- In addition, the student will be required to undergo internal appraisal processes carried out by the industrial partner(s). It is possible that the appraisal will identify an issue that will result in failure of some of the work-based learning courses. This will result in the termination of the apprenticeship contract with the industrial partner(s). At that point the student will be offered the opportunity to transfer to the joint Computer Science/Mathematics degree. This is complex

because it will require transfer of fee funding to SFC and depending on the timing of the issue this may involve and interruption of study to allow the student to synchronise with the appropriate cohort on the degree.

- All students must be employed as a condition of the graduate apprenticeship. Any student who ceases to have employment cannot proceed on the graduate apprenticeship, however as above where academic progression was acceptable the student will be offered the opportunity to transfer to the joint Computer Science/Mathematics degree.

Articulation of Learning Outcomes and Assessment Practice

There are three broad categories of learning outcome we see in this programme:

- Developing technical mathematical capability and an understanding of a range of algorithm and their behaviour. These outcomes map to assessment by pencil-and-paper exercises and to formal examinations on the chosen topics.
- Developing skills in the application of knowledge and skills to tackle a particular practical problem. This will involve developing models, deciding how to gain access to appropriate data and choosing and developing programs that tackle the problem in an appropriate way. These are dealt with by assessing the students' performance on a range of practical exercises of varying sizes and complexity.
- Developing workplace skills such as communication, dealing with clients, confidentiality, professional behaviour, etc. This will be assessed during the work-based courses and will involve a combination of company appraisal processes and more formal assessment of skills development throughout the apprentices' time in the workplace.
- The mode of study is full-time involving taught courses, work-based learning and online learning.
- Students can exit with an Undergraduate Certificate of Higher Education or an Undergraduate Diploma of Higher Education depending on their status. This will be in line with the Undergraduate Degree Programme Regulations.

This programme is closely aligned with the University delivery of digitally skilled individuals who can contribute to the delivery of Data-Driven Innovation as part of the City Deal. This programme is an experiment and may act as an important stimulus to closer partnership with organisations involved in the Bayes Centre.

TEACHING AND LEARNING METHODS AND STRATEGIES

- The programme is constructed mostly from existing courses and is very similar in structure to the existing Computer Science and Mathematics degree. This provides a range of Teaching and Learning methods that cover the main technical outcomes. Most of these courses use traditional Lecture/Tutorial/Practical methods. The more practical courses such as the Machine Learning Practical comprise a small number of orientation lectures coupled with Lab work to develop machine learning skills.
- The innovative aspects of the programme are the workplace-based learning components. Altogether these contribute 100 credit points to the degree programme:
    - **Professional Practice A** (20 points): This will be assessed by a reflective report delivered in third year that reports on the experience of the first two years of workplace learning. This will mainly cover the learning outcomes documented in **Graduate Attributes: Skills and abilities in Personal and**

Intellectual Autonomy apprentices will be asked to reflect on their experience of work over the first two summers of the programme. As part of their participation in the programme the apprentices will undergo a range of learning experiences including workshops, training sessions, mentoring, buddying to develop a good understanding of their role as a professional working for the industrial partner(s).

- **Professional Practice B** (40 points): This is an extended period of work-based learning. Apprentices will be working with The industrial partner(s) on real-world projects. They will be assessed on their client-facing skills and on their ability to apply their technical skills in a practical setting. This will be via oral assessment in reviews, reflective reports on their experience and on reports from their company mentors. These experiences will cover the learning outcomes documented in the sections: **Graduate Attributes: Skills and abilities in Communication** and **Graduate Attributes: Skills and abilities in Personal Effectiveness.** This will also provide students with practical experience that provides a context to test their academic knowledge and skills.
- **Work-based Project** (40 points) This is the capstone experience for the apprentices. The project runs as with the current Informatics honours project or the maths double project with the only exception that these are conducted in the workplace. Students will choose a project that can be undertaken in the workplace that will tackle both academic and business issues. Apprentices will be allocated academic and workplace supervisors. Typical projects will involve working with the industrial partner(s) data and utilizing their data science skills to analyse the data using techniques that involve substantial academic challenge. Assessment will be by final report assessed by academic staff but with the ability for the workplace supervisors to inform the project marker through a testimonial (but not allocate marks).

- **Some practical courses**: Introductory Applied Machine Learning and Machine Learning Practical with substantial practical components will use the workplace context to motivate practical exercises and where possible will use datasets apprentices have access to in their work with the industrial partner(s).
- **First and second year**: Lectures, Tutorials and Laboratories during semester time. Some use of flipped classrooms. Additionally, apprentices will receive training, mentoring and other Learning opportunities when they are in the workplace.
- **Third Year**: Lectures, Tutorials and Laboratories during semester one. Some use of flipped classrooms. During the long Professional Practice period apprentices will be in the workplace. The assessment will be by reflective reports on the deployment of their data science and other skills in understanding and developing solutions to clients' problems. This will be assessed by a report delivered during the Professional Practice period.
- **Final Year**: Lectures, Tutorials and Laboratories during semester one. Some use of flipped classrooms. During the Professional Project period in semester 2 apprentices students will pursue a professional project that develops their skill in applying data science techniques to real business problems. This will be jointly supervised by academics and workplace supervisors. In addition, apprentices will study for standard academic credit (e.g. in Machine Learning Practical) using distance materials developed to allow the delivery of the course in the workplace.
- Apprentices will make use of the Informatics computing environment and will have access to datasets via the workplace that they could not otherwise access.

