STUDENT ADMINISTRATION
Research Degrees Team
Examination Schools, High Street, Oxford OX1 4BG

UNIVERSITY OF OXFORD

PERSONAL & CONFIDENTIAL

Ref: EX44/MAH

Mr S Agarwal
101 Imperial Block
Eldeco Greens Apartments
Gomtinagar
Lucknow
India 226 010

9 July 2012

Dear Mr Agarwal

Result of examination for the degree of Doctor of Philosophy
Division of Mathematical, Physical & Life Sciences

I have much pleasure in informing you that the Division has granted you leave to supplicate for the degree of Doctor of Philosophy approved on 4 July 2012. On behalf of the University may I congratulate you on this considerable achievement, which is often made only by significant personal sacrifice and effort.

Arrangements for supplicating for the degree should be made through the proper officer of your college. Please note, you must submit a hardbound copy of your thesis to the Research Degrees Team (at the Examination Schools), for deposit in the Bodleian Library, before supplicating for the degree.

If your degree programme started on, or after, 1 October 2007 you are, in addition to your hardbound submission, required to deposit a digital copy of your thesis with the Oxford Research Archive. For more information see either wws.ouls.ox.ac.uk/ora/oxford-etheses or the enclosed information sheet. If your degree programme began before this date, you are invited to submit a digital copy.

Yours sincerely

Mrs M A Hames
Research Degrees Supervisor

cc: Dr N Jones, Professor C Deane
        The Tutor for Graduates, Merton College
        Mrs V C Forth, Graduate Office, Mathematical, Physical & Life Sciences Divisional Office
9 Parks Road, Oxford OX1 3PD - File Copy

Dr N Jones
Clarendon Laboratory
Parks Road
Oxford OX1 3PU

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UNIVERSITY OF OXFORD

EXAMINATIONS FOR THE DEGREES OF D.Phil.
Notes to supervisors concerning their student's examination result

A copy of the examiners' report in respect of your student is attached. A copy has also been sent to the candidate with notification of the examination result.

The student will be told, if elucidation of the comments made by the examiners is required, to seek guidance through you as supervisor, and not to communicate directly with the examiners.

GSO\EXAMRES\DPhil LTS

CONFIDENTIAL

18 JUN 2012

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UNIVERSITY OF OXFORD
DEGREE OF DOCTOR OF PHILOSOPHY
REPORT OF THE EXAMINERS

28 JUN 2012

Board/Department of	Physics: Condensed Matter
Candidate's Name	Mr Sumeet Agarwal OSS No:390111
College, Hall or other Society	Merton College
Examiner Names	Internal: Dr M D Fricker External: Professor J-P Onnela
Supervisor(s)	Dr N Jones, Professor C Deane & Dr M A Porter
Title of Thesis as approved by the Board/Department	Networks in Nature: Dynamics, Evolution, and Modularity

We have examined the above-named candidate for the degree of Doctor of Philosophy, and report to the board/department as follows:

[Please select one of the statements 1- 6 and delete all the rest. For a first examination, examiners may only select from recommendations 1, 2 or 4; for a subsequent examination, examiners may select any one of 1– 6. Full explanation of the recommendations available is on p.7 of the Memorandum of Guidance for Examiners.]

1. **AWARD OF THE D.PHIL..** (a) as the thesis stands or (b) having approved all required minor corrections
   (a) We are satisfied:
      (i) the candidate possesses a good knowledge of the particular field of learning within which the subject of the thesis falls;
      (ii) that the candidate has made a significant and substantial contribution in the particular field of learning within which the subject of the thesis falls;
      (iii) that the thesis is presented in a lucid and scholarly manner;
      (iv) that it merits the degree of Doctor of Philosophy; and
      (v) that the candidate has presented a satisfactory abstract of the thesis..
   (b) We have asked the candidate to correct certain minor errors in the thesis and confirm that these corrections have been carried out to our satisfaction and therefore (a)(i)-(v) are satisfied.*

