Course Proposal Form

THE UNIVERSITY of EDINBURGH informatics

Please see Page 2 for instructions on which parts of this form to complete, whom to consult with to avoid unnecessary effort, and where to send the completed form.

Proposer(s): H Yorston, S Goldwater **Date: 8/10/2019**

Cover page: Basic permanent course information

Unless otherwise noted, items in this section are entered into EUCLID and **cannot** be changed without creating an entirely new course.

Course Name	Discrete Mathematics and Probability
Course Acronym *(used by the School only, e.g., for the Sortable Course List)*	DMP
Course Level If the course is **only** available to MSc students, then it must be classed as Postgraduate. All other courses, regardless of level, are Undergraduate.	x Undergraduate __Postgraduate
Normal Year Taken	__UG1 x UG2 __UG3 __UG4 __UG5 __MSc
Also available in years *[This can be changed later if need be.]*	__UG1 __UG2 __UG3 __UG4 __UG5 __MSc
SCQF Credit Level Level 8 should normally be used for pre-honours courses. Level 10 should normally be used for optional UG3 courses (so UG4 students may also take them) and for courses aimed mainly at UG4 students. Level 11 should be used for courses aimed mainly at MSc students, whether or not UG4 students can also take them.	__7 x 8 __9 __10 __11
SCQF Credit Points	__10 x 20 __40 __60 __80 __Other:
Delivery Location	x Campus __On-line Distance Learning
Course Type	x Standard (default) __Dissertation __Online Distance Learning __Other (specify: Placement, Student Led Individually Created Course, Year Abroad)
Marking Scheme By default, courses use a numerical marking scheme. If you wish to use a grade-only marking scheme, your course proposal below should justify this.	x Standard (numerical) __Letter grade only

Guidance for remaining sections:

For an initial course proposal, please complete the **cover page and Section 1 (Case for Support)**, which asks you to describe the need for this course and to provide an overview of the course design, including the learning outcomes. **Please discuss your plans as early as possible with the head of Curriculum Review to avoid unnecessary effort.**

Send the form with these sections completed to the BoS Academic Secretary and head of Curriculum Review (listed on the BoS page) to obtain their comments before filling out the remainder of the form.

If a full proposal is invited, please complete the remaining sections and send to **iss-bos@inf.ed.ac.uk**.

2. Student-facing course description and additional feedback and assessment information.
This section provides most of the information students see in the DRPS entry for this course, as well as related details for BoS consideration.

3. Further information for BoS consideration: sample materials.

4. Additional Course Details required for DRPS. *[Administrative information such as delivery timing and prerequisites.]*

5. Placement in degree programme tables. *[Required for all level 9-11 courses; used to determine where the course will be added to existing degree programme tables.]*

6. Comments from colleagues. *[All course proposal should be sent to relevant colleagues in the area as well as to the appropriate year organizer and BoS Academic Secretary for comment in good time before the BoS meeting. Use this section to indicate what feedback has been solicited and received.]*

Colour coding and item-by-item guidance:

Guidance is provided in italics for each item. Please also refer to the guidance for new course proposals at http://www.inf.ed.ac.uk/student-services/committees/board-of-studies/course-proposal-guidelines. Examples of previous course proposal submissions are available on the past meetings page http://web.inf.ed.ac.uk/infweb/admin/committees/bos/meetings-directory but note that the proposal form was updated in Jan 2019.

Sections in gold are for student view and are required before a course can be entered into DRPS. You must complete these sections even if your course has already been approved based on other documentation.
Sections in orange are for School use but are still required for all courses (even those that have already been approved based on other documentation).
Section in gray are for consideration by the Board of Studies. They are normally required for all new course proposals but may be omitted in some circumstances (e.g., for invited course proposals) if you obtain permission in advance.

1. Case for support

This section is for consideration by the Board of Studies. The final two boxes (Learning Outcomes, Graduate Attributes) will also go into the student-facing course description.

Overall contribution to teaching portfolio and relation to existing curriculum

Please explain (a) what motivates the course proposal (e.g. a previous course having become outdated/inappropriate, an emergent or maturing research area or new research activity in the School, offerings of our competitors) and (b) how it relates to existing courses and degree programmes (including any prerequisite courses). Every new course should make an important contribution to the delivery of our Degree Programmes.

