# From curiosity to purpose

… or my little research story so far

(and an un-compiled list of things I learned in the process)

*Nikolaos Laoutaris*

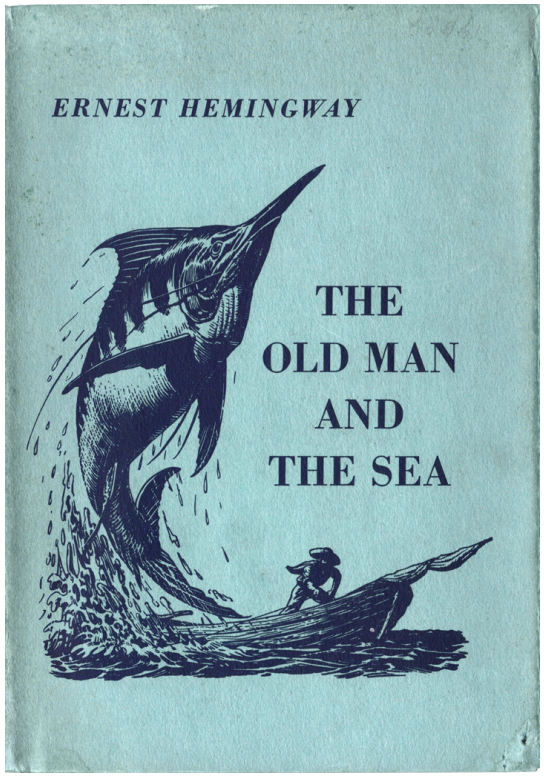
# Oh my god

what a wonderful opportunity and honor


people care about what I do and think ??? !!!

# Oh my god

I am old …



# My career in 1 slide

time

difficult

- Queueing theory
- Decision theory
- Cache replacement algorithms
- Game theory
- Facility location theory

real

- Systems
- Measurements
- Network operations

important

- Economics
- Regulation
- Privacy
- Policy making

- Video streaming
- Web caching
- CDNs
- P2P
- Online social networks
- Bulk data transfers
- Energy consumption
- Peering & interconnection
- Home networking
- Intelligent transportation
- E-commerce
- Online advertising
- Airline pricing

wider scope

tool

application

# Didn't really plan to be a researcher

- "Here read this paper and present in class"
- "Hm, why are they doing it that way? What if …" now you r researcher line
- "Hey I can do that"
- "I love algorithm design. I am going to be really great at it and get a PhD and be the smartest kid on my street" end of romance line
- "I need to graduate"
- "I need to get a job"
- "I need to prove that I deserved this job"
- "I need to get promoted, get tenure, etc" end of anxiety line
- Enjoy a bit …

