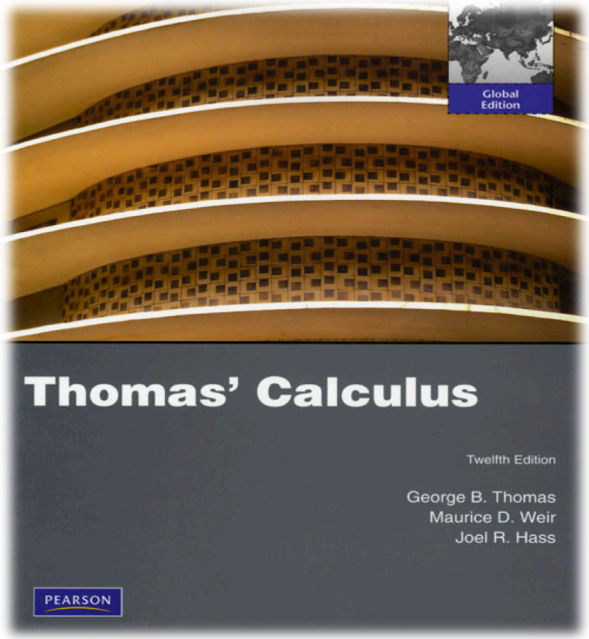
Queen Mary
University of London

Research Methods in Mathematical Sciences

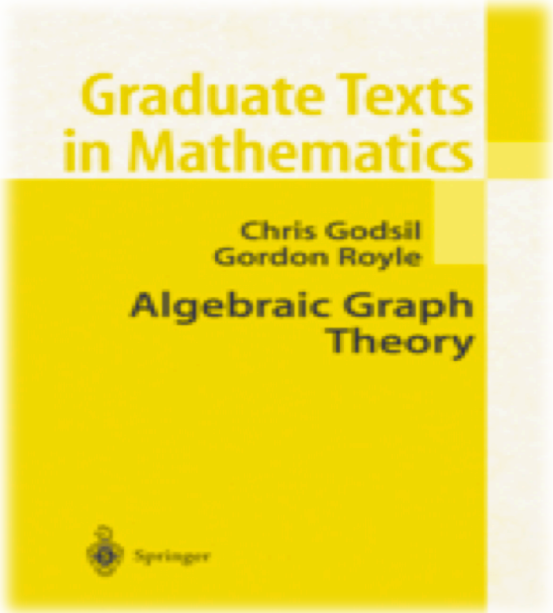
How to critically read and review an applied math paper?

What will you need to read...

Textbooks



Advanced textbooks



Peculiarities

- These usually explain in much detail, concepts are usually well known.

- Not dense, so you can almost read this as if it was some novel, slowly but in a continuous way.

- Use pen and paper to summarise the main ideas and concepts of a given book chapter

- For deeper books, use pen and paper and write down every mathematical step (to check you are following the logic)

- Once you read a given chapter, practice simple exercises on the subject

- Read textbooks in a continuous way: do not jump from formula to formula!

- Take your time for ideas to mature (the more advanced the book, the deeper the ideas and concepts) --> you might need to read a given chapter 5 or 10 times.

- Textbooks are very useful for newcomers, as initial contact with a subject. e.g. Students < PhD

What will you need to read... Scientific papers

VOLUME 86, NUMBER 24 PHYSICAL REVIEW LETTERS 11 JUNE 2001

Bose-Einstein Condensation in Complex Networks

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The evolution of many complex systems, including the World Wide Web, business, and citation networks, is encoded in the dynamic web describing the interactions between the system's constituents. Despite their irreversible and nonequilibrium nature these networks follow Bose statistics and can undergo Bose-Einstein condensation. Addressing the dynamical properties of these nonequilibrium systems within the framework of equilibrium quantum gases predicts that the "first-mover-advantage," "fit-get-rich," and "winner-takes-all" phenomena observed in competitive systems are thermodynamically distinct phases of the underlying evolving networks.

