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London School of Geometry and Number Theory

Course Handbook 2016–2017

Contents

1 Background and Aims

Welcome to the EPSRC Centre for Doctoral Training in Geometry and Number Theory, also known as the London School of Geometry and Number Theory (LSGNT).

The LSGNT will recruit and train 14–15 students per year for the next five years. Approximately half the funding for the studentships comes from EPSRC (the Engineering and Physical Sciences Research Council). The other half is provided by the three Universities involved (Imperial College, King's and UCL), with one studentship funded by the Heilbronn Institute for Mathematical Research.

As a student of the LSGNT, you will have funding for four years (subject to satisfactory progress). The focus of the first year is on broadening and deepening your mathematical background and on developing other skills that will be useful during subsequent years at the LSGNT and in your future career, whether it be in academia or elsewhere. More precisely, during first year, you will:

(A) establish a common mathematical background and language so that you can continue to communicate with each other about your research;

(B) gain a working facility and understanding in a wide variety of mathematical techniques which you will continue to use in your own research;

(C) undertake two mini-projects, allowing you to go more deeply into two different areas of research-level mathematics, with different supervisors. This will help you to make an informed decision about the topic of your PhD research project and which supervisor would be most appropriate for your chosen topic;

(D) learn to code with a common programming language and with more specialised mathematical languages to help to solve mathematical problems in your area, giving you the confidence to experiment, the persistence to debug and the ability to create tools that will help you change the world of mathematics;

(E) by working together and learning together, you will gain experience in communicating difficult mathematics to one another, to people outside your immediate area of specialisation and beyond;

(F) build a support network of researchers who will collaborate and help one another through the challenging transition to research-level mathematics.

We aim to be flexible in helping you to achieve your full potential as a mathematician. It is our expectation that you will engage fully with the courses and activities provided: however, if you and a potential supervisor have an alternative project in mind, we shall consider accommodating it: but we expect that this will only apply in exceptional cases. In this situation your intended supervisor should get in touch with the first year co-director.

2 Your first-year contacts

The first-year training programme is overseen by the LSGNT Co-director with responsibility for first year, Jonny Evans at UCL.

A feature of the structure of the LSGNT is that the supervisor of your PhD project is not finalised until towards the end of your first year. We recognize the importance of having someone to go to discuss your progress during your first year, and for this reason will assign you a *mentor* at the beginning of your first year.

2.1 First-year mentors

You can expect that your mentor will meet you at least twice in each of the two terms (i.e. in the period between your arrival and March). You can use these meetings to voice your concerns, your anxieties and to ask organisational questions. The mentor's primary role is to spot potential problems and to give advice.

We suggest the following pattern of mentor meetings:

- Term 1: Your mentor will meet you at the beginning of the term: this will be followed up with two more formal meetings, one around the middle of the term, the second towards the end of it.
- Term 2: Two formal meetings, one at the beginning of term and one mid-term to discuss, in particular, project choices and progress.

Mentors will be expected to make notes on your meetings (which will be agreed with you). These notes will generally be confined to academic matters and may be used to help review your progress during the year.

Where you feel that personal issues such as illness may be affecting your performance, you should arrange a meeting with the Centre Manager (Nicola Townsend) who will take the necessary steps to help you deal with the problem.

2.2 Other points of contact

From the second term onwards (i.e. from January onwards), you will normally be working on 2 projects (see §6). Your project supervisors will also be able to offer advice during meetings. You will also meet the people teaching courses. Our hope is that after 6 months or so at the LSGNT, you will have met a good number of London mathematicians, including academic staff (potential supervisors), post-docs, and PhD students.

2.3 Staff-student liaison committee

We shall set up a staff-student liaison committee, which we hope will be chaired by one of you. This provides the formal mechanism for you to feed back your opinions of the first year programme. Discussion at this committee will be considered, and, where appropriate, acted upon by the LSGNT Management Committee.