I need to find **purpose**

# Romance and adventure again


Moments in my career that make up for the all the pains

# Magic Moment 1 – MM1

$$W = \frac{\lambda \overline{X^2}}{2(1-\rho)}$$

M/M/1

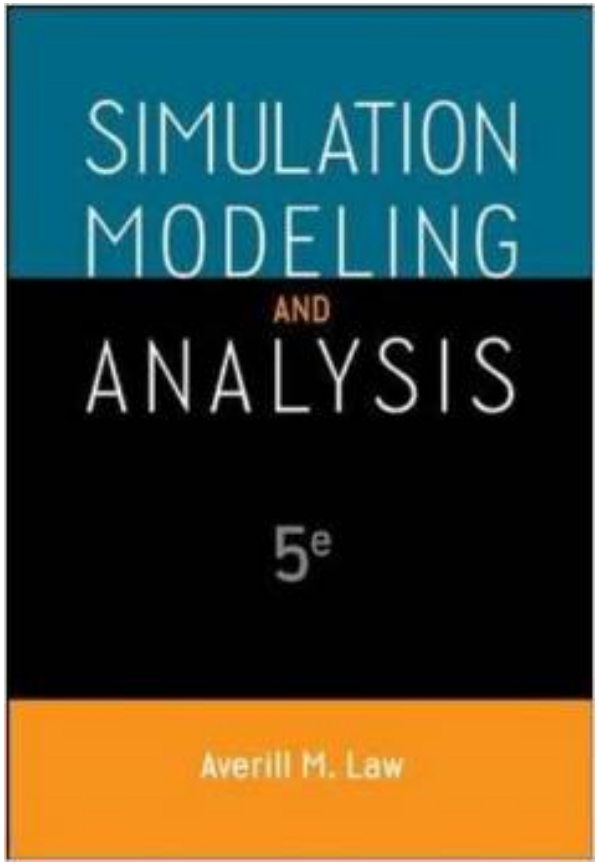
$$\overline{X^2} = 2/\mu^2$$

$$W = \frac{\rho}{\mu(1-\rho)}.$$

M/D/1

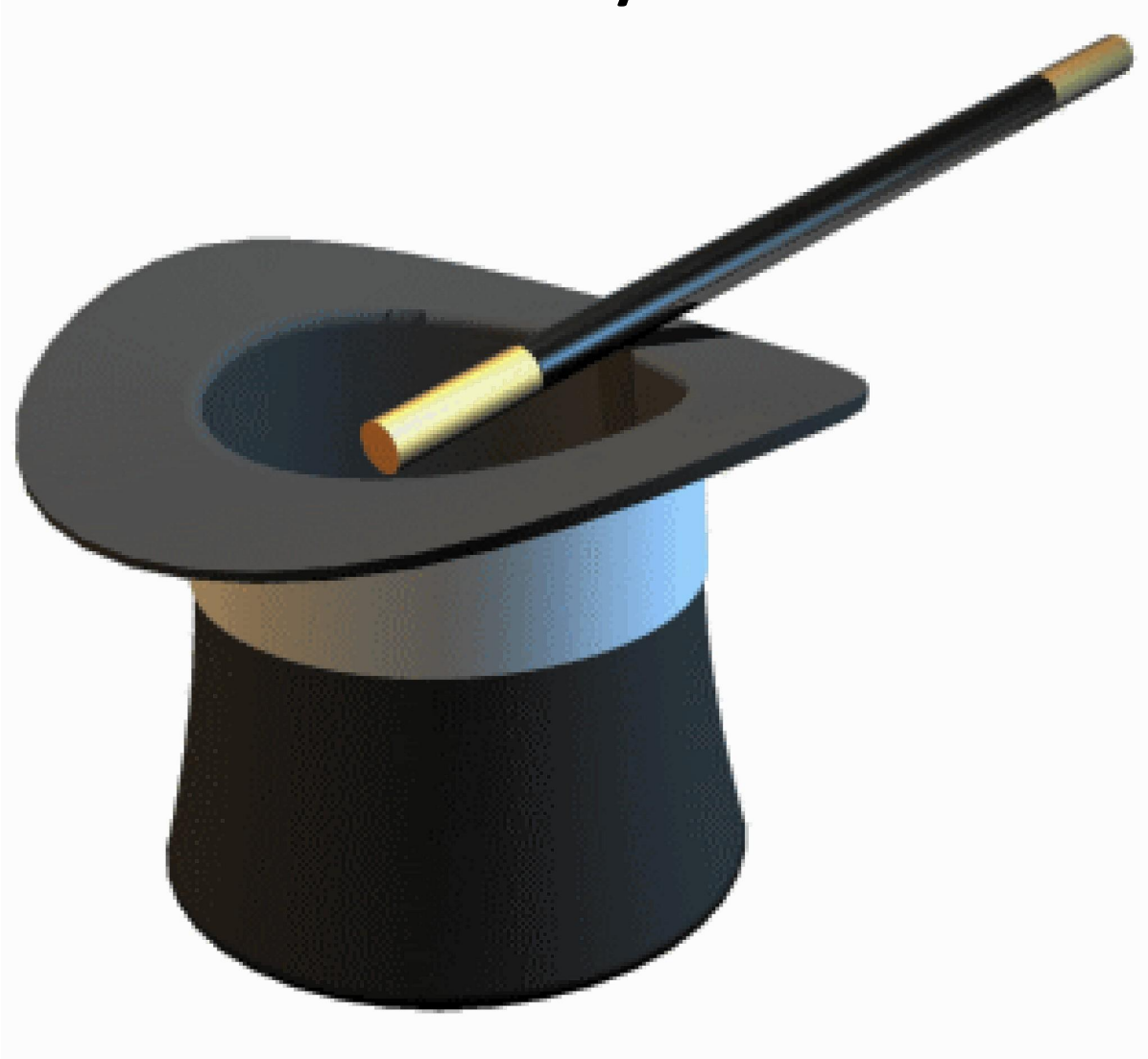
$$\overline{X^2} = \frac{1}{\mu^2}$$

$$W = \frac{\rho}{2\mu(1-\rho)}.$$

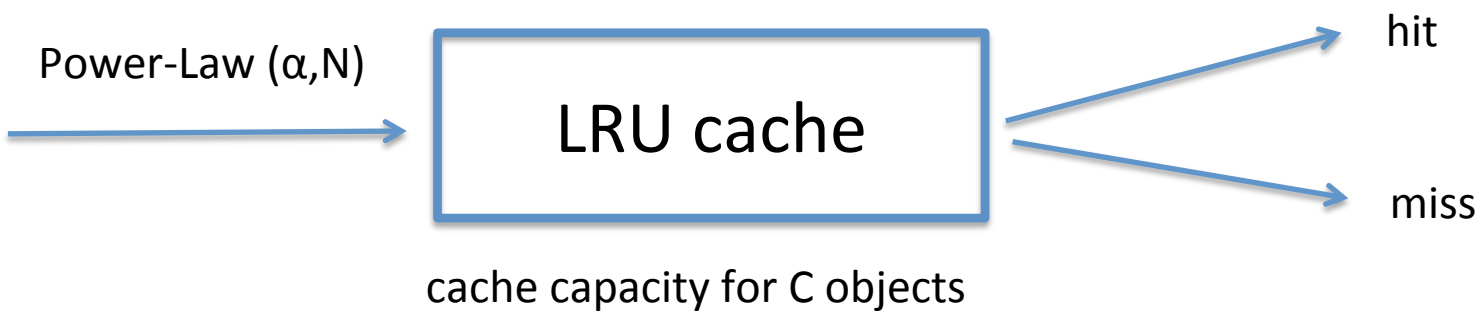



vs.

# Simulation and analysis … matched!



# Magic Moment 2



# My favorite unpublished work



## A Closed-Form Method for LRU Replacement under Generalized Power-Law Demand*

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**Abstract**

We consider the well known *Least Recently Used* (LRU) replacement algorithm and analyze it under the independent reference model and generalized power-law demand. For this extensive family of demand distributions we derive a closed-form expression for the per object steady-state hit ratio. To the best of our knowledge, this is the first analytic derivation of the per object hit ratio of LRU that can be obtained in constant time without requiring laborious numeric computations or simulation. Since most applications of replacement algorithms include (at least) some scenarios under i.i.d. requests, our method has substantial practical value, especially when having to analyze multiple caches, where existing numeric methods and simulation become too time consuming.

