

PROGRAMME SPECIFICATION	 Newcastle University
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1	Awarding Institution	Newcastle University
2	Teaching Institution	Newcastle University
3	Final Award	MRes / PGDip
4	Programme Title	Cloud Computing for Big Data
5	Programme Code	MRes 4852F PGDip 3472F
6	Programme Accreditation	N/A
7	QAA Subject Benchmark(s)	Computing
8	FHEQ Level	Level 7
9	Last updated	11/7/14

10	Programme Aims
	<ol style="list-style-type: none"> 1. To develop the multidisciplinary skills essential to produce the trained experts in cloud computing and big data required by academia and industry 2. To provide the fundamental computational knowledge and expertise required to tackle complex problems using cloud computing technology 3. To provide an understanding of the most commonly used and important statistical methods, approaches and algorithms for the analysis of large and complex data sets 4. To develop research skills necessary for pursuing a PhD in this area 5. To develop and improve skills in the use of literary resources and information technology 6. To develop skills in critical assessment, analysis and storage of data 7. To provide a qualification enhancing employment prospects 8. To develop multidisciplinary collaboration skills between students from computing and mathematical backgrounds 9. To enhance research in this area by: <ul style="list-style-type: none"> • Students undertaking substantial projects in the analysis of big data • Generating a source of qualified research students interested in pursuing PhD research in cloud computing for big data 10. To provide a programme which meets the FHEQ at Masters level and which takes appropriate account of the draft subject benchmark statements in Computing.

11 Learning Outcomes

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas. The programme outcomes have references to the benchmark statements for Computing.

Knowledge and Understanding

On completing the programme students should be able to demonstrate:

- A1. An understanding of the application of cloud computing and statistics to the analysis of big data.
- A2. An understanding of data management, integration and handling.
- A3. A demonstrable, broad knowledge of the computing, mathematical and statistical methods appropriate for dealing with large and complex data analysis problems.
- A4. Knowledge of current cloud computing technologies.
- A5. An understanding of the most commonly used statistical algorithms, their underlying assumptions, and limitations.
- A6. Advanced knowledge and understanding of a specialist area in cloud computing or statistics (MRes only).
- A7. An understanding of the theory and principles which underlie cloud computing, so that students can appreciate the current state of these subjects and can adapt to continued rapid developments throughout their subsequent careers.
- A8. Knowledge of two relevant up-to-date programming languages.

Teaching and Learning Methods

Fundamental and specialist knowledge (A1-A8) are imparted largely through direct student contact (lectures and tutorials), supplemented by practical sessions that may take the form of computing sessions (A7-A8), problem solving and assessed coursework, and project work. Student understanding and learning is enhanced by the use of computing and numerical exercises, problem solving, literature reviews, teamwork and practical work. Independent learning is encouraged through the provision of reading lists, literature reviews and critical analysis of research papers, and ready access to online information resources. Adequate time is provided in all modules for private study for independent learning. The research thesis (MRes only) will enable students to devote extensive time to developing a deep understanding of a specialist area.

Assessment Strategy

A mix of formative and summative strategies are used to assess problem solving and programming skills, group work and literature review exercises. Extra formative assessment is included to provide student feedback throughout the course, without contributing to module marks. Formal feedback is provided for each piece of assessed coursework in the form of an individual proforma and a review session in subsequent lectures (A1-A8).

Intellectual Skills

On completing the programme students should be able to:

- B1. Propose, carry out and write up an extended research project involving, where appropriate, a literature review, problem specifications, design, implementation, and analysis.
- B2. Design and implement new software packages, and compositions of existing packages.
- B3. Apply their knowledge of specific computational, mathematical and statistical techniques to the storage and analysis of big data.
- B4. Have expertise in the use and applicability of up-to-date programming languages and software tools.
- B5. Construct and analyse appropriate predictive models from data.

