



**Convergence, complexity and
exponentiality**

Irresistible forces, irreconcilable antagonists

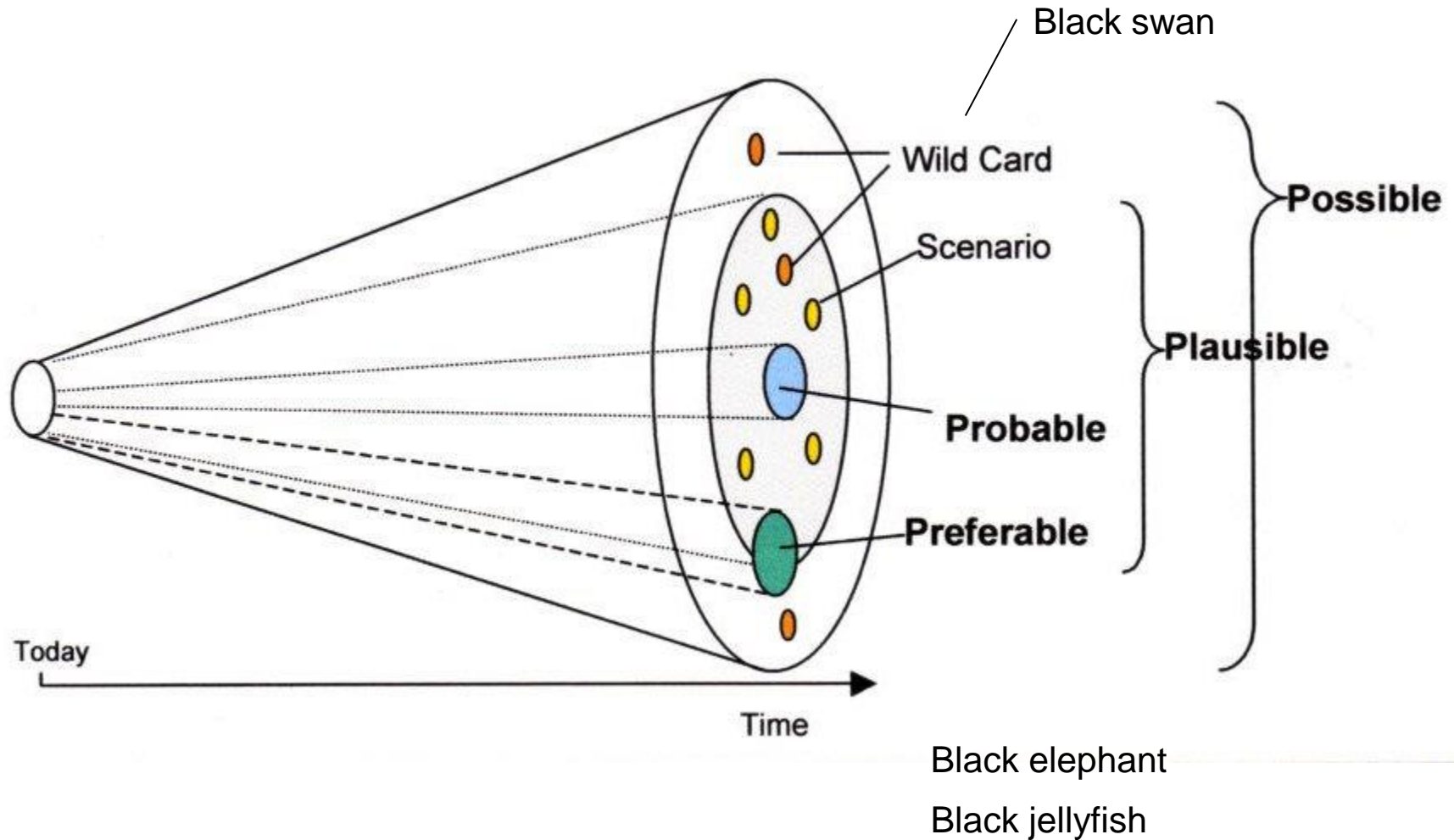
Gabriele Rizzo

Anticipation, Agency, Complexity Workshop – Trento, Italy

6-8 April 2017

Looking into the future

Horizons: 2035 – 2050



NATO Approach

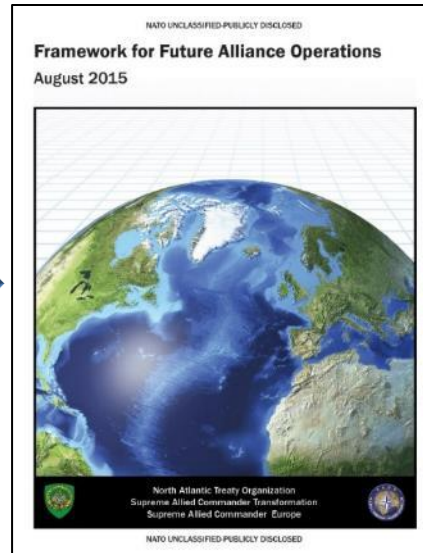
Long Term Military Transformation

What could the the future be like?