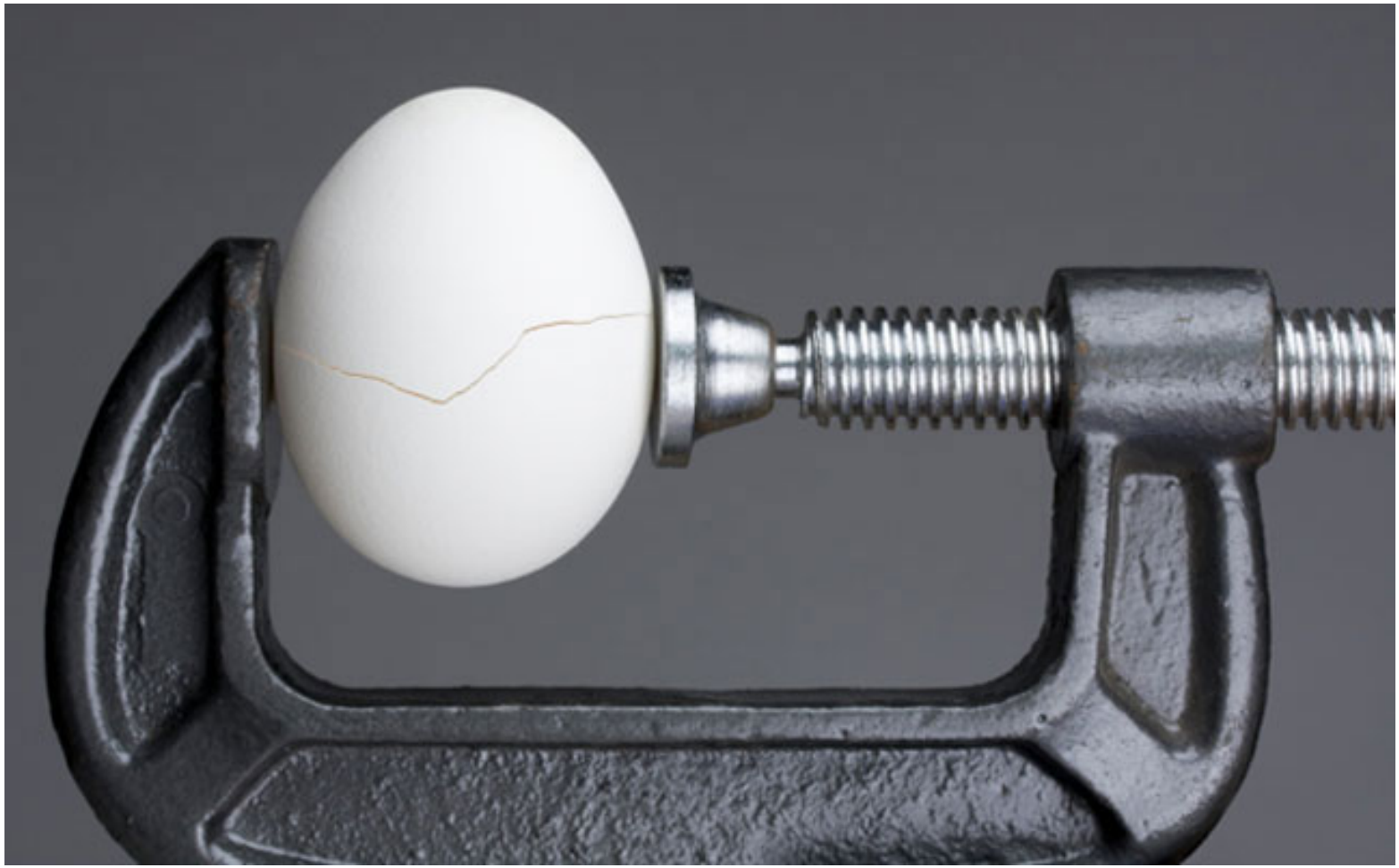
### 1 Introduction

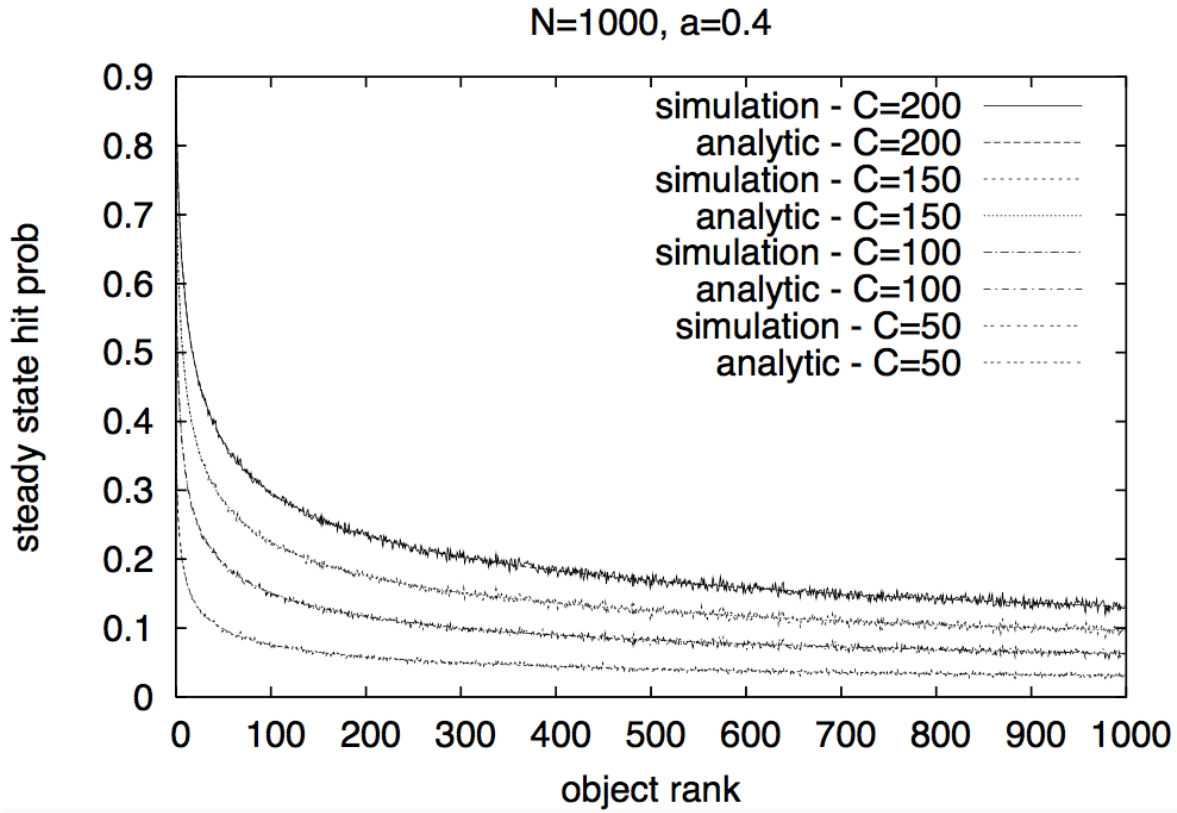
Although very simple in both conception and implementation, the LRU replacement algorithm is notoriously hard in terms of analysis. Attempts to obtain the per object steady-state hit ratio in an LRU operated cache under the independent reference model (IRM) [1] date back to the early 70's and have continued appearing in the literature until very recently [2, 3, 4]. As elaborated