Summary: This course represents an update on DMMR based on recent and planned curricular changes. By rearranging material between courses, this course will now be roughly half Discrete Mathematics (some material from DMMR moving into other courses) and half Probability (covering the first half of Probability with Applications, including both discrete and continous probability). It's important to change the title because students will no longer take PwA and need to have a course with 'Probability' on their transcript. The course will still teach mathematical reasoning (ie proofs) but it is less standard to describe that in a course title so we removed it for brevity.

It is also planned to improve the accessibility of this course to students of a wider mathematical ability than the current DMMR by careful differentiating according to difficulty the level of work required in the worksheets and assignments, giving suggested questions for practice from the textbook and supplying short video recordings of worked solutions.

Further details of changes relative to DMMR:

1) in 2019-20, we're adding new Mathematics for Computing content added to the first year UG programme. These are optional supplementary lectures now offered during Inf1a, to catch up all students to a similar level. **Consequently Lectures 1-4 of DMMR will no longer be needed in UG2 and some later lectures can be compressed.**

The Maths lectures in Inf1a cover, at a basic level: Sets, set operations, Venn diagrams and functions; Number bases and modular arithmetic; Proof techniques; Propositional logic, truth tables, and predicates; Quantifiers and Inference; Boolean algebra; Induction and recursion; Binary trees. Many of these topics will remain in DMMR at a more advanced level, but intro material can be omitted.

2) Reducing the amount of material on graphs: some of the basic definitions and matrix representations are already covered in ILA, and other bits will now be in Inf2-IADS.

3) Using the freed space from (1) and (2) to shift and consolidate content on Discrete and Continuous Probability from various courses into this one.

DMMR currently has 2 weeks on Discrete Probability, with students repeating this material in PwA and other courses. Students will no longer take PwA, but in the proposed DMP, the Probability content will take roughly the latter half (comparable to the 10 credit Probability course that Maths students take, which also includes both discrete and continuous probability).

This will then make a better bridge to understanding the content of the new UG2 Foundations of Data Science course, where students will be introduced to statistics and its relationship to probability, using simulation and sampling. They will also be able to see practical applications of probability in the machine learning parts of that course.

Target audience and expected demand

Describe the type of student the course would appeal to in terms of background, level of ability, and interests, and the expected class size for the course based on anticipated demand. A good justification would include some evidence, e.g. by referring to projects in an area, class sizes in similar courses, employer demand for the skills taught in the course, etc

It is expected that the current numbers would be the same as DMMR at present (~256).
However, there would be an exclusion on Mathematics students taking this module as it would duplicate the content of their PPS and Probability courses – currently around 23 at present.

Anticipated Resource Requirements

Estimate how much lecturing, tutoring, exam preparation and marking effort will be needed in steady state, and any additional resources needed to set the course up initially. Provide estimates relative to class size where applicable and discuss how support staff will be recruited and supervised, if the class is likely to be very large. Please mention any scaling limits due to equipment or space. If equipment is required, say how it will be procured and maintained.]

This would be the same as DMMR at present but tutorials would be longer with 1hr 20mins instead of 50 mins.

Quotas, special arrangements or unusual characteristics

Please specify if this course requires any special arrangements such as quotas or other registration arrangements; is a collaboration with another school or institution, or has other atypical characteristics that may affect finances or student registration. Further justification/information may be requested for such courses.

Narrative description of the course aims and structure

Please describe the main goals of the course and how the course design will allow students to achieve those goals. This section should be consistent with the student-facing information provided below, but should provide additional information to help colleagues at BoS understand the vision and structure of the course. This description may refer to the learning outcomes and graduate attributes (next two boxes) and should explain how activities such as tutorials, labs, or in-lecture activities will support them, and how the proposed assessments will assess them.

For courses that are important pre-requisites for other courses, this section may also provide content/syllabus information which is too detailed for the student-facing description, such as a lecture-by-lecture syllabus.

This course is redesigned to cover the existing DMMR omitting trees (included in 2B) and allowing for the new Mathematics for Computing being delivered to UG1 from Sept 2019 and some content that is covered in ILA. This leaves enough time to spend longer on probability and include continuous probability.