We shall seek candidates for a chair of this committee at the beginning of the year. If there is more than one candidate, we shall ask you to organise a vote.

3 Core first-year activities

The items 1–5 listed on this page form the core of your first-year training at the LSGNT. We expect all students to engage with them. Items 2, 4 and 5 will carry an assessment component that needs to be passed in order for you to progress to your PhD research.

3.1 Overview

Here is a brief overview of the specific activities we have designed with an indication of the aims in §1 they are intended to address.

1. **2–day Residential Induction (10–11 October 2016, Chicheley Hall):** The purpose is to introduce you to the other students in your cohort in an informal context. The focus of the course will be on communication skills.

   (E,F)
   10–11 October 2016

2. **Topics Courses in Geometry and in Number Theory:** Lecturer-led discussion groups which deal with particular topics in depth. The lecturer will set problems and examples for you to work through between sessions. In a subsequent 'wrap-up session' (moderated by a postdoc or more senior PhD student) you will discuss the examples and present solutions or worked examples to the rest of the cohort.

   (A,B,E)
   See Section 4.

3. **Courses:** A variety of in-depth lecture courses giving more detail on core topics across the spectrum of geometry and number theory.

   (A,B,C)
   See Section 5.

4. **Mini-projects:** Over the course of the year (Jan–May/June) you will work on two mini-projects with two (preferably different) supervisors. These could be, for example, an exposition of a difficult paper, a calculation or a small research problem. They could include a group project and could be supervised by a group of supervisors. You will give a presentation on one of these mini-projects in May/June 2016.

   (B,C,E)
   See Section 6.

5. **Computing course:** This will run in the first term for three hours per week.

   (B,D)
   See Section 7.

4 Topics courses

4.1 How topics courses work

Each topics course will have two distinct components each week: a topics session and a wrap-up session. Each topics course will have a *topics coordinator*, who marshals an array of lecturers to deliver the topics session each week (*topics session leader*) and has overall responsibility for the coherence and structure of the course. The wrap-up sessions are led by a postdoc or PhD student (*wrap-up session leader*). The topics courses are *not* traditional formal lecture courses: the onus is on you, the students, to work together and learn together.

This year's geometry topics coordinator, explains his vision of his topic course here:

http://wwwf.imperial.ac.uk/~rpwt/CDT.html.

4.1.1 Course content

The material covered by the topics courses will be determined by the topics coordinators, in consultation with the faculty at all three departments. There will be some flexibility to accommodate requests and suggestions from the first-year student cohort. The aims are to provide:

- scaffolding for students to help them survive in seminars, projects and other courses,
- general background we believe every good geometer/number theorist should know,
- a self-contained, in-depth introduction to a core topic of wide interest to researchers in the three departments.

4.1.2 Learning outcomes

Working with the course coordinator, the session leaders and their peers, we expect you to be able to:

1. handle examples and computations effectively, demonstrating a good working level of competence in the topics covered;
2. explain what you have learned effectively to others in their group;
3. ask questions that further your understanding;
4. think on your feet.

4.1.3 Topics sessions

- Each topics sessions will be run by a topic session leader, who might be the topics coordinator or a guest lecturer.
- Each topics session will last 90 minutes and will be an informal lecture on some fundamental topic.
- The topics session leader is expected to set a series of examples and problems for you to work on through the week in preparation for the next wrap-up session. You may be given a specific topic or examples to work on and present to the rest of the cohort at a wrap-up session.

As mentioned above, topics covered will be determined by the topics coordinator, but you are strongly encouraged to direct the focus of these courses towards topics of particular interest.

4.1.4 Wrap-up sessions

These 90-minute sessions serve the dual purpose of being a space of student presentations on the week's topic and a forum for more general discussion of the topic and the examples and problems set by the topic session leader the previous week.