Teaching and Learning Methods

Intellectual skills (B1-B5) are imparted by a combination of lectures, practicals, case studies, a group project, and an in-depth research project tailored to individual interests (MRes only). Modules are delivered in the form of 'short fat' modules that augment formally taught material with more directed self-learning including the use of interactive tutorials (both tutor and student led), self-directed study, laboratory practicals, problem-based learning and investigative work. The use of short fat modules has several advantages: (i) key skills development and deep learning is enhanced due to increased student participation and interest; (ii) learning is concentrated, allowing the student to focus in depth on one subject at a time; (iii) modules have the potential to be made available as short courses aimed at continuing professional development (for industry or academia); and (iv) enables future extension of module choices. Practical sessions and problem-solving exercises are used to develop programming and analytical skills (B2-B3). Tutorials are used to focus on specific research topics in detail, to carry out problem solving exercises (B1) and critical analysis of the current software libraries (B4), analytical techniques (B3) and research literature, to ensure up-to-date knowledge of subject-specific research fields.

Assessment Strategy

Intellectual skills (B1-B5) are assessed by written examinations and continuously-assessed material that includes written reports, practical write-ups, literature reviews, group projects, oral presentations, a poster presentation and a research thesis. The assessment methods aim to evaluate the students' understanding and ability to apply the computational and statistical techniques that form the basis for the interdisciplinary science of cloud computing for big data.

Practical Skills

On completing the programme students should be able to:

- C1. Critically evaluate research and literature relating to cloud computing, distributed computing and computational statistics.
- C2. Solve computational problems using cloud computing technology.
- C3. Present, store, query and statistically model big data.
- C4. Demonstrate appropriate scalable computational workflows and solutions applied to large information handling problems.

Teaching and Learning Methods

Critical evaluation of current research will be developed through literature searching, through coursework exercises and in the research project in particular (C1). The ability to solve computational and statistical problems at scale (C2) will be acquired through practical sessions and self-directed learning. Tutorials and group discussion will be used to reinforce specific computational and statistical methodology (C4). Problem solving exercises and the group project will be used to improve student skills in the application of appropriate statistical methods to big data handling and analysis (C3,C4).

Assessment Strategy

Practical skills (C1-C4) are primarily assessed continuously in the form of individual reports from practical studies, literature reviews, tutorial exercises and group project reports. Data and information handling and interpretation are a strong component of many modules and are also assessed through the use of examinations and continuously assessed problem solving exercises.

Transferable/Key Skills

On completing the programme students should have:

- D1. The ability to communicate orally
- D2. Written communication skills
- D3. The ability to use computer based literacy resources
- D4. The ability to work as part of a team
- D5. Creativity skills

Teaching and Learning Methods

Oral presentation skills are exercised by group discussions in tutorial sessions, by communication during group exercises, and by the preparation of oral presentations on specific research topics (D1). Written communication skills are developed during independent study, the preparation of coursework, web page design, poster presentation and through the completion of the group project and the project thesis (MRes only) (D2). Formal lectures and practicals address the use of online literacy resources and research techniques, reinforced through the use of practice exercises (D3). Group project and student-led tutorials are used to develop team skills (D4). The preparation of web pages and poster presentations are used to enhance writing and creativity skills (whilst also improving computing skills) (D5).

Assessment Strategy

Written communication skills are assessed by report preparation, the research thesis and literature reviews. Oral communication skills are assessed in oral presentations. The ability to use computer-based literacy resources is assessed through the preparation of literature reviews and through peer- and self-assessment. Team work is formally evaluated using group-based problem solving and data analysis exercises. Independent work is assessed in literature reviews and research projects. Creativity is assessed through problem-solving exercises and poster preparation. The production of web pages is included in some modules to assess students' abilities to provide synopses of information in a scientific but creative fashion.

12 Programme Curriculum, Structure and Features

Basic structure of the programme

This one-year programme forms the initial training component for the 4-year EPSRC Centre for Doctoral Training in Cloud Computing for Big Data. Students will be recruited from the computing, mathematical and statistical sciences, with an approximately even split between students with a computing degree and students with a mathematical and/or statistical background. The taught component will provide intensive training in necessary foundational material in scalable computing and computational statistics that will underpin subsequent PhD study. All students will initially register for the MRes programme, but students performing sufficiently well will switch their registration to PhD in June and be awarded the PGDip.