The course activities (lecture plus tutorials) follow DMMR. The syllabus will be as follows:

Part 1: Discrete Mathematics and Mathematical Reasoning (5-6 weeks)

Sets, functions, relations
Sequences and sums
Cardinality
Induction
Modular arithmetic, primes, greatest common divisors
Multiplicative inverses and cryptography
Counting and the pigeonhole principle
Permutations and combinations, binomial coefficients
Some graph topics (but less than DMMR, needs to be coordinated with IADS)

Part 2: Probability Theory (4-5 weeks)

Axioms of probability, sample space, events
De Morgan's Law, inclusion exclusion principle
Probability distributions, Bernoulli, binomial, Poisson
Joint and conditional probabilty, independence
Chain rule, law of total probability, Bayes' formula
Random variables, expectation, variance, covariance
Joint and conditional pmfs, marginal probabilities
Markov and/or Chebyshev inequalities
Continuous random variables, probability density functions
Uniform, exponential, normal distribution; standard normal
Joint/conditional distribs and exp/var for continuous RVs
Central limit Theorem

Summary of Intended Learning Outcomes (MAXIMUM OF 5)

List the learning outcomes of the course. These must be assessable (i.e., observable), so must specify what the student should be able to do concretely, not simply what they should "understand". Use concrete verbs that indicate (a) what type of assessment would be appropriate, and (b) what level of knowledge/thinking is expected (from recall to analysis to novel creation). ***Example verbs:*** *define, explain, implement, compare, justify. Assessments (described later) should be tied to the learning outcomes.*

Outcomes should typically focus more on the types of thinking/skills developed than on the detailed course content, and the level of thinking should be appropriate to the level of the course: outcomes for a Level 11 course should include more higher-level thinking skills than for a Level 8 course. Further guidance on writing learning outcomes can be found at https://www.ncl.ac.uk/ltds/assets/documents/res-writinglearningoutcomes.pdf

On completion of this course, the student will be able to

1) Use mathematical and logical notation to define and formally reason about mathematical concepts such as sets, relations, functions, and integers, and discrete structures, including proof by induction.
2) A brief introduction to graph theoretic models to model and solve some basic problems in Informatics (e.g., network connectivity, etc.)
3) Prove elementary arithmetic and algebraic properties of the integers, and modular arithmetic, explain some of their basic applications in Informatics, e.g., to cryptography
4) Carry out practical computations with standard concepts from discrete and continuous probability, such as joint and conditional probabilities, expectations, variances, standardization.
5) Construct and/or identify appropriate discrete or continuous probability distributions and apply them to model and solve concrete problems.

2. Student-facing course description and additional feedback and assessment information

Except where noted, all fields are required and will go into the DRPS entry for the course (for use by students). Important: any text in DRPS is effectively a contract with students, so should not include details that are likely to change from year to year.

Summary Description *Provide a brief official description of the course, around 100 words. This should be worded in a student-friendly way, it is the part of the descriptor a student is most likely to read. If this course replaces another course, please say so in this summary.*	The first part of this course covers fundamental topics in discrete mathematics that underlie many areas of computer science and presents standard mathematical reasoning and proof techniques such as proof by induction. The second part of this course covers discrete and continuous probability theory, including standard definitions and commonly used distributions and their applications.
Keywords *Give a list of searchable keywords.*	Relations, Functions, set theory, Proof, Integers and modular arithmetics, discrete and continuous probability, conditional probabilities, expectations, variances, standardization.
Course Description *A more detailed student-facing description of the course, which should normally include (a) a more in-depth academic description of the learning aims, nature and context of the course, (b) a rough outline of the content or syllabus, often as bullet points, and (c) a description of how the course will be taught, how students are expected to engage with their learning and how they will be expected to evidence and demonstrate their achievement of the intended learning outcomes.]*	The course will cover roughly the following topics: Part 1: Discrete Mathematics and Mathematical Reasoning • Sets, functions, relations, cardinality • Sequences and sums • Induction and recursion • Modular arithmetic, primes, greatest common divisors and their applications • Counting and the pigeonhole principle • Combinatorics • Introductory graph topics Part 2: Probability Theory • Axioms of probability, sample space, events, De Morgan's Law • Joint and conditional probability, independence, chain rule, law of total probability, Bayes' Theorem • Random variables, expectation, variance, covariance • Common discrete and continuous distributions (e.g., Bernoulli, binomial, Poisson, uniform, exponential, normal) • Markov and/or Chebyshev inequalities • Central limit Theorem