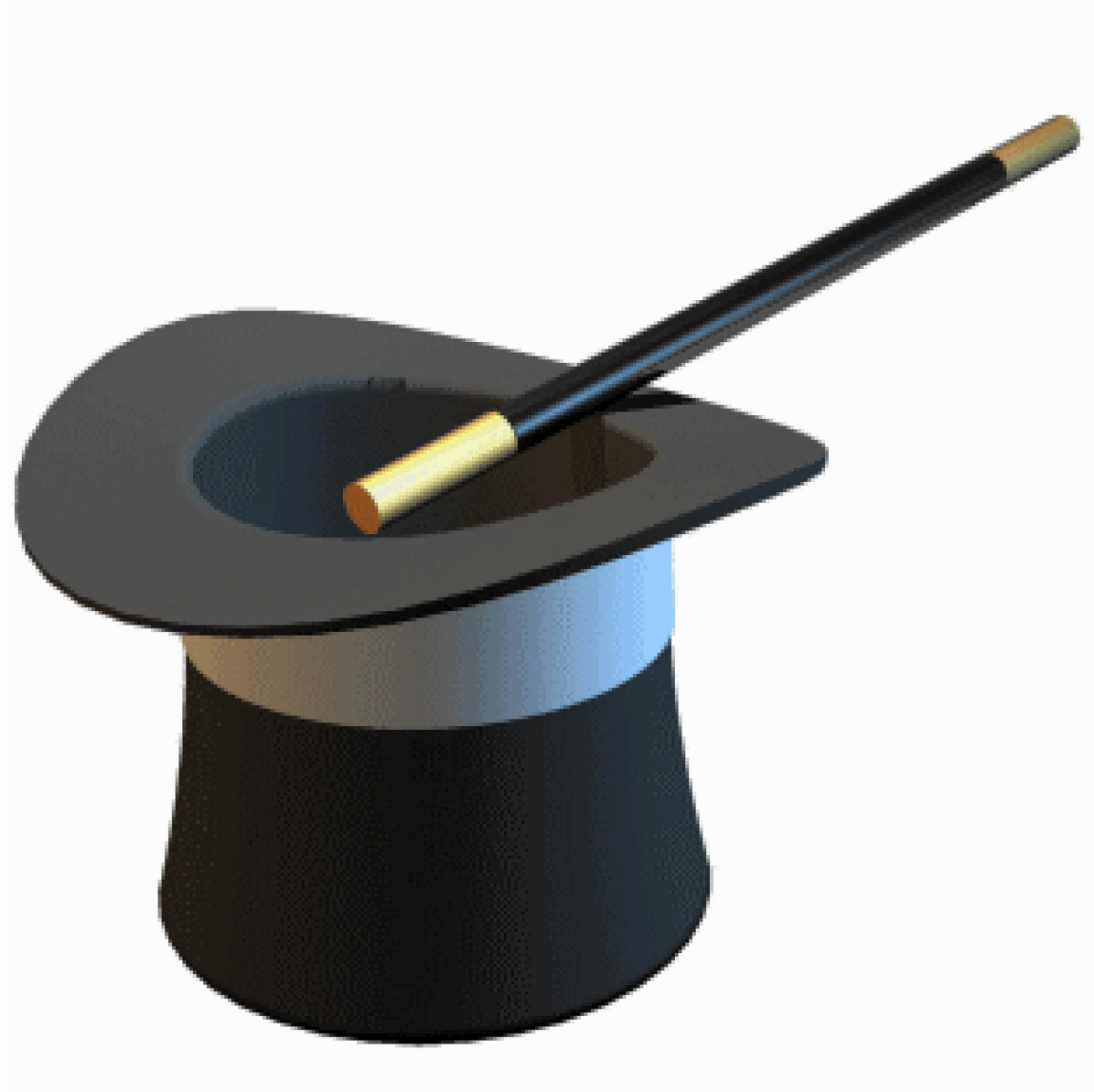
$$\alpha_3 r^3 + \alpha_2 r^2 + \alpha_1 r + \alpha_0 = 0$$

$$
\begin{aligned}
\alpha_3 &= -\frac{\Lambda^3}{6} H_N^{(3a)} + \frac{\Lambda^4 C}{6} H_N^{(4a)} - \frac{\Lambda^5 C^2}{12} H_N^{(5a)} + \frac{\Lambda^6 C^3}{36} H_N^{(6a)} \\
\alpha_2 &= \frac{\Lambda^2}{2} H_N^{(2a)} - \frac{\Lambda^4 C^2}{4} H_N^{(4a)} + \frac{\Lambda^5 C^3}{6} H_N^{(5a)} - \frac{\Lambda^6 C^4}{12} H_N^{(6a)} \\
\alpha_1 &= -\Lambda H_N^{(a)} + \frac{\Lambda^4 C^3}{6} H_N^{(4a)} - \frac{\Lambda^5 C^4}{12} H_N^{(5a)} + \frac{\Lambda^6 C^5}{12} H_N^{(6a)} \\
\alpha_0 &= C - \frac{\Lambda^4 C^4}{12} H_N^{(4a)} - \frac{\Lambda^6 C^6}{36} H_N^{(6a)}
\end{aligned}
\tag{11}
$$