INFORMS

What could the long-term impact to the Alliance be?



INFORMS

Long-Term input to:



SACT Six Focus Areas



NDPP

- 5 Themes
- 15 Long-Range Trends
- 8 Emergent Trends
- 34 Defence & Security Implications

- 10 Instability Situations
- 5 Strategic Military Perspectives
- 460+ Military Implications

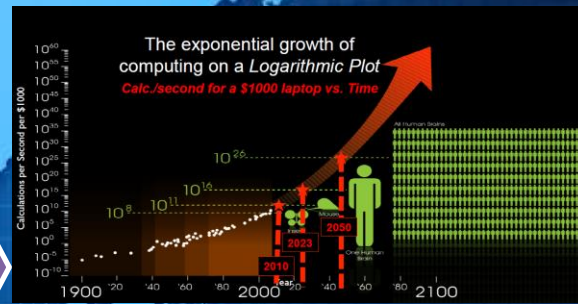
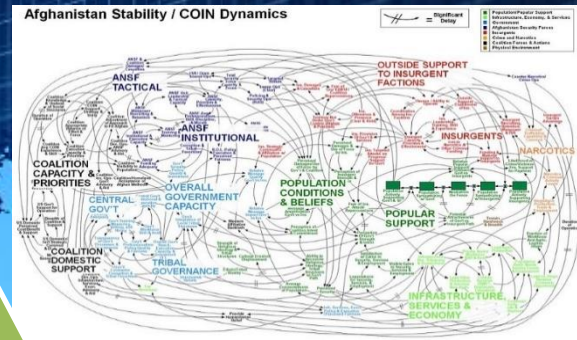
Characteristics of the future

LINEAR → **EXPONENTIAL**



1996	2012	April 2012
MarketCap: \$28B	Bankrupt	MarketCap: \$1B
Employees: 140,000	Employees: 17,000	Employees: 13

"The New Kodak Moment"