- You will be expected to make at least one 30-minute presentation in one of the wrap-up sessions. The topics course organizer will help you choose topics for your presentations.
- A postdoc or more senior PhD student (wrap-up session leader) will attend to help guide the wrap-up session and to make sure that the discussion of the topic is useful to the whole cohort. The wrap-up session leader will also give feedback on your presentations.
- After presentations, the wrap-up session leader should try to ensure that the students who are not presenting ask questions of the presenter. After the presentation and questions, the wrap-up session leader should make sure the problems set by the lecturer are discussed.
- Further unanswered questions from this session can be passed back to the relevant topic session leader.

4.1.5 Assessment

Assessment will be student-led, formative and based on participation in the wrap-up sessions. Each student will give a presentation during one of the wrap-up sessions. The other students will be given assessment forms (see Appendix A.2) which will be used to give constructive, formative feedback to the presenter. Copies of these forms will be collated by the session leader, who will then report back to the topics coordinator. Together, they will decide on a pass/fail grade.

If you fail this assessment with your first presentation, you can present again at another wrap-up session. The assessment criteria are contained in Appendix A.1.

4.2 Topics in Geometry

Terms 1 and 2

Coordinator: Richard Thomas.

Number of sessions: Term 1: 10 topics + 10 wrap-ups. Term 2: 5 topics + 5 wrap-ups.

See http://wwwf.imperial.ac.uk/rpwt/CDT.html for more information.

4.3 Topics in Number Theory

Terms 1 and 2

Coordinator: Payman Kassaei.

Number of sessions: Term 1: 10 topics + 10 wrap-ups. Term 2: 5 topics + 5 wrap-ups.

5 Courses

We are offering lecture courses: some stand-alone, some in collaboration with the London Taught Course Centre (LTCC),

http://www.ltcc.ac.uk/courses/index.php

some through the Taught Course Centre (TCC)

http://tcc.maths.ox.ac.uk/

(two different entities with confusingly similar names). We expect students to attend at least two of these in Term 1 and at least one in Term 2.

This year we are offering:

5.1 Term 1

- S. Donaldson, Mathematical aspects of gauge theory. (TBA: December/January/February.) Imperial.
- M. Kakde, Class field theory. (Five 2-hour lectures, Mon 10:50–12:50, Oct 3–Oct 31) LTCC, KCL.
- S. Zerbes, Geometry of modular curves. (Five 2-hour lectures, Mon 13:10–15:10, Nov 5–Dec 5) LTCC, De Morgan House.
- T. Coates and C. Manolache, Quantum cohomology and Gromov-Witten theory. (Thu 12:00–14:00, Oct–Dec) TCC, Imperial.
- M. Singer, Introduction to elliptic operators and the index theorem. (Five 2-hour lectures, Mon 15:30–17:30, Oct 3–Oct 31) LTCC, De Morgan House.
- P. Wedrich, Khovanov homology. (Two half-day sessions, TBA) LTCC, De Morgan House.

5.2 Term 2

- S. Donaldson, Mathematical aspects of gauge theory (continued).
- N. Shepherd-Barron, Principal bundles over elliptic curves. (TBA) KCL.
- F. Diamond, Galois representations. (Five 2-hour lectures, Mon 13:10–15:10, Jan 16–Feb 13). LTCC, De Morgan House.
- J. Berndt, Lie group actions on manifolds. (Five 2-hour lectures, Mon 15:30–17:30, Jan 16–Feb 13) LTCC, De Morgan House.
- J. Lotay, Calibrated geometry and geometric flows. (Five 2-hour sessions, Mon 13:10–15:10, Feb 20–Mar 20) LTCC, De Morgan House.
- J. Nicaise, Non-archimedean geometry. (TCC, TBA) Imperial.
- A. Pál, Infinity categories. (TCC, TBA) Imperial.

6 Projects

6.1 General information

You will normally be expected to complete two mini-projects with two different supervisors at two different institutions. The reason for having two mini-projects is to encourage you to develop greater mathematical breadth while you practice the skills (independent study, working with a supervisor) necessary for a successful PhD research project[1].