# True story – stress testing CDNs




N=1000, a=0.4
simulation - C=200
analytic - C=200
simulation - C=150
analytic - C=150
simulation - C=100
analytic - C=100
simulation - C=50
analytic - C=50
steady state hit prob
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
100
200
300
400
500
600
700
800
900
1000
object rank



Lets get practical

# ON WITH THE ADVICE

# Don’t fall in love with the tools

(do … but get over it sometime)

- Toolsmiths excluded

# Better to solve a problem

- Preferably real
- Preferably somebody else's problem

# Don’t fall in love with the data

- Serious empiricists excluded

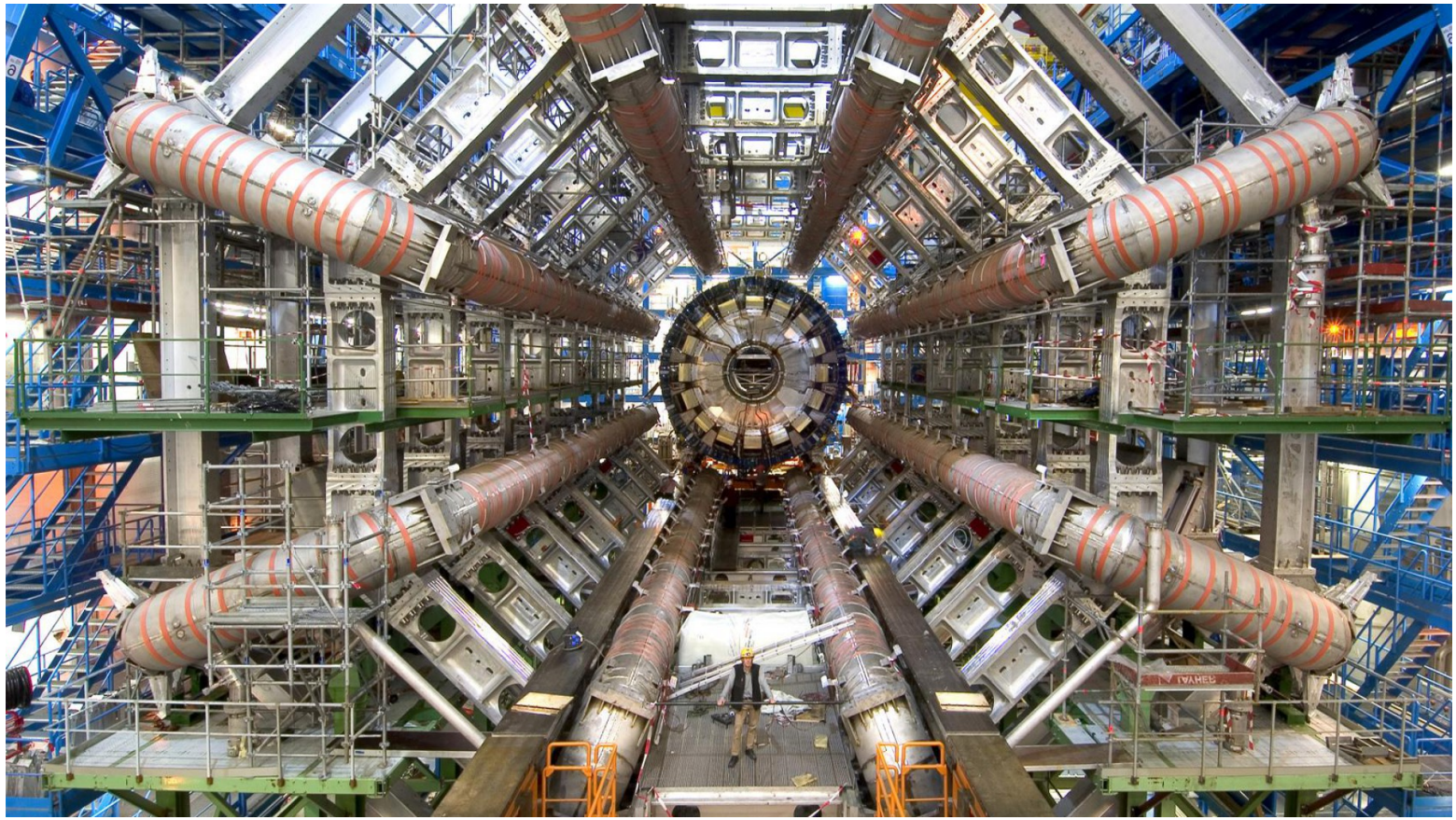
Answer a question, don’t write about the data!

# Don’t fall in love with the application

- People trying to solve serious technical challenges excluded

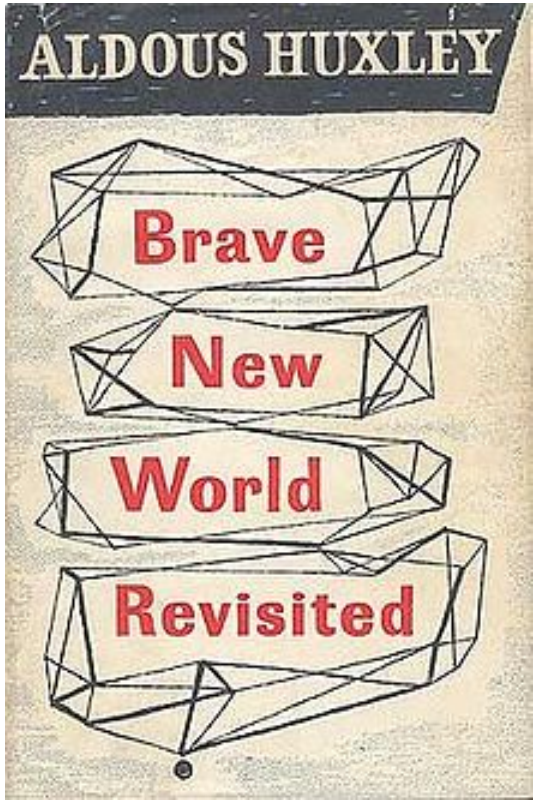
Anyway, like I was sayin', shrimp is the fruit of the sea. You can barbecue it, boil it, broil it, bake it, saute it. Dey's uh, shrimp-kabobs, shrimp creole ...

