

For prospective students

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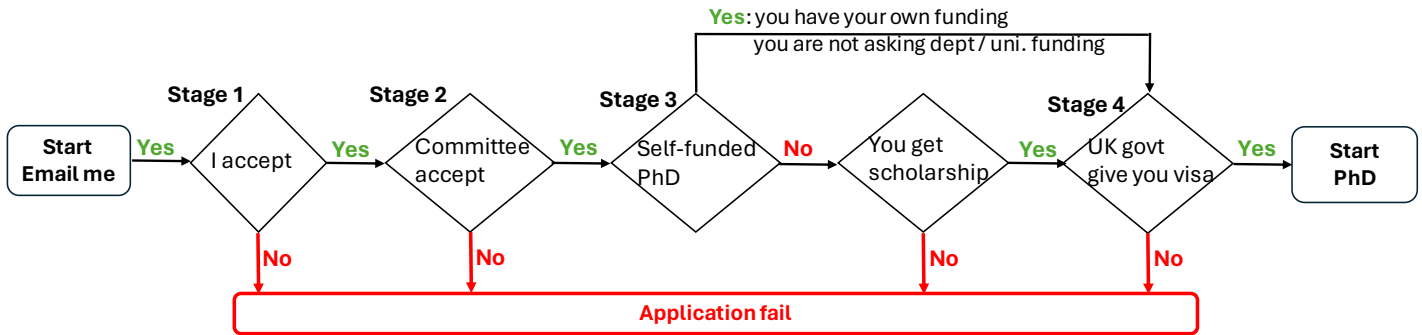
Doing a PhD requires lots of reading. If you can't even finish reading this, it gives me a negative impression that you don't have reading skill.

General info

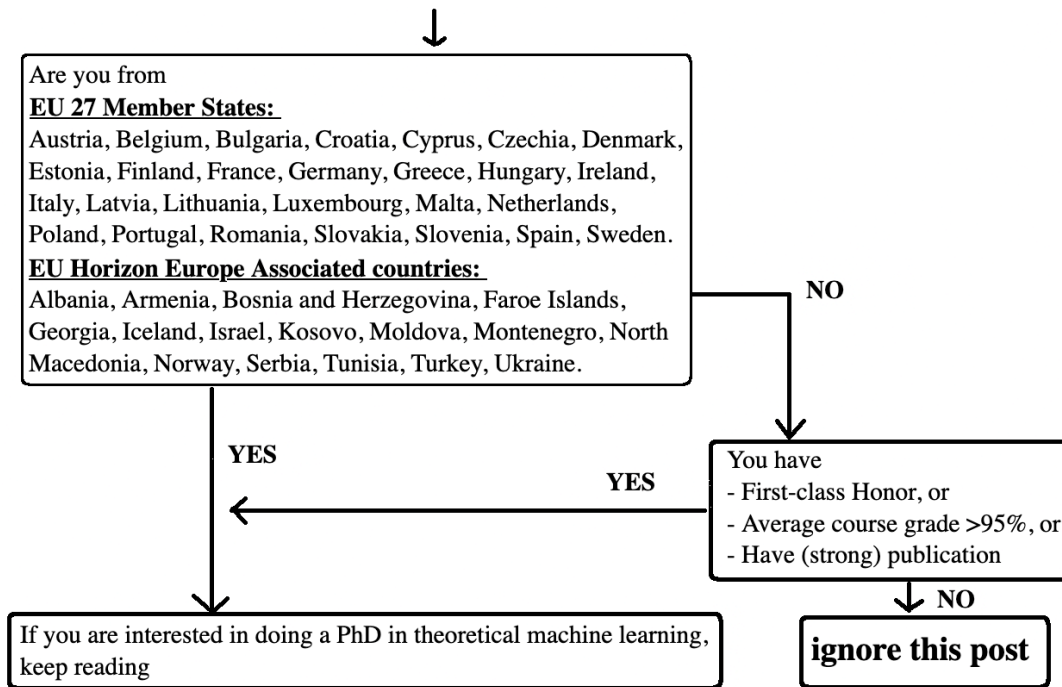
- PhD scholarships available for Theoretical Machine Learning (ML)
- I am seeking highly qualified candidates for doctoral positions:
 - I am looking for a MSc in math, applied math, computer science, operations research, statistics, engineering, physics, or a discipline with strong math training.
- The project focuses on the theory, algorithms and applications for ML. The goals include designing faster algorithm, understanding the working principle behind ML, applying ML to solve applications.
 - This research is basically just math, it is not “applying method X on data Y”. You are expected to learn, understand, and develop theory to prove that “why method X will work”, “when will method X work” and “how fast will method X work”.
 - **I reject projects like “I want to apply deep learning method X on data Y”. Unless you are proposing something interesting such as “Using algebraic geometry to study why deep learning works”.**
- You will have the flexibility to choose a topic on Theoretical Machine Learning within:
 1. Nonsmooth Nonconvex Optimization
 2. Nonsmooth Optimization on Manifold and Differential Geometry
 3. Analysis of Algorithm by Differential Equations and Dynamical System
 4. Submodularity
 5. Spectral Graph Theory
 6. Algebraic Geometry (e.g. Clifford, Jordan, Tropical)
 7. Convex Geometry
- What we offer
 - High quality training to do theoretical machine learning
 - Exciting theoretical research topics
 - Flexible research environment
 - Full PhD scholarships (£18622 per year for 3.5-4 years)
 - £1400 per year for conference
- Requirement
 - good math
 - good coding skills in a numerical language (such as MATLAB, Python, or Julia)
 - good communication in English, both written and oral
- Go to angms.science for more information.
Contact Andersen Ang (andersen dot ang at soton dot ac dot uk) for details.