6.2 Learning outcomes

The intended outcomes of the mini-projects are that you will:

1. learn some advanced mathematics in depth which will be relevant to your future research;
2. get a good idea of two possible areas for your PhD, helping you to make a well-informed decision about what you want to study for the remaining three years of the programme;
3. be exposed to different supervisors and supervisory styles, to make a more informed decision about which supervisors you are likely to be able to work with most effectively.

You will also

1. develop breadth of outlook;
2. develop time-management skills by juggling both projects in the second term;
3. practice verbal and written presentational skills.

6.3 Timeline

Sep 26	Call for mini-project topics to all available supervisors;
Oct 28	Deadline for mini-project topic submission from supervisors;
Nov 28	Deadline for students to send a choice of 3 possible topics, with different supervisors, to first-year co-director;
Dec 5	Meeting between director, first-year co-director and students to agree mini-project assignments; all supervisors informed about mini-project assignments;
Apr 28	Hand-in for mini-project I.
May	Mini-project presentation days.
Jun 30	Hand-in for mini-project II.

6.4 Assessment

Mini-project I will be assessed in May. Your supervisor will assess your **mini-project write-up** and will assign a mark using the written project assessment criteria in Appendix A.3. You will also be provided with feedback on the quality of the mathematics writing and presentation. There will also be a **30 minute presentation** on mini-project I; this presentation will happen in May. All members of the CDT can attend presentations; the supervisor (in conjunction with an assigned second examiner) will give a mark using the

[1] This could mean breadth *within* a field; it is not necessary to do two vastly different projects. Individual fields of study are sufficiently broad that we will not insist that you take 'one project in geometry and one in number theory'

presentation assessment criteria in Appendix A.4. These two marks will be averaged (with equal weighting) to provide a final mark for mini-project I. Each presentation will be allowed a 40-minute time slot, 30 minutes for the talk, 10 minutes for questions and comments.

Mini-project II will be submitted at the end of June; your supervisor should give you feedback about this over the summer.

6.5 Group projects

We strongly encourage staff to team up to supervise projects (offering different perspectives, spreading the advisory workload, providing more exposure to different supervisory styles) and for students to team up to do group projects. For example:

> Three students decide they want to learn about Bridgeland stability conditions. They seek out a supervisor who realises that the students are likely to learn more by working together as a group. The supervisor finds a colleague to help with the work. Together, the students and supervisors decide on what would be an acceptable project: the students will form a reading group to study Bridgeland's original paper, then they will each go and study a number of further papers individually. The final project ends up being 90 pages long (the absolute maximum for three students added up); the first 30 pages are jointly written on the basis of the reading group, the remainder covers computations of the space of stability conditions for some quiver categories and a sketch of the computation for K3 surfaces. The supervisors read half each and decide this ambitious project gets 85%; *all three students receive this mark.*
>
> In May, each student presents: the three presentations are consecutive and are linked, each one developing the content built by the previous talks rather than being three different versions of the same talk. *These presentations are marked individually* so students' total marks for a group project may differ.

The group-marking of the written project is intended to make all students take responsibility for the content (just like one does in a joint paper). However, group-marking of a presentation does not make sense, because the presentation skills of individuals are the main thing being assessed.

6.6 Comments

1. During the period 26 Sep–28 November students with particular interests are welcome to come up with mini-project ideas and to seek out suitable staff members to supervise them. This is also the time for students to consider teaming up with each other for group projects.[2]

2. While respecting the interests of students and supervisors, we strongly encourage novel mini-project topics at the geometry/number theory interface. Thus we encourage group projects involving students with complementary backgrounds in geometry and number theory and/or topics suggested by supervisory teams involving both geometers and number theorists.

3. The write-up of each mini-project should be 15–25 pages in length. Being concise is an important skill. Not only does it force you to clarify your understanding, but it may help you write more publishable papers; many journals have implicit or explicit page limits. By keeping to the page limit, you are learning how to choose what material to include and what not to.

