On Models & Theory

Elchanan Mossel

MIT

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All models are bad

- All models are bad
- but some are useful (Box and Norman, 87)
- Which ones?

Couplas in finance

- David X. Li, a ”mathematical genius”, ”invented” the Gaussian coupla function (2000) to ”compute” the correlation in risk:

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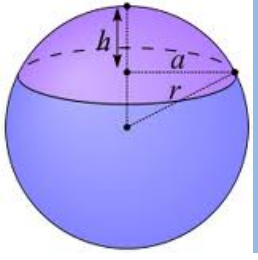
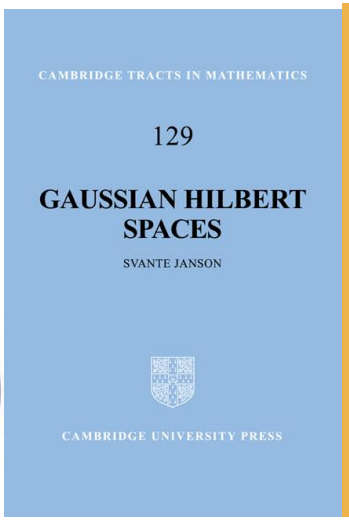
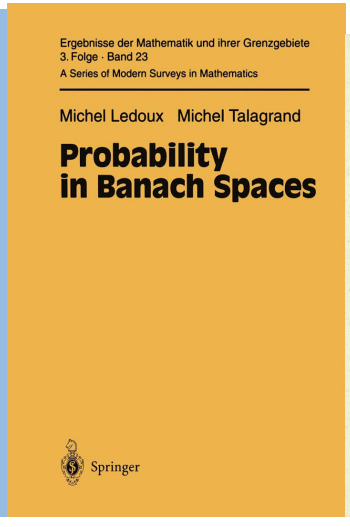
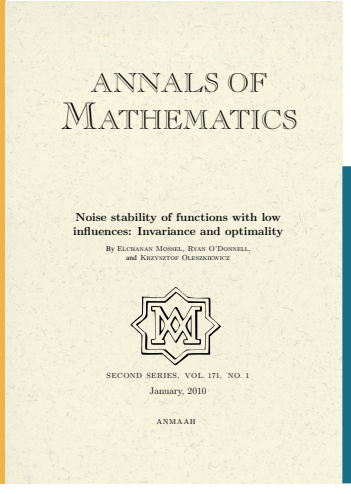
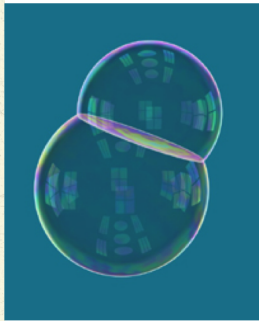
- Borell, Janson, Ledoux, M ...











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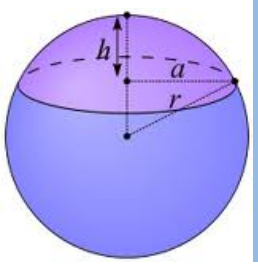
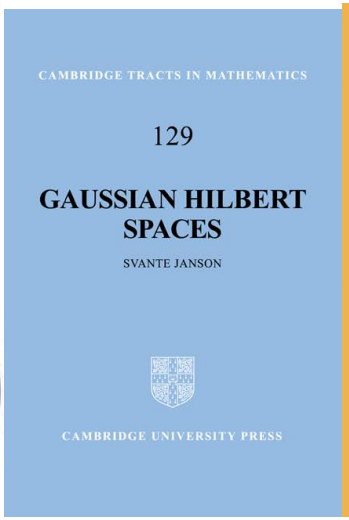
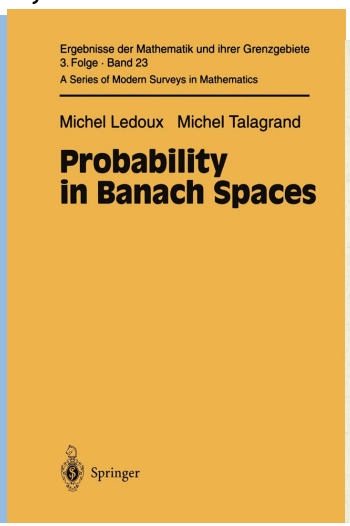
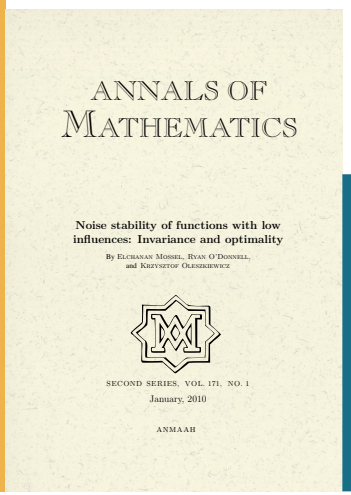
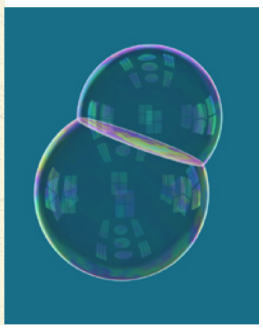