DOI: 10.1103/PhysRevLett.86.5632 PACS numbers: 89.75.Hc, 03.75.Fi, 05.65.+b, 87.23.Ge

Papers (level: from graduate)

- Much denser and shorter than textbooks
- Piece of original and previously unknown research

Standard papers (Length: 4 - 40 pages)
- Title
- Abstract
- Introduction
- Result Sections:
  usually theory, numerical simulations and data are in different subsections
- Conclusion / Discussion
- Appendix
- References

Letters (usually short pieces of high importance, usually 4 pages)
- Title
- Abstract
- Text

Impact factor of the journal and citations are 1st order approximants of quality of a paper

Papers (level: from graduate)

Quality

- Impact factor of the journal and
- Citations ro the paper

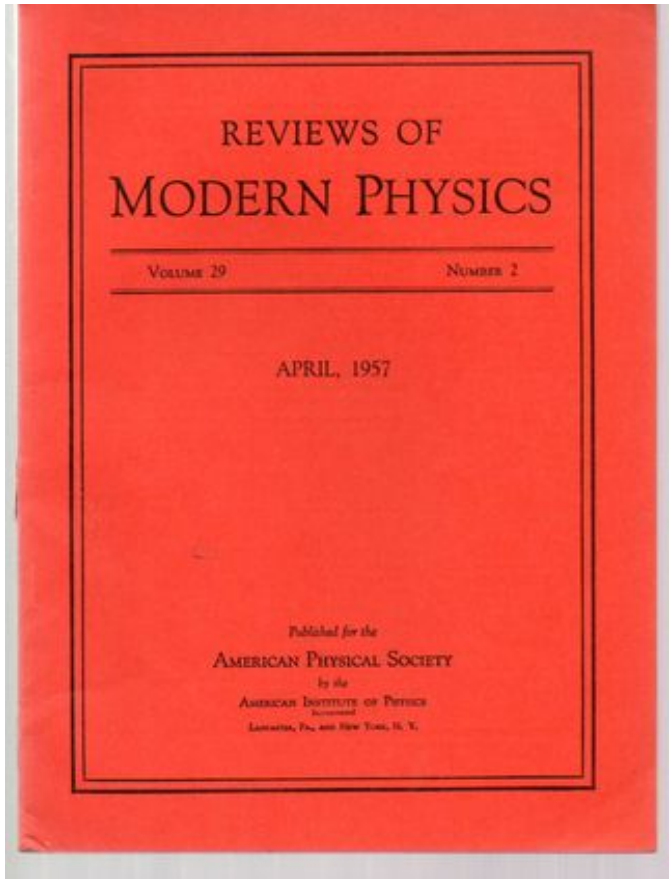
are 1st order approximants of quality of a paper

Examples of good journals

- Interdisciplinary: *Nature, Science, PNAS, Nature Communications, SIAM Review*
- Broad scope but narrower: *Physical Review Letters, Nature Physics*
- Specialised:

Nonlinear dynamics – *Nonlinearity*
Mathematical Physics – *Communications in Mathematical Physics*
Statistical Physics - *Physical Review E*
Computer Science – *IEEE Transactions on Pattern Analysis and Machine Intelligence*
etc

What will you need to read... Reviews



The structure and function of complex networks

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Inspired by empirical studies of networked systems such as the Internet, social networks, and biological networks, researchers have in recent years developed a variety of techniques and models to help us understand or predict the behavior of these systems. Here we review developments in this field, including such concepts as the small-world effect, degree distributions, clustering, network correlations, random graph models, models of network growth and preferential attachment, and dynamical processes taking place on networks.

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Reviews/monographs (level: from graduate)

- Comprehensive and organised collection and synthesis of a new body of knowledge (like a collection of papers but not yet a textbook)

- The structure is:
- Title
- Abstract
- Index
- Introduction
- Many sections (either independent or not)
- Discussion
- References

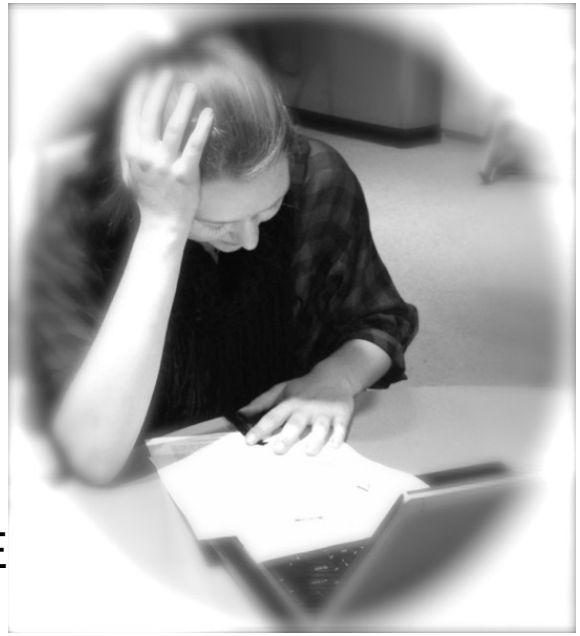
Several strategies for reading, depending on your interest and goal