4. The mini-projects are about showing understanding rather than showing off. If you are in the lucky and unusual circumstance of having completed publishable original research in your project, great. But you still need to stick to the page limit.

5. Presentations should be aimed at beginning graduate students, not at your supervisors. It is very easy to lose everyone in a talk: much harder to keep your audience with you all the way through.

[2] For many of us, working together on mathematics is one of the most enjoyable parts of the job. Why not start in your PhD years?

6. Neither mini-project commits you to a PhD research project. In many cases, though, one of them *will* lead on to your PhD project. Many supervisors will want to have the experience of working with you in the first year before committing to be your research supervisor.
7. The meeting between Director, First-year Co-director and students is to decide, in as fair a way as possible, who will be working with whom. Some degree of compromise may be necessary to avoid overloading particular supervisors, many of whom have significant demands on their time from outside the LSGNT.

7 Computing course

Lecturer: John Armstrong.

Time: Tuesdays 14:00–17:00.

Computer programs can be incredibly helpful research tools. For instance:

- in symplectic geometry, Seidel's proof of homological mirror symmetry for the quartic surface used Singular and Python for some of the computations;
- in algebraic geometry, there is a finite list of deformation classes of Fano 4-folds and the Fanosearch project is hoping to classify them by enumerating their mirror Landau-Ginzburg superpotentials and grouping them according to mutation equivalence: a massive computational task;
- in additive number theory, Helfgott's recent proof of the ternary Goldbach conjecture relied on computer calculations (finite verifications of the generalised Riemann hypothesis) by Platt;
- computations with modular forms often use Sage, an open-source mathematical programming language developed by Stein.

If these are a few examples showing how important advances in geometry and number theory can be supported (in the case of the ternary Goldbach, crucially!) there are other more general reasons for having a good working knowledge of computer coding.

We firmly believe that the next generation of mathematicians need to be competent coders so that they can create the infrastructure for the future of mathematics. Facilities like arXiv, programs like Sage, Macaulay and Snappea were all created by active researchers in mathematics and physics; these have revolutionised our ability to do and to communicate mathematics. We want our graduates to be at the forefront of the next generation of change.

And, of course, coding will be an invaluable skill in many careers outside of academia.

7.1 Overview

The course will provide an introduction to computer programming for research in geometry and number theory and in practical applications of these subjects. The course will teach specifically Mathematica and Python skills, but aims to give a broad overview of key programming concepts such as objected oriented programming, functional programming and algorithmic efficiency that you can apply to other languages. The skills learned will be motivated by geometry and number theory. They are also skills valued by industry.

7.2 Organisation

The computing course will comprise one two-hour session each week in the first term (as well as an optional hour at the end where you continue to work on your code with the lecturer close at hand to advise and help with debugging). It will teach the fundamentals of good coding practice with plenty of motivational examples drawn from geometry and number theory.

7.3 Learning outcomes

You will be able to:

1. Develop programs for mathematics research and education in Mathematica and Python.
2. Use the procedural, functional and object oriented programming styles.
3. Explain and use object oriented programming concepts (polymorphism, encapsulation, modularity, reuse).
4. Understand and use development best practices such as unit testing and source control.

7.4 Recommended reading

- E. Abbena, S. Salamon, A. Gray, *Modern Differential Geometry of Curves and Surfaces with Mathematica*, Third Edition (Textbooks in Mathematics) (2008)

7.5 Assessment

At the end of the course you will complete a coding mini-project in groups of 2-3 and will present your findings to the class and an audience of invited CDT academics. This will be assessed on a pass/fail basis.

8 Other courses on offer

If there is room in your busy schedules, you may wish to attend some of the other courses on offer from the London Taught Course Centre (LTCC) or the Taught Course Centre (TCC). Below are some details of a selection of these courses which may be of interest (no guarantee that they do not clash with LSGNT activities).