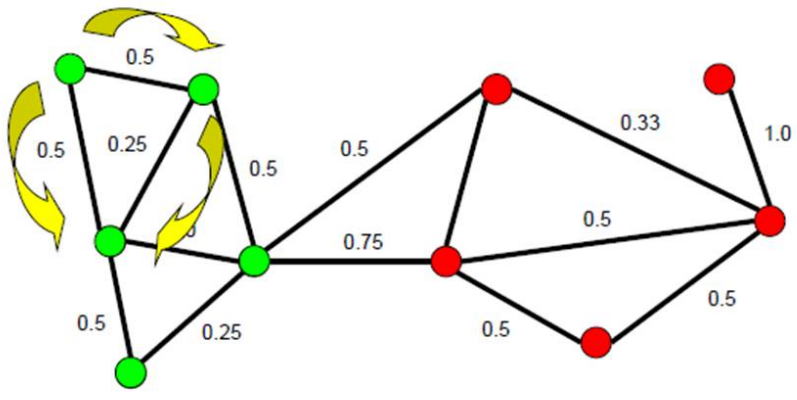




- Lesson 1: Danger in using math you do not understand.

Cascades in Social Networks

- Kempe, Kleinberg and Tardos 03,05, Mossel-Roch-05:
- Elegant model of spread on social networks.
- $+$ Assuming the model, rigorous proof for excellent performance for finding the most influential sets.



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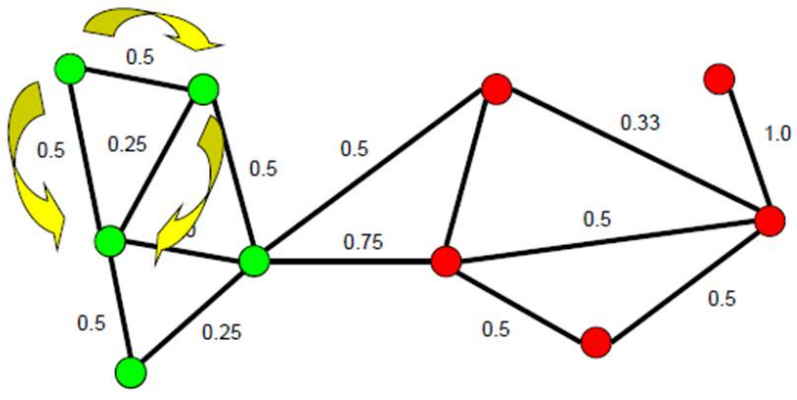

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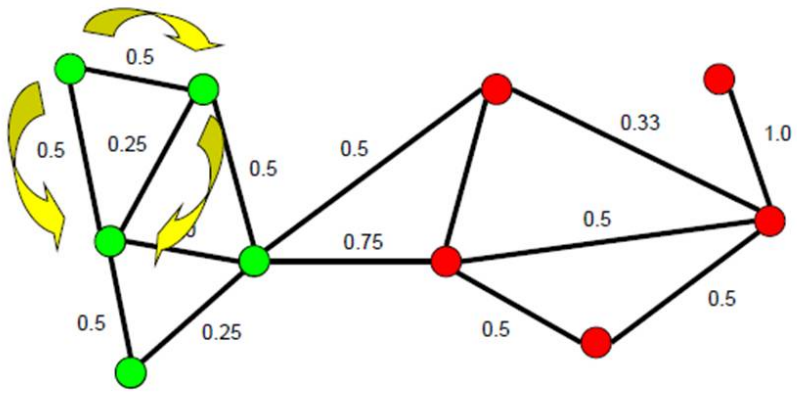

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- Consulting experience: a terrible model.
- Lesson 2: Beautiful models are not enough. Area expertise is needed.