Semester 1

Students will begin their taught programme with a crash course in **either** "Mathematics and Statistics for Computer Scientists" (**MAS8380**, 10 credits) **or** "Computer Science for Mathematicians" (**CSC8621**, 10 credits). This will cover the essential concepts required for the whole-cohort modules to follow. These will take place in teaching Weeks 1 and 2. Knowledge of the content of both of these modules is assumed for the remainder of the course. Students will be admitted to the programme only if they already possess knowledge of the material covered in one of these modules.

For weeks 3 to 8 **all** students will take **two** modules running in parallel. One will be on “Statistics for Big Data” (**MAS8381**, 15 credits), covering essential statistical concepts necessary for analysis of big data. The other module will be “Programming for Big Data” (**CSC8622**, 15 credits), mainly covering programming in R and Java, but in the context of data mining, algorithms and databases. Due to the nature of the material (which requires both computer science and statistical knowledge) and the style of delivery, the above new modules will be suitable only for the cohort of students on this degree programme. For weeks 9 to 12, **two** modules will run in parallel. The first will be on “Cloud Computing” (**CSC8110**, 10 credits), covering distributed computing, cloud architectures (public and private), virtual machines, cloud security, distributed algorithms and scalable computing patterns. The other module will be on “Machine Learning” (**CSC8111**, 10 credits), covering the design of algorithms for recognising patterns in data. Evaluation of progress in each module will be the same as that of other Computing Science Masters programmes, typically including both assignments and formal written examinations.

Semester 2

Weeks 1 to 4 will have **two** modules running in parallel. One will be on “Time Series Data” (**MAS8382**, 10 credits), covering time series modelling in a big data context. The other will concern “Big Data Analytics” (**CSC8101**, 10 credits). During Weeks 5 to 12, three modules will run in parallel. A module on “Research skills” (**CSC8623**, 10 credits) will provide essential skills for subsequent project and research work. Another module covering “Professional skills” (**CSC8624**, 10 credits) will provide the foundation for further training in innovation and entrepreneurship studies which will continue throughout the programme of study.

In addition, there will be a Group Project module (**CSC8625**, 20 credits). For this, students will be in groups of size two or three, containing at least one student from a computing background and one from a mathematical background, and together they will solve a practical applied problem in the analysis of big data. This will provide opportunity for mutual peer-to-peer mentoring in complementary areas of expertise, and help form cross-disciplinary relationships that can persist throughout the period of study. Where possible, the projects will be relatively small but genuine research problems provided by our industrial or applied academic collaborators.

Semester 3

Research projects will be selected during Semester 2, and students making satisfactory progress will be encouraged to switch their registration from MRes to PhD, and start their main research project in July. Such students will be awarded the PGDip. We will adopt a three supervisor model for each student, consisting of one from Computing Science, one from Mathematics and Statistics, and one other, either an academic from another discipline or an industrial collaborator from the problem domain that inspired the project. Typically, the lead supervisor will be from Computing Science or Mathematics and Statistics. Students who have not performed sufficiently well to transfer to a PhD may continue on the MRes programme with the main MRes dissertation (60 credits).

Key features of the programme (including what makes the programme distinctive)

The main feature of this programme is that it forms the initial training component of the four year CDT. Additionally, this programme is distinctive for a number of other reasons. Firstly, the programme is very skills focussed. The use of short fat modules allows hands-on, real-world skills training scenarios to be delivered. Secondly the programme offers a high degree of research training in the area of cloud computing and big data; students with these kinds of skills are currently in high demand by both academia and industry. Thirdly, the interdisciplinary programme caters for students from both computing and mathematical backgrounds and emphasises a cohort approach to training. Finally, the programme is managed and delivered by a team of genuinely interdisciplinary researchers, with an excellent track record in research and training in both computing science and computational statistics.

Programme regulations (link to on-line version)

<http://www.ncl.ac.uk/regulations/programme/>

13 Criteria for admission

Entry qualifications

The programme is available to graduates in any Computer Science or Mathematical Science discipline (minimum entry qualification is a 2(i), or equivalent).