See here for more complete information on LTCC courses:

http://www.ltcc.ac.uk/courses/index.php

and here for TCC courses:

http://tcc.maths.ox.ac.uk/

D. Loeffler (Warwick), Homological algebra. (Oct 14–Dec 2, Fri 10:00–12:00) Imperial TCC via video-link

For more information, see here:

http://www2.warwick.ac.uk/fac/sci/maths/people/staff/david_loeffler/teaching/homalg

A. Pacetti (Warwick), Computing modular forms. (Oct–Dec, Wed 10:00–12:00) Imperial TCC via video-link

T. Dokchitser (Bristol), Galois representations. (Oct 13–Dec 1, Thu 10:00–12:00) Imperial TCC via video-link

For more information, see here:

http://www.maths.bris.ac.uk/ matyd/GR/index.html

9 Seminars in London

9.1 The L$_{SGNT}$unch seminar

- **Tuesdays 12:00–14:00 (KCL term 1, UCL term 2)**
- **Organiser:** Dougal Davis.

This is a weekly seminar in which LSGNT students arrange for LSGNT faculty to come and describe their research areas, over lunch. This is the perfect chance to meet potential PhD supervisors and find out what is going on mathematically in London.

9.2 Research seminars and reading groups

For reference, here is a list of the seminars and other related mathematical activities that may be of interest. These do *not* form part of the core first-year programme.

For up-to-date information, consider signing up to the mailing lists.

Number Theory study group

- **Wednesdays 12:00–15:30 (ICL)**
- **Mailing list:** https://mailman.ic.ac.uk/mailman/listinfo/london-number-theorists
- **Website:** http://wwwf.imperial.ac.uk/~buzzard/LNTS/lntsg.html

The study group will have one talk of approximately 3 hours per week, 12:00–15:30 on Wednesday afternoons with a 30 min lunch break in the middle.

Number Theory seminar

- A research-level number theory seminar.
- **Wednesdays 16:00–17:00 (ICL).**
- **Organiser:** Kevin Buzzard.
- **Mailing list:** https://mailman.ic.ac.uk/mailman/listinfo/london-number-theory-seminar
- **Website:** http://wwwf.imperial.ac.uk/~buzzard/LNTS/lnts.html

UCL/KCL Geometry Seminar

- A research-level geometry seminar, however the organisers are making a particular effort to encourage speakers to make their talks accessible and useful to LSGNT students.
- **Wednesdays 15:00–16:00 (Term 1 KCL, Terms 2 and 3 UCL).**
- **Organisers:** Jason Lotay, Yankı Lekili.
- **Mailing list:** https://mailman.kcl.ac.uk/mailman/listinfo/geometry
- **Website:** http://www.ucl.ac.uk/geometry/

London Topology and Geometry Seminar

- A research-level geometry colloquium.
- **Friday 13:30–14:30 (ICL).**
- **Organiser:** Paolo Cascini.
- **Mailing list:** https://mailman.ic.ac.uk/mailman/listinfo/geometry
- **Website:** http://geometry.ma.ic.ac.uk/seminar/?page_id=10

MAGIC (More Algebraic Geometry at Imperial College)

- A research-level algebraic geometry seminar.
- **Mondays 13:00–15:00 (ICL).**
- **Organiser:** Tom Coates.
- **Mailing list:** https://mailman.ic.ac.uk/mailman/listinfo/magic-seminar
- **Website:** http://coates.ma.ic.ac.uk/magic/

Geometric Analysis Seminar

- A research-level seminar in geometric analysis.
- **Thursdays variable times, 60 minutes, between 13:00 and 15:00 (ICL).**
- **Organisers:** André Neves, Mark Haskins, Gustav Holzegel, Ben Sharp.
- **Website:** http://geometry.ma.ic.ac.uk/gaseminar/

Geometric Analysis Reading Seminar (UCL/KCL)