TEACHING AND LEARNING WORKLOAD

Please indicate the typical workload for a student on this programme for each year of study

Start Year	Time in scheduled teaching (%)	Time in independent study (%)	Time in workplace (%)
Year 1	**50**	**50**	**(10 weeks in summer vacation)**
Year 2	**50**	**50**	**(10 weeks in summer vacation)**
Year 3	**25**	**25**	**50% in workplace during semester + 5 months in workplace.**
Year 4	**25**	**25**	**50% in workplace in semester 2**

ASSESSMENT METHODS AND STRATEGIES

- **Year 1:** Examination, practical examination, formative and summative assessed practical exercises, coursework exercises. Workplace experience will involve developing the skills identified under the graduate attributes listed in the programme learning outcomes.
- **Year 2:** Examination, practical examination, formative and summative assessed practical exercises, coursework exercises. Workplace experience will involve developing the skills identified under the graduate attributes listed in the programme learning outcomes.
- **Year 3:** Examination, practical examination, formative and summative assessed practical exercises, coursework exercises, large practical exercises. Workplace-based learning is oriented to developing the Graduate Attributes listed in the programme learning outcomes.
- **Year 4:** Examination, practical examination, formative and summative assessed practical exercises, coursework exercises, large practical exercises and a capstone project. Workplace-based learning is oriented to developing the Graduate Attributes listed in the programme learning outcomes.

ASSESSMENT METHOD BALANCE

- **Year 1**: Apprentices will experience programming examinations in programming courses, traditional unseen examinations in Mathematics and Informatics, summative coursework exercises , and formative coursework in programming and other courses.
- **Year 2:** Apprentices will experience traditional unseen examinations in Mathematics and Informatics, summative coursework exercises , and formative coursework in programming and other courses.
- **Year 3:** Apprentices will experience traditional unseen examinations in Mathematics and Informatics, summative coursework exercises , and formative coursework in programming and other courses. In addition, there will be large practical courses where the assessment will be by coursework only. Work-based

learning will involve oral and written reviews and the development of reflective review papers that encourage the student to evaluate their participation in the work of the company.

- **Year 4:** Apprentices will experience traditional unseen examinations in Mathematics and Informatics, summative coursework exercises , and formative coursework in programming and other courses. In addition, there will be large practical courses where the assessment will be by coursework only. Work-based learning will involve oral and written reviews and the development of reflective review papers that encourage the student to evaluate their participation in the work of the company. A capstone project will allow the students to gain experience of developing and documenting a sizeable piece of work.

Assessment Matrix Template.xlsx

Start Year	Assessment by written exams (%)	Assessment by practical exams (%)	Assessment by coursework/workplace (%)
Year 1	60	15	25/0
Year 2	70	0	30/0
Year 3:	30	0	20/50
Year 4:	30	0	20/50

CAREER OPPORTUNITIES

This programme as a graduate apprenticeship is predicated on students being employed by the industrial partner(s) from the outset with the programme providing employability focussed development in the context of a graduate apprenticeship. Individual employers may set progression requirements at the end of the programme, but all graduating students will be extremely well prepared for a continuing career in a data science role. There is very high demand for well-qualified apprentices.

OTHER ITEMS

The most distinctive characteristic of this degree is that it is an apprenticeship and so offers apprentices much more support and development than a “standard” degree programme.

ABOUT THE PROGRAMME

ADDITIONAL REQUIREMENTS

PRSB Accreditations (where relevant)	N/A
Admissions requirements **Before completing this section please contact a member of the Recruitment and Admissions team for further guidance.**	To be demonstrated through certificated or experiential learning (around 100 words). English language requirements across the accepted tests should also be included.
To be completed by R & A Team	*Please select to confirm that a member of the R & A section have consulted on the Admissions requirements.* ☒
Work experience/work based learning opportunities	Apprentices will work with PwC on four separate workplace experiences. These will be in the context of working (or preparing to work) with clients on the use of data science to transform their business model or make much more accurate analyses based on the available data sets. The main learning out comes will be focussed on graduate attributes around the ability to work effectively in a multidisciplinary environment on real-world problems.

CONSULTATION

Student body	*The main driver for this has been the employers. They have a specific requirement for talented undergraduates and this is the driver. We have briefly consulted with class reps and they seem broadly to welcome the proposal*
External Review/Critical Friend	*We have consulted with City Deal partners in the University and with Tony Venus (an external consultant) and they agree this is a programme that is well positioned strategically and offers strong advantages to prospective apprentices. In addition, they believe this model is reproducible in other contexts where graduate apprenticeships are an appropriate model.*

ADDITIONAL DOCUMENTS	
Memorandum of Agreement (if applicable)	N/A
Award letter (if applicable)	N/A
DPT (please use your current template)	N/A

APPROVAL

Programme Title:	
Programme Proposer:	

STAGE 1: SCHOOL BOARD OF STUDIES REVIEW AND APPROVAL

Confirmation of approval of the proposal at the School Board of Studies should be entered below.

Date of BoS:
Convener Name:
Comment and Approval (BoS Minute): *Please provide either a link to the minutes of the Board or a copy of the relevant text from the minutes.*

STAGE 2: HEAD OF SCHOOL REVIEW AND APPROVAL

Head of School: *Please print name*
Comment and Approval:
Signature:

STAGE 3: COLLEGE CURRICULUM APPROVAL BOARD REVIEW AND OUTCOME

Date of CCAB:
Convener Name:

Stage 2 Outcome (please select as appropriate)	
Proposal approved ➧ Proceed to *New Programme Request & DPT creation*	☐
Proposal approved with conditions	☐
Proposal rejected with recommendations	☐
Proposal rejected	☐
Comment:	

DOCUMENT CHECKLIST	
Document	**Completed**
DPT	☐
Memorandum of Agreement (if applicable)	☐
Assessment Matrix	☐
Award letter (if applicable)	☐