Admissions policy/selection tools

The admissions policy conforms to the University's standard policy for postgraduate students. Upon receipt of a completed application form candidates may be offered an interview. Offers of places may be made to suitably qualified candidates, conditional upon two satisfactory references and upon the applicant achieving a minimum of a 2(i) degree (or overseas equivalent), if they do not hold such a degree at the time of application. The number of places on the degree programme will be limited.

Non-standard Entry Requirements

Graduates will be considered with a strong background in one of Computer Science or Statistics and a genuine interest in the other.

Additional Requirements

None.

Level of English Language capability

IELTS 7.0 (or equivalent), due to the intensive nature of the training programme.

14 Support for Student Learning

The Student Services portal provides links to key services and other information and is available at: <http://www.ncl.ac.uk/students/>

Induction

During the first week of the first semester students attend an induction programme. New students will be given a general introduction to University life and the University's principle support services and general information about the School and their programme, as described in the Degree Programme Handbook. New and continuing students will be given detailed programme information and the timetable of lectures/practicals/labs/ tutorials/etc. The International Office offers an additional induction programme for overseas students.

Study skills support

Students will learn a range of Personal Transferable Skills, including Study Skills, as outlined in the Programme Specification. Some of this material, e.g. time management is covered in the appropriate Induction Programme. Students are explicitly tutored on their approach to both group and individual projects.

Numeracy support is available through Maths Aid and help with academic writing is available from the Writing Development Centre (further information is available from the Robinson Library).

Academic and Pastoral support

Each undergraduate and taught postgraduate student will be assigned a personal tutor.*

A personal tutor is one part of a wider network of advice and guidance available to students to support their personal and general academic development. The module leader acts as the first point of contact for subject-specific academic advice. Thereafter the Degree Programme Director or Head of School may be consulted. Issues relating to the programme may be raised at the Student-Staff Committee, and/or at the Board of Studies. Within the academic unit, students may also receive additional academic and pastoral advice from a range of other student-facing staff including degree programme directors, dissertation/project supervisors, and administrative support staff.

*Arrangements may vary for students taking special types of provision.

The University also offers a wide range of institutional services and support upon which students can call, such as the Writing Development Centre, Careers Service and Student Wellbeing Service. This includes one-to-one counselling and guidance or group sessions / workshops on a range of topics, such as emotional issues e.g. stress and anxiety, student finance and budgeting, disability matters etc. There is specialist support available for students with dyslexia and mental health issues. Furthermore, the Student Union operates a Student Advice Centre, which can provide advocacy and support to students on a range of topics including housing, debt, legal issues etc.

Support for students with disabilities

The University's Disability Support team provides help and advice for disabled students at the University - and those thinking of coming to Newcastle. It provides individuals with: advice about the University's facilities, services and the accessibility of campus; details about the technical support available; guidance in study skills and advice on financial support arrangements; a resources room with equipment and software to assist students in their studies.

Learning resources

The University's main learning resources are provided by the Robinson and Walton Libraries (for books, journals, online resources), and Information Systems and Services, which supports campus-wide computing facilities.

All new students whose first language is not English are required to take an English Language Proficiency Test. This is administered by INTO Newcastle University Centre on behalf of Newcastle University. Where appropriate, in-session language training can be provided. The INTO Newcastle University Centre houses a range of resources which may be particularly appropriate for those interested in an Erasmus exchange.

15 Methods for evaluating and improving the quality and standards of teaching and learning

Module reviews

All modules are subject to review by questionnaires which are considered by the Board of Studies. Changes to, or the introduction of new, modules are considered at the Board of Studies and/or the School Teaching and Learning Committee. Student opinion is sought at the Student-Staff Committee and/or the Board of Studies. New modules and major changes to existing modules are subject to approval by the Faculty Learning, Teaching and Student Experience Committee.

Programme reviews

The Board of Studies conducts an Annual Monitoring and Review of the degree programme and reports to Faculty Learning, Teaching and Student Experience Committee. The FLTSEC takes an overview of all programmes within the Faculty and reports any Faculty or institutional issues to the Faculty Learning, Teaching and Student Experience Committee.

External Examiner reports

External Examiner reports are considered by the Board of Studies. The Board responds to these reports through Faculty Learning, Teaching and Student Experience Committee. External Examiner reports are shared with institutional student representatives, through the Student-Staff Committee.