Assessment Weightings: *These should correspond approximately to the proportion of learning outcomes that each component assesses. More than 30% coursework requires specific justification.* *The expectation for a 10pt course is 20% coursework with the equivalent of one 15-20hr assessed assignment (but possibly split into smaller pieces). See 'components of assessment' below.*	Written Exam __85___% Practical Exam _____% (*for courses with programming exams)* Coursework 15_____%
Further Assessment Information *Provide any further information that should go on DRPS for students. E.g., if the assessment includes required group work or if students must pass some individual component of assessment as well as the course overall.*	
Components of assessment and time spent on assignments (for BoS only) *If not already included in the course narrative description, please describe the type of assessments (oral presentation, report, programming, etc) and* ***how each component of assessment will assess the intended learning outcomes****. Where coursework involves group work, it is important to remember that every student has to be assessed individually for their contribution to any jointly produced piece of work.* *Also estimate* ***how many hours*** *students will spend on assignments. Please see the School policy on Workload and Assessment, which states that students should not be expected to spend more than 6-7 hrs/wk per 10 credits, including contact hours.* *Note that it often desirable to include formative assignments which are not formally assessed but submitted for feedback, often in combination with peer assessment.*	The assessment will be identical to DMMR with 2 hand-in assignments: One on Discrete maths and one on Probability. Total Hours: 200 (Lecture Hours 30, Seminar/Tutorial Hours 15, Summative Assessment Hours 2, Programme Level Learning and Teaching Hours 4, Directed Learning and Independent Learning Hours 148) You should expect to spend approximately 40 hours on the coursework for this course.
Feedback Information *Provide a high-level description of how and what type of feedback will be provided to students, for inclusion in DRPS.*	Feedback is given weekly in tutorials, when students can discuss their solutions to homework questions. Sample answers are also given for students to compare their own homework answers. Peer assessment will also be carried out in tutorial sessions. Piazza will be used to answer student queries. This will give lecturers, TAs and fellow students the chances to help those who are struggling or have queries. Formative and summative feedback is given on the assignments that are handed in and marked. The marks on

Commented [GS1]: I removed 'two'. We don't usually specify the number of hand-ins in the descriptor, because it sometimes changes from year to year. (eg DMMR used to have weekly hand-ins).

	these assignments make up the 15% coursework element of this course.
Additional Feedback Information (for BoS use only) *If not already included in the course narrative, provide further details on planned feedback arrangements. This includes how course feedback is solicited from the class and responded to, as well as what feedback students will get (either on work that contributes to their final mark, or not).* *The University is committed to a baseline of principles regarding feedback that we have to implement at every level, and the School encourages submission of at least one piece of written work for formative feedback.* *In general, formative feedback:* • *Should say how students can improve.* • *Need not be on individual work (e.g., consider a lecture or document summarizing common issues.)* • *Can include oral feedback during labs/tutorials* • *Can include feedback from peers* • *Clickers/TopHat/equivalents can provide in-class feedback for both students and lecturer.* • *Is returned in time for other forms of assessment to which it relates, to allow feedforward.*	Longer tutorials will give students a chance to submit and compare their own answers with the model solution and discuss differences and any misunderstanding. A better use of Piazza or a similar discussion forum will help also to support students' learning. During lectures Tophat will be used to provide formative feedback on students' understanding of the theory covered. Quizzes on Learn will also be used to cover a section read from the book and test understanding. Videos will be made that present the solutions to questions set in the homework that students find difficult and would take a large amount of time to cover in the tutorials. Use will be made of the online open textbook http://discrete.openmathbooks.org/dmoi3.html which has a lot of examples and worked solutions. Links will be given to further learning resources and previous material from the first year Mathematics for Computing lectures.
Breakdown of Learning and Teaching Activities *State how many hours students spend on each part of the course. The total should be 10 x course credits, but please also see the School policy on Workload and Assessment.which states that students should not be expected to spend more than 6-7 hrs/wk per 10 credits, including contact hours.* *Assume 10 weeks of lectures slots and 10 weeks of tutorials, but these need not all be used. As a guideline, a 10-pt course typically has 18-20 lecture hours, but should have only around 15 lectures of examinable material; the rest should be used for guest lectures, revision sessions, introductions to assignments, etc.*	**Contact hours** **Hours** | **Type** **30** | Lecture Hours **15** | Seminar/Tutorial Hours | Dissertation Project Supervision Hours | Supervised practical/Workshop/Studio hours | Feedback/Feedforward hours **2** | Summative assessment hours **3** | Revision Session Hours **Non-contact hours** **Hours** | **Type** **148** | Directed Learning & Independent Learning hours **Total hours:**