- An informal reading seminar on topics in geometric analysis organised by geometers at King's and UCL, which is also of interest to analysts. The topics we cover range from the elementary to the advanced and the seminar is meant to be informal and a chance to learn about the subject, so suggestions for future topics are greatly encouraged. We particularly encourage participation by PhD students.
- **Website:** http://www.homepages.ucl.ac.uk/~ucahjdl/gaseminar.html

Symplectic Cut

- A seminar on homological mirror symmetry and symplectic topology, suitable for interested graduate students and post-docs.
- **Wednesdays 13:00–15:00 (S4.36, KCL).**
- **Organisers:** Yankı Lekili and Jonny Evans.
- **Website:** http://nms.mth.kcl.ac.uk/yanki.lekili/symplecticcut/index.html

Junior Geometry Seminar (ICL)

- A geometry seminar run by graduate students.
- **Friday 17:00–18:00, Room 139 Huxley, ICL**
- **Organiser:** Zak Turcinovic and Francesca Carocci.
- **Mailing list:** https://mailman.ic.ac.uk/mailman/listinfo/junior-geometry
- **Website:** http://www3.imperial.ac.uk/geometry/seminars/junior

Junior Geometry Seminar (UCL)

- Another geometry seminar run by graduate students.
- **Thursday 17:00–18:00 (Term 1 UCL, Term 2 KCL).**
- **Organiser:** Emily Maw and Nick Lindsay.
- **Website:** http://www.homepages.ucl.ac.uk/~ucahehe/juniorgeom/

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10 Beyond the first year

10.1 Years 2–4: PhD Project Supervisors

For your PhD research project, you will be assigned two supervisors, a principal supervisor and a second supervisor. If your first supervisor is not at UCL, you will transfer to the College of your first supervisor at the start of your second year. Formal support (in the event of your getting into difficulties of any kind) will then be dealt with by the local graduate tutor, who will keep LSGNT Research Co-director in the loop.

Professor Jürgen Berndt (KCL) coordinates the PhD supervisor allocation process.

The allocation process will start on Monday 15th May and finish on Friday 30th June.

At the beginning of the process students will be invited to submit their preferences for PhD project and supervision. This can include a ranked or unranked list of preferred supervisors for research project preferences, or alternatively, a research group within which the student would like to pursue the research. Management Committee members will then carry out a consultation process with potential supervisors, research group leaders and students, as appropriate. The Management Committee makes the final decision about the PhD supervisor allocation taking into account the following two constraints:

1. All supervisors must be from IC, KCL or UCL;
2. Students must be distributed equitably amongst IC, KCL and UCL with at least four of the cohort going to each of the three institutions.

10.2 Progression to second year

At the end of the first year, subject to satisfactory progress, you will be allowed to continue to the second year. Satisfactory progress means:

- Passing the topics course assessment.
- Achieving a mark of 50% or more in the assessment of Project I.

- Passing the computing course (see §7.5).

Most students will be informed by the end of May if these requirements have been met.

In some cases, where the student has met the formal requirements of the first year training but where the proposed supervisor has expressed concern over the student's project work, it may be necessary for the student to demonstrate their potential further by writing an upgrade/transfer report or having an upgrade/transfer interview during their second year, as per the usual practice of the student's chosen host institution. In such cases the supervisory team should lay out clear goals for what they expect the student to accomplish in this report or interview. For instance, if the student has struggled with exposition, it could be to produce a clear exposition of the background to their proposed research; if the student has struggled with the detail of the arguments in their project, it could be to present a complete worked example of a piece of theory relevant for the PhD project. This will be handled on a case by case basis. A student may begin work on their PhD research, but the transfer to PhD status will happen only when the supervisory team is satisfied that the student has achieved the desired goals. Transfer to the host institution might be delayed in this situation.

10.2.1 Unsatisfactory progress

We expect that the following will only need to be applied in very rare cases, but if your progress is *not* satisfactory, we shall proceed as follows:

- You will be notified by the end of March if you have failed the coding and topics course assessments.
- This will result in an immediate meeting with your mentor to discuss your progress.
- Your mentor will then monitor the final month of Project 1.
- If the assessment of Project 1 is unsatisfactory in May, you will be referred to the departmental graduate tutor for further monitoring.
- You will have a further two months, under close supervision, to improve your performance if you wish to remain on the programme.