number for 2024

1 Your application has 4 stages



On funding The finance people will be “more favourable” towards the following students:



Send your complaints to the UK government if you think this is unfair.

2 Basic info

- PhD entry requirements (from the university)

- 1st / upper-2nd class honours degree or equivalent
- English: IELTS ≥ 6.5 overall & ≥ 6.0 each item

On English level requirements

- What you will get

- PhD program: PhD in Computer Science
- You will have two supervisors, one is me.
- Standard PhD scholarship length: 3.5 years
- Money numbers: £90000 (local student) and £180000 (international student)
 - * Tuition fee: £4700 - £5000 (local student), £25500 (international student)
 - * Your stipend (your take home salary): £18622 - £20000 (**tax free**)
 - * You have £1400 for conference travel, books, course, computer

per year
per year
per year

* **Summary:** in 3.5 years, you get salary £65177, £4900 for conference, computer and training

- What you need to do to pass my stage

- All non-math experience will be irrelevant to the application.
- If I think that you are not math-oriented, I reject your application.
If you do not have sufficient experience on relevant background, I reject your application.

3 Procedure for PhD applications

Professors do not directly admit students. You apply through the university.

Steps

- **Step 0** You (the student) contact me (the proposed supervisor) & send me the following
 - CV, Academic transcript $\left\{ \begin{array}{l} \text{in English} \\ \text{to date} \end{array} \right.$ & degree certificate (if graduated) no page limit
 These tell me about your academic background.
 (If I think that you are not math-oriented, I reject your application.)
 - Personal statement 0.5 - 1 page
 This explains your motivation
 (If I think that you are not math-oriented, I reject your application.)
 - Research statement / research proposal 1 - 2 pages
 This explains your research interest & how it aligns to mine, and your understanding of the field
 (If I think that you are not math-oriented, I reject your application.)
 - 2 reference letters in official letter head 1 - 2 pages each
 This is for the committee.

THEN I read your file.
 IF I am interested, I will reply your email and arrange an online meeting.
 After the meeting, IF I agree to accept you as a PhD student, go to step 1a.

- **Step 1a.** The student make a formal application to the university

- put my name on the application
- say in the application how you plan to fund your studies: you are looking for funding from
 - * Internal scholarship (Scholarship within University of Southampton)
 - University scholarship
 - Faculty funding / School of ECS funding: DTP/ECS studentships
 - **Right now I have no own fund but I am prioritized for ECS funding, see Section 4**
 - * External scholarship (Scholarship outside University of Southampton)
 - UK Government scholarship
 - Government scholarship from your country
 - Other external funding
 - UK government loan Not recommended

- **Step 1b** Faculty sends me your application, I accept, go to step 2. No promise of funding at this stage
- **Step 2 Funding**
 - IF {you look for funding from me} AND {I have funding}:
 - * IF I say yes THEN go to step 3.
 - * IF I say no THEN go back to step 2.
 - IF you look for university / faculty funding, the application goes to a committee that will decide on funding.
 - * Each application can only be considered twice by the committee.
I.e., if you failed twice, you will never be considered again.
 - * More change for stronger student: good degree / achievement / research experience / publication record.
Contact me, I will look at your application material and advise how to improve.