   Initials: _MF_   Date: _11/6/2012_

2. **REFERENCE BACK FOR D.PHIL. OR AWARD OF THE M.LITT./M.SC.**
We recommend that the board should offer the candidate a **choice between**:
(a) reference of the thesis back for revision for re-examination for the Degree of Doctor of Philosophy, **or**
(b) (i) leave to supplicate for the Degree of Master of Letters or of Master of Science, as appropriate, as the thesis   stands **or**
(b) (ii) leave to supplicate for the Degree of Master of Letters or of Master of Science, as appropriate, subject to minor corrections, on the basis that the thesis has not reached the standard required for the Degree of Doctor of Philosophy but has nevertheless reached that required for the Degree of Master of Letters or of Master of Science.

We have set out the respects in which the thesis falls below the standard required for the degree in the full report and we understand that the full report will made available to the candidate following approval by the board.

   (Please delete (b) (i) or (ii) as applicable)

3. **REFERENCE BACK FOR M.Litt./M.Sc. ONLY**
We recommend that the candidate's thesis be referred back for revision for re-examination for the degree of Master of Letters/Master of Science, and we have set out the respects in which the thesis falls below the standard required for the degree in the full report and we understand that the full report will made available to the candidate following approval by the board.
   (Please delete as necessary)

Approved: _Patrick Baird_   4/7/12

* The University's Examination Decrees now require examiners to report only after they have confirmed that minor correction have been satisfactorily completed. Please initial and date (b) in box 1 to confirm that the required corrections have been made and approved.

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4. **REFERENCE BACK FOR D.PHIL. or for the degree of M.Litt./M.Sc.** *as the candidate may choose.*
We recommend that the board should offer the candidate a choice between (a) reference of the thesis back for revision for re-examination for the Degree of Doctor of Philosophy, or (b) reference of the thesis back for revision for re-examination for the Degree of Master of Letters or Master of Science.

We have set out the respects in which the thesis falls below the standard required for the degree in the full report and we understand that the full report will made available to the candidate following approval by the board.

(Please delete as necessary.)

5. **AWARD OF M.Litt./M.Sc.** *(Please delete as necessary)*
We are satisfied that candidate's work while not of sufficient merit to qualify for the degree of Doctor of Philosophy, has nevertheless reached such a standard as to entitle the candidate to supplicate for the degree of Master of Letters/Master of Science; and are satisfied that (a) the candidate possesses a good general knowledge of the field of learning within which the subject of the thesis falls; (b) that the candidate has shown competence in investigating the chosen topic; (c) that the candidate has made worthwhile contribution to knowledge or understanding in the field of learning within which the subject of the thesis falls; (d) that the thesis is presented in a lucid and scholarly manner; (e) that it merits the award of the degree of Master of Letters/Master of Science.

6. **OUTRIGHT FAILURE**
We recommend that the candidate's application for leave to supplicate be refused.
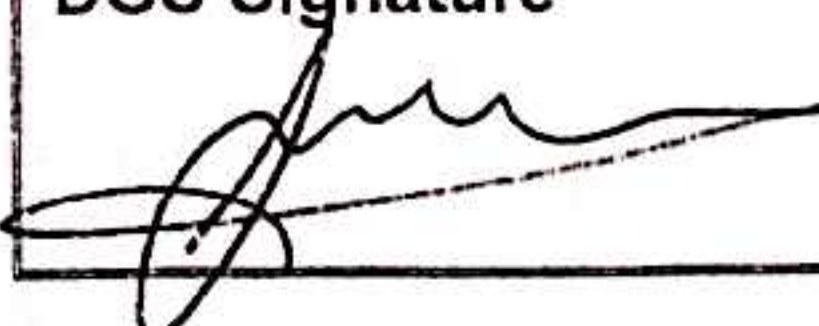
We provide a detailed report below/annexed. (Examiners are asked to provide reports in word-processed or typewritten form if at all possible.)