The above is consistent with UCL policy on research student progression.

10.3 Moving host institution and transfer to PhD status

We expect most students will have agreed a supervisory team by the end of June and we shall ensure that all students have been matched to supervisors by the end of August.

If your first supervisor is not at UCL, you will need to transfer institution: you will be given advice about this nearer the time.

There may be further formal procedures associated with the transfer to PhD status which may vary slightly from College to College. We expect that Project 2 will form the major part of this process.

11 Who's who

Director:

Konstanze Rietsch (konstanze.rietsch@kcl.ac.uk)

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Industrial Partners:

Bank of England

Heilbronn Institute for Mathematical Research

RBS

Satellite Applications Catapult

Schlumberger

A Assessment forms/criteria

A.1 Topics course presentation

Pass	Fail
The student presents the material in a well-structured, comprehensible way.	The student's presentation is unclear or poorly structured.
The student tailors their presentation to the level and abilities of their audience.	The student does not tailor their presentation well to the intended audience (the level is either too high or too low and did not engage the audience).
The student displays facility with the material they are presenting and are able to field questions from the audience.	The student cannot field questions effectively.

A.2 Peer assessment form for topics presentations

1. Do you feel that the presenter pitched their talk at an appropriate level? Briefly justify your answer.

2. Did you learn something new from the presentation? If so, what?

3. Do you feel they focused on important aspects of the topic? If not, what could they have done better?

4. How could the presenter have improved the structure of their presentation?

5. How could the presenter have improved the delivery of their presentation?

6. Any more comments?

A.3 Project I: Written project

Mark	Written project assessment criteria
X	Exceptional exposition, of publishable quality (in an expository or even non-expository journal). Very well-structured, indicating an intimate understanding of how the subject fits together. High degree of mathematical accuracy. Covers deep or difficult content or displays significant originality.
A	Very clear exposition, illustrated with cogent examples and remarks. Well-structured, indicating a good understanding of how the subject fits together. High degree of mathematical accuracy. Covers deep or difficult content or displays some degree of originality.
B	Good exposition. Coherent structure. Substantially mathematically correct. Covers a substantial piece of nontrivial mathematics.
C	Adequate exposition displaying some understanding of the topic. Some thought given to overall structure. Substantially mathematically correct. Covers some nontrivial mathematics.
F	Poor exposition, muddled or inconsistent. Little or no thought given to structure of arguments and ordering of material. Many factual mistakes or inaccuracies. Covers material only in a superficial way or focuses mostly on trivial details.

A.4 Project I: Presentation

Mark	Presentation assessment criteria
X	Exceptional and engaging exposition. Very well-structured, indicating an intimate understanding of how the subject fits together. Keeps to time limit. High degree of mathematical accuracy. Fields questions expertly and shows sophistication in answers. Explains difficult concepts effectively to mixed audience.
A	Very clear and engaging exposition. Well-structured, indicating a good understanding of how the subject fits together. Keeps to time limit. High degree of mathematical accuracy. Fields questions competently. Explains difficult concepts effectively to mixed audience.
B	Good exposition. Coherent structure. Keeps to time limit. Substantially mathematically correct. Is able to respond well to most questions. Communicates some concepts effectively to mixed audience.
C	Adequate exposition displaying some understanding of the topic. Some thought given to overall structure. Keeps to time limit. Substantially mathematically correct. Is able to respond well to some questions. Explains some nontrivial piece of mathematics to the satisfaction of the project supervisor.
F	Poor exposition, muddled or inconsistent. Little or no thought given to structure of arguments and ordering of material. Poor time-keeping Many factual mistakes or inaccuracies. Cannot formulate reasonable responses to audience questions. Covers material only in a superficial way or focuses mostly on trivial details.