After you have finalized the funding, go to step 3.

- **Step 3.** University send you an offer / conditional offer letter.
 - Apply for student visa (<https://www.gov.uk/student-visa>) (English test / ATAS)
 - We decide the exact starting date of your PhD study.
 - You look for accommodation (Section 8) and start preparing.

4 Faculty / Department funding for PhD (PGR) students

ECS has funding for several PhD students and **I am prioritized for the funding.**

- Terminology
 - home/local: UK students, EU or HE-associated
 - overseas: non-UK students
 - PGR: postgraduate research
 - ECS: School of Electronics and Computer Science
- If you are from UK/EU **and you are strong**, you have a high chance to get ECS fund to support you.
- If you are from overseas but **you are very strong**, you have a high chance to get ECS fund to support you.
- Priority of PGR funds goes to home student, if overseas student need other funds to cover extra international fees, see Section 2.
- (I will do these) Before a student can be considered for funding
 - they are required to undergo an interview with at least two academic staffs
 - read paragraphs 13 and 14 of the PGR Code of Practice
 - Complete Postgraduate Application Form, ask me for the form
 - Complete forms 3 (I will do it)
 - Complete ECS PhD Studentship Application Form 4 (I will do it)

5 Documents you need to prepare

- Readable academic transcript (to date) and degree certificate (if any) in English no page limit
- CV no page limit
- Personal statement Max 1 page
- Research statement Max 2 pages (you can put figure)
- 2 reference letters Max 2 pages each
- English language certificate (if needed) for student visa
Make sure your English certificate is recognised by UKVI (UK Visas and Immigration)
- If you apply for ECS scholarships
 - Form 2, Form 3, ECS PhD Studentship Application Form (form 4) ask me for the forms
- ATAS certificate apply after you get the offer
- UK student VISA see Section 7

If your documents are not in English, they need to be translated into English. You either get the official English version of the document, or you pay for certified translation service (those recognized by UKVI¹) to translate your document to English. If you are not doing this, the UK government will reject your student VISA application. Send your complaints to the UK government.

6 Tips and links

- **Don't send me your research proposal before knowing what I do.**
 - An immediate reject: you didn't even do research on knowing what my research is.
99% I will reply your email like this

Hi,
 Thanks for your interest, however I reject your application.
 Reason: Insufficient experience on relevant background.
 Best & Good Luck.

 - Explain why you want to work with me
 - Explain what topics within my expertise interested you
 - Elaborate your understanding of the field
- Online resources
 - Apply for a research degree <https://www.southampton.ac.uk/study/postgraduate-research/apply>
 - Write a PhD CV <https://uk.indeed.com/career-advice/cvs-cover-letters/phd-cv>
- Scholarships
 - Southampton PhD Scholarships
<https://www.southampton.ac.uk/doctoral-college/presidential-scholarships.page>

¹UK Visas and Immigration <https://www.gov.uk/government/organisations/uk-visas-and-immigration>

- Southampton funding opportunities
<https://www.southampton.ac.uk/doctoral-college/funding-opportunities.page>
- Postgraduatesearch.com
<https://www.postgraduatesearch.com/funding>
- PROSPECTS (scholarship search)
<https://www.prospects.ac.uk/postgraduate-study/funding-postgraduate-study>
- British Council (Search for UK courses and scholarships)
<https://study-uk.britishcouncil.org/scholarships-funding>
- Look for industrial scholarship
- Look for government scholarship from your country

7 After you get the university offer: UK VISA

1. Info from the university
<https://www.southampton.ac.uk/student-services/visa-and-immigration/index.page>
2. UK government page <https://www.gov.uk/browse/visas-immigration/student-visas>
 - English requirement <https://www.gov.uk/student-visa/knowledge-of-english>
This is the government's requirement, not the university's requirement (and they can be different)
 - Bringing your partner and children <https://www.gov.uk/student-visa/family-members>
 - Academic Technology Approval Scheme (ATAS)
<https://www.gov.uk/guidance/academic-technology-approval-scheme>