Reading List/Learning Resources *You are encouraged to create resource lists using LEGANTO*	Discrete Mathematics and its Applications by Kenneth Rosen http://discrete.openmathbooks.org/dmoi3.html

3. Further information for BoS consideration: sample materials

A full proposal for a new course must include examples of exercises and assessment. Please provide these below, along with publicity information if the course is to be advertised outwith the School.

Course information and publicity *The course web page (typically the Learn landing page) will be linked from the Sortable Course List, and information such as timetables and assignment deadlines must be made available prior to the start of the academic year. Please specify here if any additional info/publicity is needed for your course: typically only if it is aimed largely at non-SoI students.*	(not needed; compulsory)
Sample tutorial/lab sheet questions *Provide a list of tutorial questions and answers and/or samples of lab sheets. These need not be fully fleshed out but should indicate what sort of exercises will be provided to help students learn the material.*	See tutorials from DMMR and/or first half of PwA
Sample assessment materials *If the course is primarily assessed by **exam**, provide a sample exam question with model answers. Any non-standard exam format must be justified. The online list of past exam papers gives an idea of typical and alternative exam formats: http://www.inf.ed.ac.uk/teaching/exam_papers/.* *If the course is largely or primarily assessed by **coursework**, provide a sketch of a possible assignment with an estimate of effort against each sub-task and a description of marking criteria.*	Similar to DMMR and PwA exams. The choice between 2 out of 4 longer questions in the second half of DMMR would be removed and 4 more questions worth 10 marks which covered probability would be substituted. This would mean for Part A there would be 6 short 10 mark questions covering discrete maths and for Part B there would be 4 short 10 mark questions for probability.
Any other relevant materials *Include anything else that is relevant, possibly in the form of links. If you do not want to specify a set of concrete readings for the official course descriptor, please list examples here.*	

4. Additional Course Details for DRPS

Except where otherwise noted, these fields are required for entry into EUCLID and will be visible to students in the DRPS entry.

Planned Academic Year of Delivery *(The first year you anticipate the course running, e.g. AY 2019-20)*	2020-21
Course Organiser *(By default, the course proposer)*	Heather Yorston
Intended Delivery Period	_x_ Semester1 __ Semester 2 __ Full Year __ Summer __ Other (please specify):
Timetable considerations/conflicts *For School use. Please specify any constraints to be considered (e.g. overlap of popular combinations, other specialism courses, external courses etc). Include whether the semester delivery is constrained or could be flexible.*	Schedule as DMMR (avoiding conflicts with Inf1 and Inf2 courses, including required maths courses)
Is this course available to visiting students?	_x_ Yes (default) __ No **If no, please provide a justification here:**
Required pre-requisite courses *Use sparingly: these are enforced in PATH and can only be waived by approval from the School's Curriculum Approval Officer. Note that cross-year required pre-requisites may prevent MSc students from registering; consider using recommended pre-requisites or "other requirements" instead.*	__ No _x_ Yes (please specify full course name(s) and code(s)): Students MUST have passed: Introduction to Linear Algebra (MATH08057) and Calculus and its Applications (MATH08058)
Recommended pre-requisite courses	__ No _x_ Yes (please specify full course name(s) and code(s)): Informatics 1 - Introduction to Computation (INFR08025)
Required co-requisite courses *Specify any courses that must be taken in parallel with the existing course. Note that this leads to a timetabling constraint that should be mentioned elsewhere in the proposal.*	_x_ No __ Yes (please specify full course name(s) and code(s)):