# Don’t shoot a fly with a canon



# Respect complexity

- Reality cannot be squeezed into a queue, graph, dataset, or script




1958

## Foreword

The soul of wit may become the very body of untruth. However elegant and memorable, brevity can never do justice to all the facts of a complex situation. On such a theme one can be brief only by omission and simplification. Omission and simplification help us to understand -- but help us, in many cases, to understand the wrong thing; for our comprehension may be only of the abbreviator's neatly formulated notions, not of the vast, ramifying reality from which these notions have been so arbitrarily abstracted.

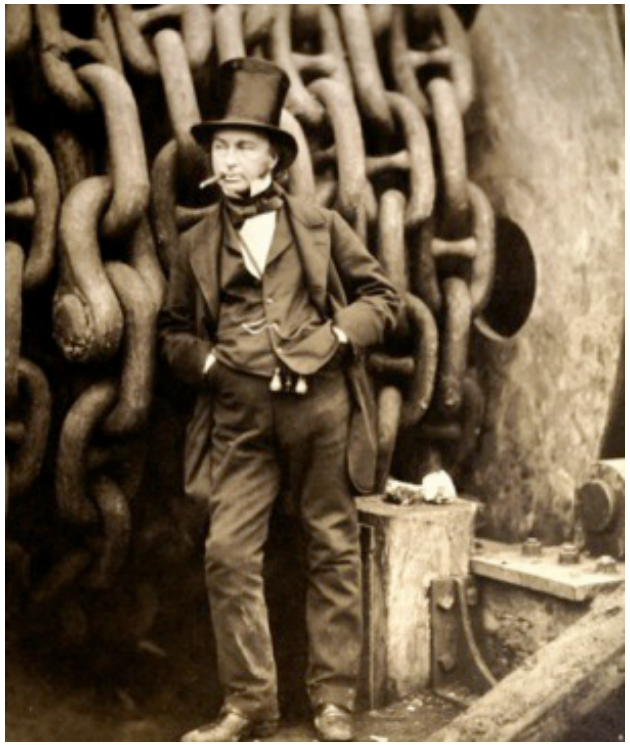
But life is short and information endless: nobody has time for everything. In practice we are generally forced to choose between an unduly brief exposition and no exposition at all. Abbreviation is a necessary evil and the abbreviator's business is to make the best of a job which, though intrinsically bad, is still better than nothing. He must learn to simplify, but not to the point of falsification. He must learn to concentrate upon the essentials of a situation, but without ignoring too many of reality's qualifying side issues. In this way he may be able to tell, not indeed the whole truth (for the whole truth about almost any important subject is incompatible with brevity), but considerably more than the dangerous quarter-truths and half-truths which have always been the current coin of thought.