8 After your VISA is successful: prepare your PhD life

- Apply for a UK bank online before the trip.
UK banks have low efficiency, it takes a month to open your bank account.
- Prepare a UK sim card
- Prepare some £, I recommend £1500 - £2000 for your first month bills, rents and living expenses.
(Some landlords may ask you to pay for 3 months of rent in advance.)
- Plan your finance: your PhD stipend (£18622 - £20000) is tax free. Your salary each month is £1541 - £1666.
- Cost of living
 - Accommodation: Student accommodation in Southampton, VITA student, uni-homes. The first two options will lump everything together into one single cost and free yourself from dealing with electricity bill, gas bill, water bill, internet bill, phone bill, TV bill, etc.
 - Local transportation: £2 per bus trip or £360 year-pass
 - Personal advice: do not put more than 35% – 40% of your salary on rent (excluding bills). That is about £600 - £750.
 - For lower rent, look for house share in rightmove.
- In UK all adults pay Council Tax. PhD students are exempt from paying Council Tax. If you are moving with your partner, your partner has to pay council tax. See Southampton City Council.

- Familiarize yourself with Southampton map, zip code, and important locations
 - post office (apart from mail, UK post offices also deal with bills, ID card, internet, currency exchange)
 - hospital
 - bank

9 Work expectation

- Flexible 40 hours of work per week 8 hours each day Mon-Fri
 Flexible, lunch time / sport time counted in working hours.
 You should go to gym and I will encourage you to go gym.
- A year has 52 weeks, so in theory you have 2080 work hours. In practice you have 1500-1600 work hours.
- A course takes < 50 hours. For a “intro-intermediate-advanced” 3-unit course structure, it takes 150 hours to master a subject.
- Counting half of the time to study (other half go to research), you need to master at least 4 subjects.

10 My view about PhD study

- PhD should be about theoretical frontier, not on application.
 PhD focusing too much on a particular application should be considered “industrial practioner”.
 I am not saying you should do no application, I am saying you shouldn’t do no theory.
- Math is important. No math, no PhD.
 Math is the queen of science. Math is a formal language system for doing research. All researcher has to master at least TWO FIELDS of maths (not two topics, two areas, but two fields).
- Depth is important. No depth, no PhD.
 In the future all shallow things will be replaced by artificial intelligence. People with no in-depth skills have no competitiveness.
- Breath is important. No breath, no PhD.
 I believe maths is not invented but discovered. You make discovery by connecting the dots. To connect dots you have to know at least TWO DOTS, hence you have to know at least TWO FIELDS of maths.
- My minimum requirement for PhD

– Math genius? Not necessary.	– Good at English? Should.	– Hardworking? Must.
– Good at math? Not necessary.	– Good at reading? Should.	– Willing to learn? Must.
– Good math grade? Not necessary.	– Good at writing? Should.	– Motivated to learn? Must.
– Good at coding? Not necessary.	– Good at presenting? Should.	– Ambitious? Must.

11 Lists of things I am interested (not in any order)

Optimization

- Nonlinear optimization
- Nonsmooth optimization and subdifferential
- Optimization algorithm design
- Convergence analysis of optimization algorithm
- Acceleration of optimization algorithm
- Block-coordinate descent
- Nonconvex optimization
- Convex analysis for optimization
- Inexact proximal gradient method
- Trust-region methods
- Nonproximable optimization and proximal average
- Differential equation technique for optimization
- Proximal bundles
- Manifold for optimization on non-Euclidean space
- Zeroth order method
- Semi-smooth Newton's method
- Semidefinite optimization
- Randomization for optimization

Linear algebra

- Nonnegative matrix factorization
- Nonnegative tensor factorization
- Numerical Linear Algebra
- Randomized Linear Algebra

Graph topics

- Spectral graph theory
- Sum-of-norms clustering

Expository topics

- Multi-level/scale/grid methods for optimization
- Fractional derivative for optimization
- Exterior algebra and derivative for optimization
- Wasserstein metric
- Matorid
- Complex derivative for optimization on \mathbb{C}

Applied pure mathematics

- Algebraic geometry for optimization
- Differential geometry for optimization
- Convex geometry for optimization
- Algebraic topology for optimization
- Functional analysis for optimization
- Abstract algebra for optimization
- Combinatorics for optimization
- Probability for optimization
- Hyperreal analysis for optimization

Applications

- Identifiability
- Signal processing
- Blind source separation
- Hyper-spectral imaging
- Text mining
- Bioinformatics
- Snake / active contour model
- Sparse optical flow