Note that the 3-pass strategy that Mark will teach you is also valid in applied math, but as a complement:

- **Ultrafast**: title (arxiv) – takes about 5''
- **Fast**: title + abstract (arxiv) – takes about 2'
- **Diagonal reading** – 15' – 30'
- **Full reading** – 1h-3h (and will require several readings)

1. A researcher looks daily the arxiv in ultrafast/fast mode
2. Usually we read 1-2 papers per day (diagonal reading) to keep up-to-date with state of the art
3. Full reading of the papers we want to work on, or those which are related to our very own research
4. Textbooks are usually read in the Full reading mode

Reading papers is typically an ACTIVE process, not PASSIVE



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What you want to learn from the paper determines the way you read it

- To learn a new technique (core)
Am I able to apply the technique in a simple example?
Is this technique sound?
- To check a result (abstract - core)
Can I explain, with words, the main message of the paper?
- To learn from a new field (introduction/discussion/central part)
- Be updated (title/abstract)
- Referencing

Diagonal reading

The order of this reading should be: title/abstract/figures/introduction/conclusions/ central part (results)

Be able to respond to:

- What is the main message of the paper?
(in pure maths it´s a theorem, in applied it can be a physical result, a new method, a new technique, etc)

- What techniques did the authors use to support the exposition?
What *Theory / numerical simulations / experiments ?*
For instance:
they used the generating functions formalism to find analytical results on some properties of a model that describes the evolution of biological networks. These properties were then compared to data obtained from experiments on brain networks.

- Why is the paper relevant? For instance, because:
* the results/ideas are conceptually new (we learned new phenomenon)
* the mathematical model presented is analytically solvable and results match experiments (i.e. We gained understanding of an already known phenomenon)
* the authors present new methods (broad applicability in other fields)
* etc

Full reading

1. Never read from beginning to end at first: always make a diagonal reading first

2. take time to read the introduction with care, and check some of the references to get sure you have a good understanding on the background of the questions the paper is addressing (although don't get too crazy) – maximum 2 hours

3. Central part:
* Make a first reading through the results, understand the basic steps and forget the details
* In the second reading you can stop in the details you are interested in (a concrete technique, a concrete calculation, etc) – no average time
* Use pen and paper to go through every step of the calculations yourself. Try to reproduce the results

4. Once you are done, read again the conclusions/discussion and check you understand the implications of the results

Critical reading – Evaluate What makes an applied math report/paper GOOD?

1- Concise

How it should be - ONE or TWO key messages tops: More is confusing and is not good for clarity
Question to be asked - What is the topic of this paper? How many key messages does this paper present? What are they? Are these messages relevant?

2- Highlight and contextualise

* Summary of the the key result in title and abstract?
* Results are contextualised in the introduction?
* Has the introduction motivated why this research is worthy? Do the authors reference previous works?

3- Coherent structure

How it should be -The structure should serve (i) clarity of exposition, (ii) reinforce key message.
Question to be asked - Did the authors followed
introduction / statement / calculations, numerical simulations, and or experiments / discussion ?

4- Logic flow

Question to be asked

* Does the paper incorporates information in a sequentially logic way?
* Do conclusions follow logically?

5- Simple

Keep as simple as possible (but not simpler). The paper should avoid artificial difficulty (ex: excess of notation)

6- Readable

Question to be asked

* Have technical points that do not help understand the key message been put in an appendix?
* Is notation consistent all over the paper?
* Did the authors make good use of figures to illustrate parts of the work / data ?
• Do simulations / theoretical developments / experiments help and support the key message effectively?

…

How to make a critical review of a paper

- Understand the key message delivered as well as what kind of techniques the author used to answer those messages, and be able to summarize them in a few lines.
“In this paper, the authors ...”

- Assess the paper according to:
1) The soundness of both the message and the methods used
2) 6 Criteria on previous slide

WORKING GROUP SESSION 2 Make a diagonal reading of the paper "Scaling and Universality in the Human Voice" and try to respond to the following questions:

1- Concise

How it should be - ONE or TWO key messages tops: More is confusing and is not good for clarity

Question to be asked - What is the topic of this paper? How many key messages does this paper present? What are they? Are these messages relevant?

2- Highlight and contextualise

* Summary of the the key result in title and abstract?
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