Student evaluations

All modules, and the degree programme, are subject to review by student questionnaires. Informal student evaluation is also obtained at the Student-Staff Committee, the Board of Studies. The results from student surveys are considered as part of the Annual Monitoring and Review of the programme and any arising actions are captured at programme and School / institutional level and reported to the appropriate body.

Mechanisms for gaining student feedback

Feedback is channelled via the Student-Staff Committee and the Board of Studies.

Faculty and University Review Mechanisms

Every six years degree programmes in each subject area undergo periodic review. This involves both the detailed consideration of a range of documentation, and a review visit by a review team (normally one day in duration) which includes an external subject specialist and a student representative. Following the review a report is produced, which forms the basis for a decision by University Learning, Teaching and Student Experience Committee on whether the programmes reviewed should be re-approved for a further six year period.

Accreditation reports

Additional mechanisms

16 Regulation of assessment

Pass mark

The pass mark is 50%

Course requirements

Progression is subject to the University's Masters Degree Progress Regulations, Taught and Research and Examination Conventions for Taught Masters Degrees. There are reassessment opportunities, with certain restrictions. Limited compensation up to 40 credits of the taught element and down to a mark of 40% is possible for candidates who commenced their programme in 2013/14 or earlier. For students starting their programme in 2014/15 or later, no compensation is possible.

The University employs a common marking scheme, which is specified in the Taught Postgraduate Examination Conventions, namely:

Summary description applicable to postgraduate Masters programmes

<50	Fail
50-59	Pass
60-69	Pass with Merit
70 or above	Pass with Distinction

Summary description applicable to postgraduate Certificate and Diploma programmes

<50	Fail
50 or above	Pass

Students who qualify for the PGDip on the basis of the 120 credits delivered in Semesters 1 and 2 with an *average of 60 or more* will be permitted to switch their registration to PhD and will be awarded a PGDip. Other students will remain registered on the MRes programme and undertake their MRes dissertation.

Role of the External Examiner

An External Examiner, a distinguished member of the subject community, is appointed by the University following recommendation from the Board of Studies. The External Examiner is expected to:

- i. See and approve assessment papers
- ii. Moderate examination and coursework marking
- iii. Attend the Board of Examiners
- iv. Report to the University on the standards of the programme

In addition, information relating to the programme is provided in:

The University Prospectus: <http://www.ncl.ac.uk/postgraduate/>

The School Brochure: <http://www.ncl.ac.uk/marketing/services/print/publications/ordering/>

Degree Programme and University Regulations: <http://www.ncl.ac.uk/regulations/docs/>

The Degree Programme Handbook:

Please note. This specification provides a concise summary of the main features of the programme and of the learning outcomes that a typical student might reasonably be expected to achieve if she/he takes full advantage of the learning opportunities provided. The accuracy of the information contained is reviewed by the University and may be checked by the Quality Assurance Agency for Higher Education.

Mapping of Intended Learning Outcomes onto Curriculum/Modules

Module	Type	Intended Learning Outcomes			
		A	B	C	D
MAS8380	Optional	3, 5	5		3
CSC8621	Optional	2, 3	4		3
MAS8381	Compulsory	1, 3, 5	3, 5	1, 3	2, 3
CSC8622	Compulsory	2, 8	2, 4		3
CSC8110	Compulsory	1, 4, 7	3, 4	1, 2, 4	2
CSC8111	Compulsory	2, 3, 5	3, 4, 5	1, 3, 4	2, 3
MAS8382	Compulsory	1, 3, 5	3, 5	3, 4	2, 3
CSC8101	Compulsory	1, 2, 3, 4, 7	2, 3, 4	1, 2, 3, 4	2, 3
CSC8623	Compulsory		1	1	1, 3, 4, 5
CSC8624	Compulsory				1, 2, 3, 4, 5
CSC8625	Compulsory	1, 2, 3, 7, 8	1, 2, 3, 4, 5	1, 2, 3, 4	1, 2, 3, 4, 5
CSC8699	Compulsory/Optional	1,2,3,4,5,6 ,7	1,2,3,4,5	1,2,3,4	2,3,5