Signed Date: 3/4/2012	
Name: DR M D FRICKER	**} Examiners**
Signed Date: 3/4/2012	
Name: PROFESSOR J-P ONNELA	

Notes
Examiners should note that their full report will now be made available to the candidate.

1. *In the case of a first examination, where the examiners are not able to recommend the award of the D.Phil., examiners are normally required to annex to their report a statement (for transmission to the candidate) setting out the respects in which the thesis falls below the standard required for the degree in question, and what changes are necessary for it to reach that standard. In exceptional circumstances, and notwithstanding a recommendation under 2 or 4, the examiners may certify (as an appendix to their report and after indicating the respects in which the thesis falls below the standard required for D.Phil.)) that they are unable to indicate how the thesis might be changed, within the time allowed, in order to reach the required standard for the degree of Doctor of Philosophy.*

DGS Signature	DGS Name	Date DGS Approved
	DR ACHILLEFS KAPANIDIS	27/6/12

with effect from 1 February 1996 (revised 2 April 2007, revised 9 January 2008)   GSO1\GSO11

The thesis of Mr. Sumeet Agarwal combines network science, biology, and machine learning in a seamless way, making a very strong and timely contribution to this multidisciplinary area. The overall scientific quality of the thesis is excellent, and the thesis is extremely well written. The examiners were of the opinion that the work contained in the thesis can be published in scientific journals of the highest quality, and indeed parts of the thesis have already been published.

Chapter 1 starts with a brief statement about the history of graph theory, the predecessor of network science, placing the work in a broader context. It then proceeds by introducing the basic network concepts, and covers several network diagnostics and summary statistics in detail.

Chapter 2 deals with protein interaction networks. It covers some introductory biological material, and does this in a reader-friendly way. It then introduces the major data sets in this field of research, and discusses the measures that can be used to characterize topological communities and their relationships to the functional organization of protein interaction networks. The chapter proceeds by revisiting the notion of "date hubs" and "party hubs," concepts that were introduced a few years ago in a very influential article published in Nature, finding that some of the conclusions of the original paper, as well as some subsequent studies, were not fully supported by data.

Chapter 3 introduces the idea of high-throughput analysis of networks. The approach, which has its basis in machine learning, essentially consists of taking a very large collection of networks, both empirical and synthetic, and computing a very large number of different network measures and characteristics for each network. Perhaps the main finding is that one can cluster networks remarkably well by using just the first two principal components of the underlying design matrix. The chapter then employs various network features to learn about the nature of the solution to the traveling salesman problem (TSP) on various networks. The chapter ends with an interesting section on phylogeny regression, where the idea is to explore the changes in networks of interacting pathways over the course of evolution.

Chapter 4 examines patterns of correlations between different network features. Although presented as exploratory work, the approach is actually very interesting in that it enables one to get a sense of the variability within network categories, e.g. how variable social networks or brain networks are, but also, importantly, what are the main differences across these categories.

Chapter 5 deals with two different notions of entropy, and investigates the nature of their correspondence with one another. This section features some interesting analytical calculations, with the details (rightly so) deferred to the Appendix. The main finding of the chapter is that the two notions of entropy employed are actually quite different, at least for the studied systems, and hence one cannot be used as a substitute for the other.

Chapter 6 follows pushes some of the earlier ideas further by incorporating ideas from the Bayesian paradigm. This is very appealing, as in the Bayesian context one can (indeed, has to) be transparent about the modeling assumptions in the sense that one needs to explicitly specify prior distributions for the parameter(s) of interest. It is surprising how little has been done in the intersection of networks and Bayesian modeling, and this chapter of the thesis clearly demonstrates what may be gained from combining the two.

Mr. Agarwal was very thoughtful and clear in his responses to the questions presented to him during the 4.5-hour examination. He obviously had a very deep understanding of the topic, which enabled him to provide very detailed answers. In addition to mastering the technical details, he also had a clear perception of where his work falls in the broader scientific context.

Overall, the examiners regarded the thesis and its defense as excellent and are happy to recommend award of the D.Phil.