Phylogenetic Mixtures

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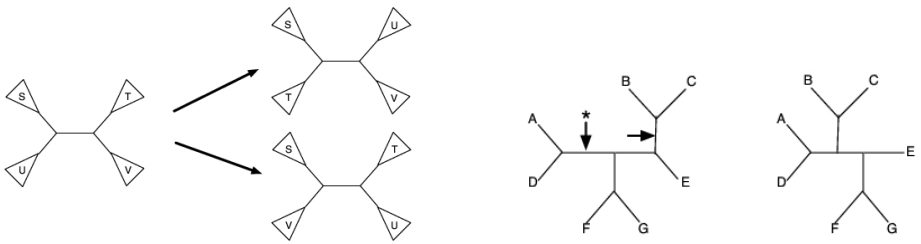

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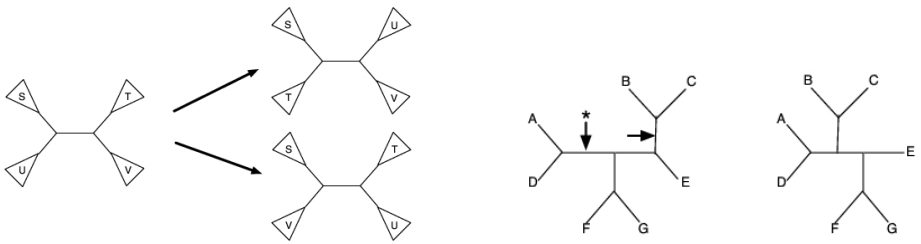

- Lesson 3: Important to explicitly state modeling assumption, so experts can evaluate these assumptions.

A success story: Phylogenetic reconstruction - a success story

- Steel, M, Roch (starting $\sim$ 2002) ...
- Theory provides excellent practical predictions:
- Information theory bounds, phase transitions, gene trees vs. species trees etc.
- Why?

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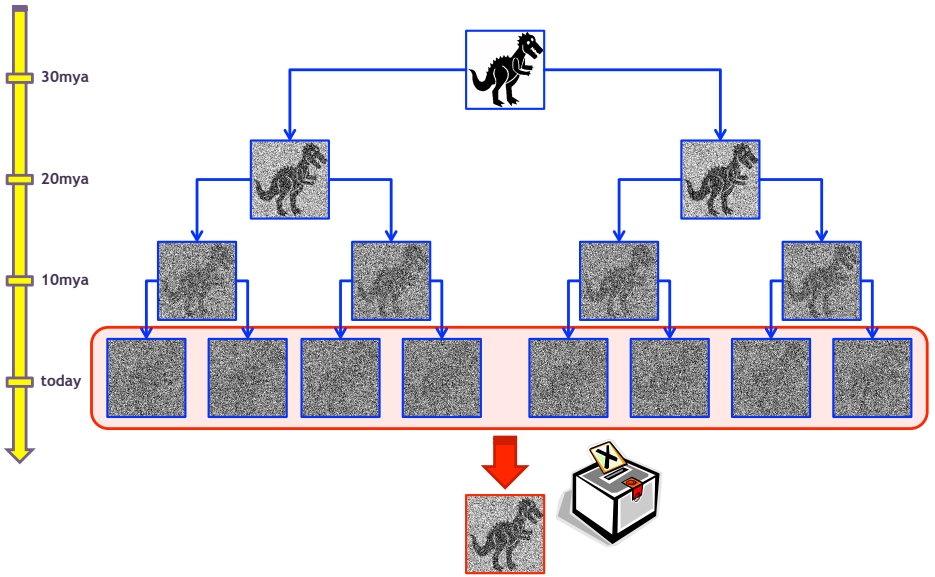
- Why?
- Good feedback between specialist in biology, phylogenetic software developers, theoreticians.