# Common sense goes a long way

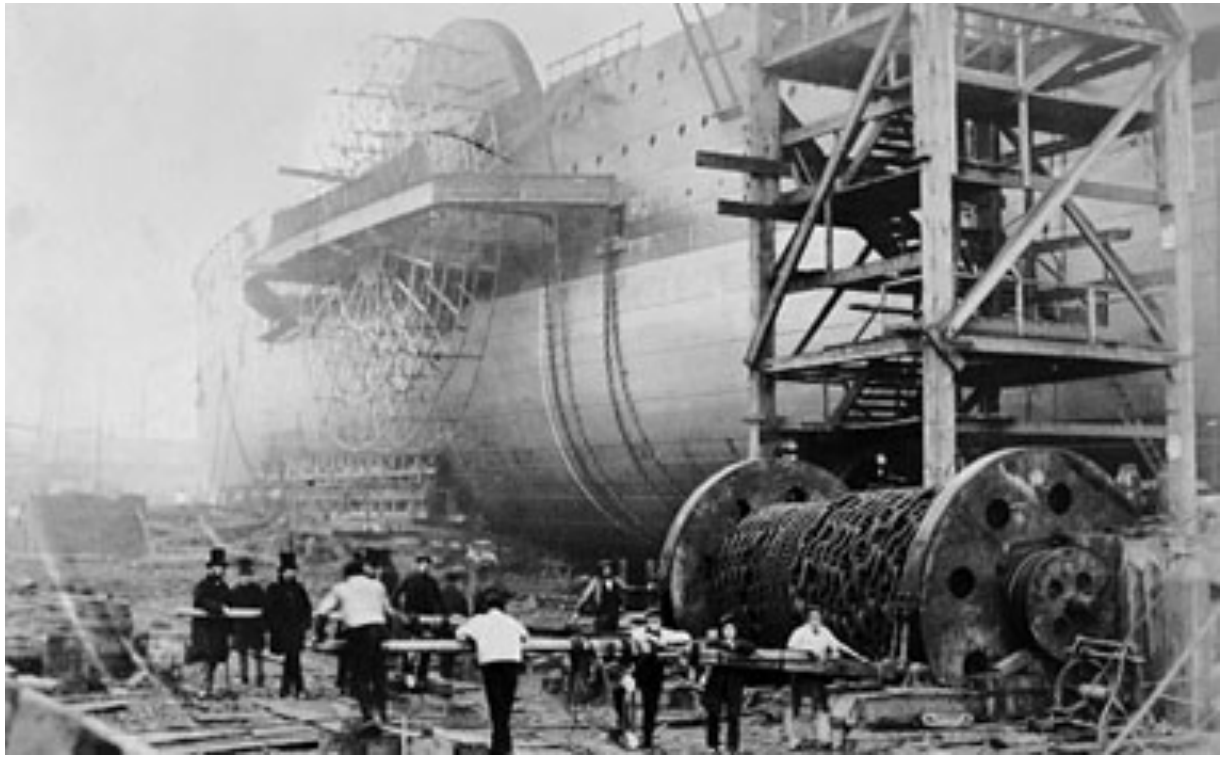
Enough with the philosophy

# SOME PRACTICAL STUFF NOW

# Get over the ownership ego



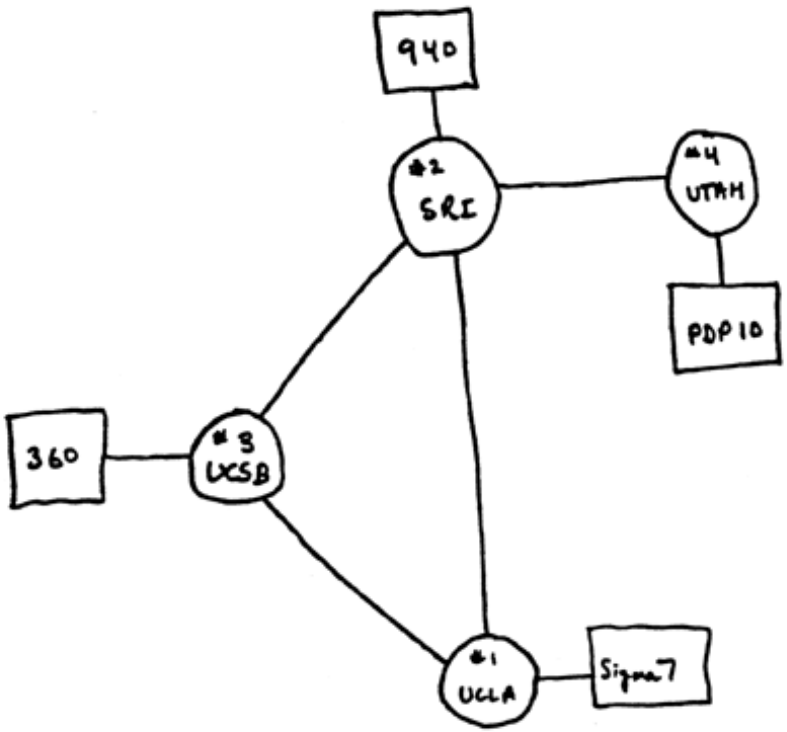
Isambard Kingdom Brunel



SS Great Eastern

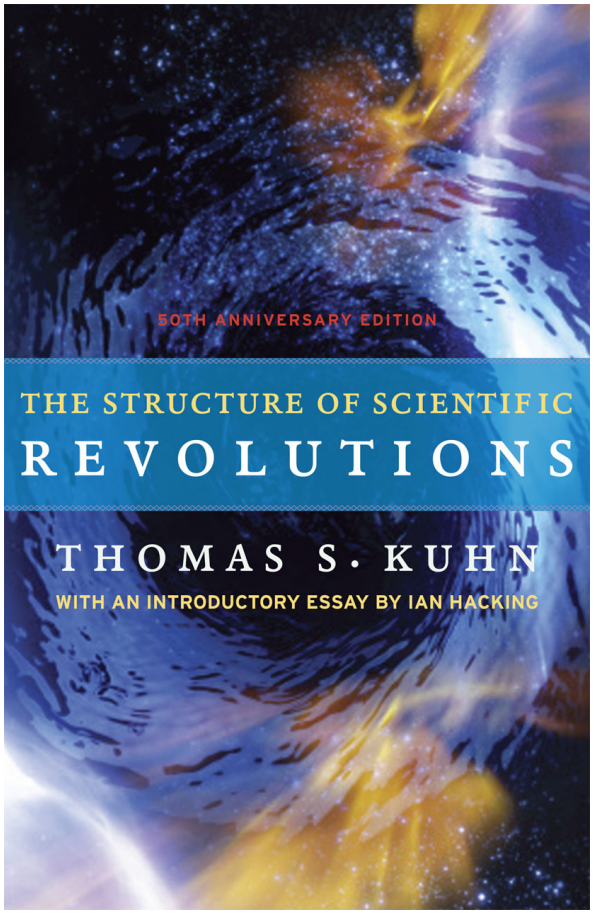
# Great discoveries

- Have gone against the status quo of their time



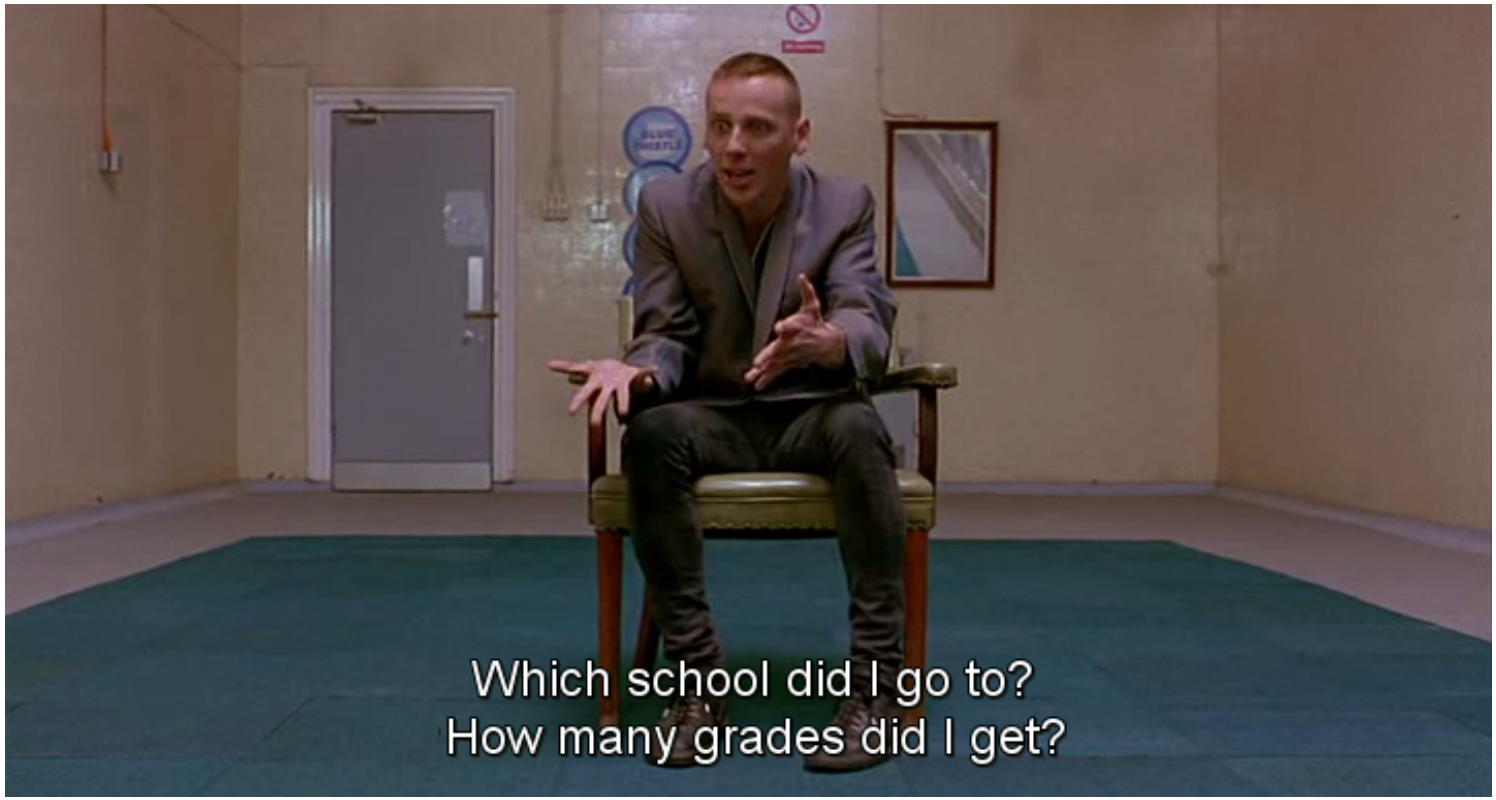

# Don’t be a parrot

- Test for yourself
- Things change …



# Interviewing for a job

- Basic rule: <u>You are not a student anymore</u>

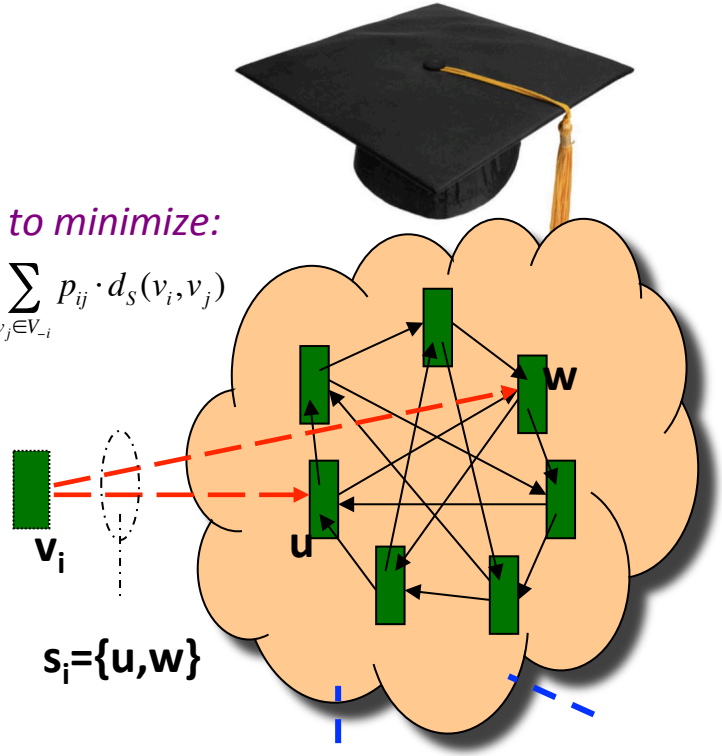


# Academia vs. Industry

# Academia & Industry

*$v_i$ wants to minimize:*

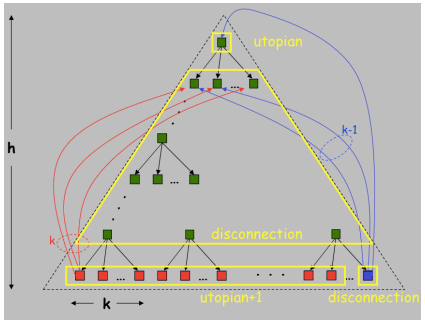
$$C_i(S) = \sum_{v_j \in V_{-i}} p_{ij} \cdot d_S(v_i, v_j)$$




$s_i$={u,w}

$G_{-i}=(V_{-i},S_{-i})$

from Network Formation Games
to CAPEX, OPEX, 95-percentiles, etc.




# There are opportunities in “bridging the gap”

Scholarly research

Real Ops

- ✓ Can handle complexity (graph theory)
- ✓ Can handle dynamicity (game theory, economics)

- ✓ Has the data
- ✓ Defines the operations

- ✗ Misses the data
- ✗ Misses the operating practices

- ✗ But can it connect the dots?

# Don’t do any of the following

- Cheat
- Out- or over-sell (ok you can oversell but just a bit)
- Be a CV builder (it will eventually catch-up with you)
- Become mean
- Do research just because you have to
- Think that just being researcher makes you smart(er)

To be a good researcher you have to:

# LEARN A LOT OF STUFF AND THEN … UNLEARN THEM

# Now that you've heard me

- Go out and do great research
- Live your magic moments
- Discover your own truths
- And find your purpose

When you do … please come and tell me


Thank you !