Prohibited Combinations *Specify any courses that may not be taken in combination with the proposed course].*	__No _x_Yes (please specify full course name(s) and code(s)): Probability (MATH08066) and Proof and Problem Solving(MATH08059)
Other Requirements/Additional Information *This information is often used by MSc students and students from other Schools to see if they have appropriate background without having done our School's courses. So please avoid course titles, instead list specific knowledge and skills (such as mathematical concepts, programming ability or specific languages, etc).* *Also list any other constraints on registration, for example: "Only available to 4th Year Informatics students including those on joint degrees." or "This course is open to all Informatics students including those on joint degrees, and to students in the School of Mathematics. Other external students whose DPT does not list this course should seek permission from the course organiser."*	_x_No __Yes (please specify):
Visiting Student Pre-requisites	__Same as "other requirements" _x_Different than "other requirements" (please specify): Visiting students should have done a previous University-level mathematics course, be comfortable with univariate calculus (differentiation and integration), and have some familiarity with basic concepts from discrete mathematics such as binary numbers, sets, functions, and relations. A previous computer science course is recommended.

5. Placement in degree programme tables: for level 9-11 courses only

This section is for consideration by the Board of Studies and will be used later by ITO to determine where the course will be added to existing degree programme tables.

Is this course restricted to students on a specific degree? *E.g., some courses are only available to students on a specific CDT or MSc.*	__No __Yes (please specify and provide justification):
Is this course compulsory for students on any degree(s)?	__No __Yes (please specify and provide justification):
Any issues for part-time students? *Normally, part-time students have access to the same courses as full-time students on the equivalent degree. If you anticipate any problems with this, please specify here.*	

For optional courses:

If this course is available but non-compulsory for students on various degrees (most courses), please fill in this section. The choices here determine where the course appears in degree programme tables (DPTs) and the 2-3 character tags are displayed in the Informatics sortable course list.

Should this course be tagged as 'ML' (machine learning foundations and methods)? *Courses with the ML tag are typically very high-demand and most degrees limit the number of ML credits. If your course might appeal to a similar audience but draw off students from these large courses, please select 'no' and choose one of the tags below.*	__No __Yes
If you chose 'no', please choose at least one of the following tags… *Ideally, select exactly one, unless there is a good argument for more than one. These three are used in various combinations for many of our degrees.*	__**FSS** (CS foundations, systems, and software) __**AIA** (artificial intelligence applications and paradigms) __**COG** (cognitive science: including HCI and NLP courses, but not most other AI courses. Please restrict to courses most relevant to natural cognition.)
…and also tick if any of the following tags or categories apply. *Do not tick any of these if you selected 'ML' already.*	__**NS** (natural systems: e.g., computation by or about biological or social systems. Many COG courses are also NS. This tag is mainly relevant for MSc in Informatics.) __**SE** (software engineering: including courses that are highly relevant to SE degrees. All SE courses should also be FSS. This tag is mainly relevant for UG SE degrees.) __Databases and data management systems (used for Data Science MSc and MSc(R))

	__Unstructured data and applications (used for Data Science MSc and MSc(R)) __Level 11 Security courses (used for Security MSc)
If you are not sure which tags are most appropriate or have other questions about this section, please note any comments/issues here.	

6. Comments from colleagues

All course proposal should be sent to relevant colleagues in the area as well as to the appropriate year organizer and BoS Academic Secretary for comment in good time before the BoS meeting. Please indicate here what feedback has been solicited and received.

Additional Comments *Summarise any comments received from relevant individuals prior to proposing the course. If you have not discussed this proposal with others please note this.*	
Year Organiser Comments *Year Organisers are responsible for maintaining the official Year Guides for every year of study, which, among other things, provide guidance on available course choices and specialist areas. The Year Organisers of all years for which the course will be offered should be consulted on the appropriateness and relevance on the course. Issues to consider here include balance of course offerings across semesters, subject areas, and credit levels, timetabling implications, fit into the administrative structures used in delivering that year.]*	
BoS Academic Secretary Comments *Proposals must be checked by the Secretary of the Board of Studies prior to discussion at the actual Board meeting. This is a placeholder for their comments, mainly on the formal quality of the content provided above.*	