Block Models and non backtracking walks

- Simple (but really terrible) model of communities in graphs.
- Lets us ask very precise mathematical questions: phase transitions, optimal algorithms? (Decelle,Moore,Zdeborova,Zhang ... 2011)
- Lead to new practical, fast algorithms ($+$ M-Neeman-Sly, Bordenave,Lelarge,Massouille, ...)
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- Why?
- A **bad model** but a **simple** one.
- Bridging communities: data science, stat. physics, math and computer science.

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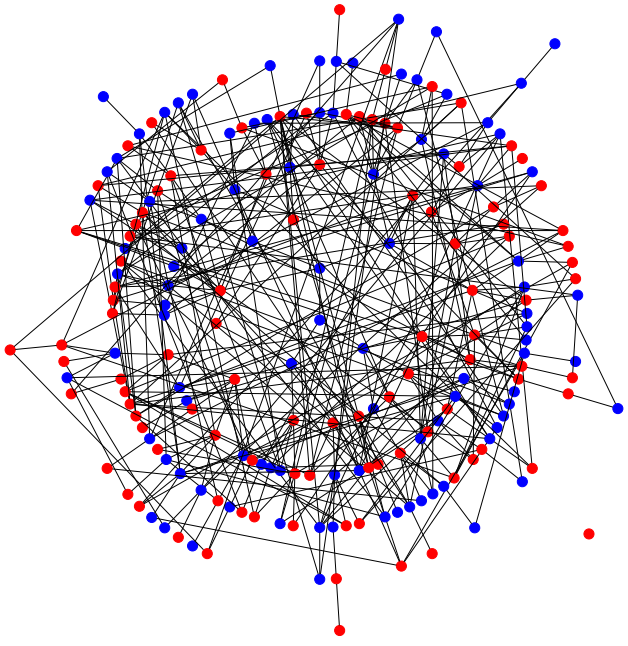

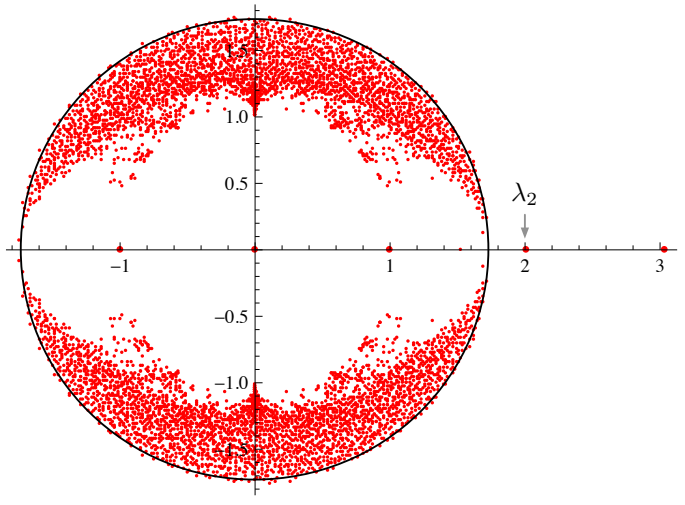

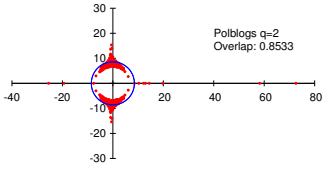

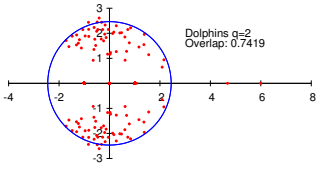

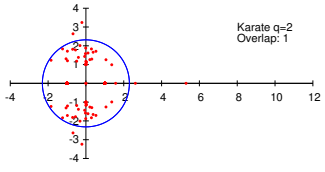

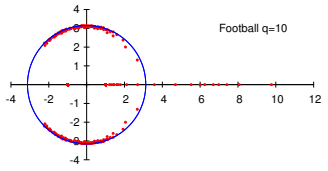

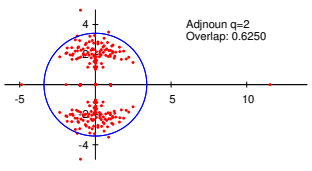

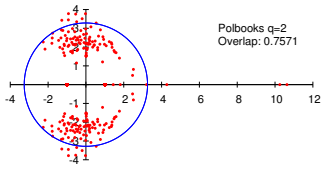

Conclusion

- Lessons: Know your math, be an expert in the area, transparent.
- Integration between different disciplines increasingly necessary.
- The simpler the better.