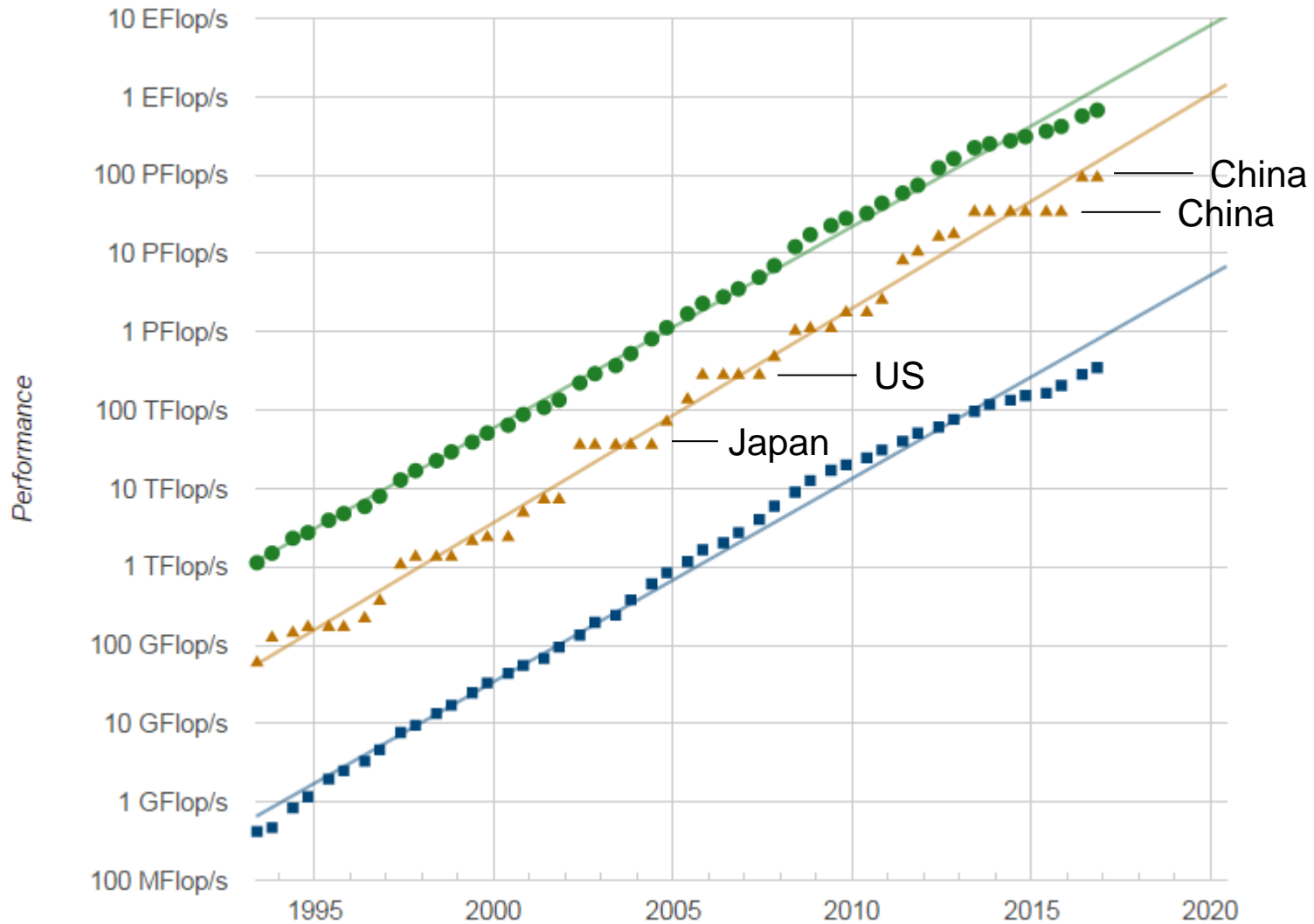




Telling exponentials apart

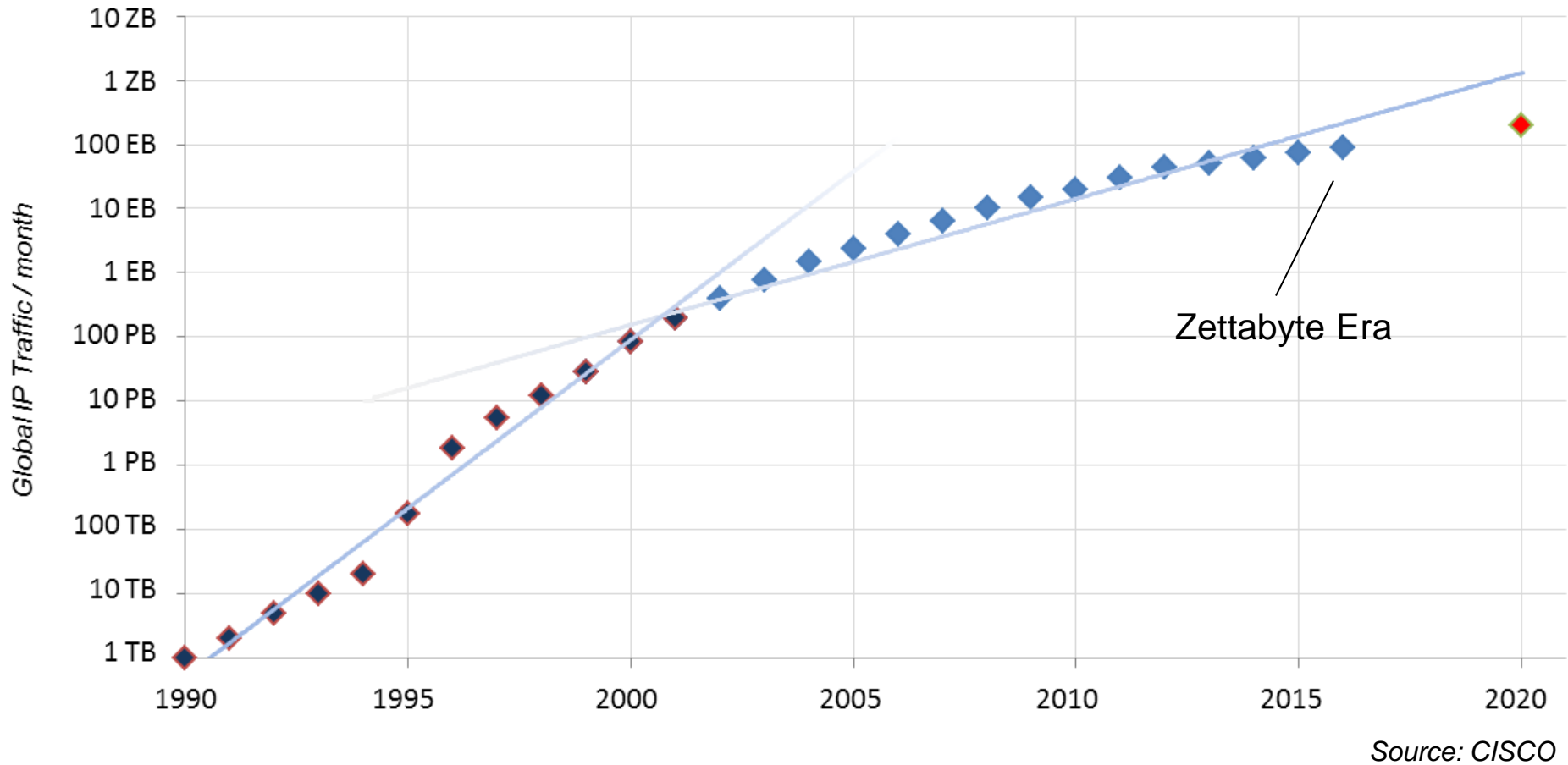
A quantitative deep dive on complexity

Exponentiality: computing



Source: Top500

Exponentiality: connectivity

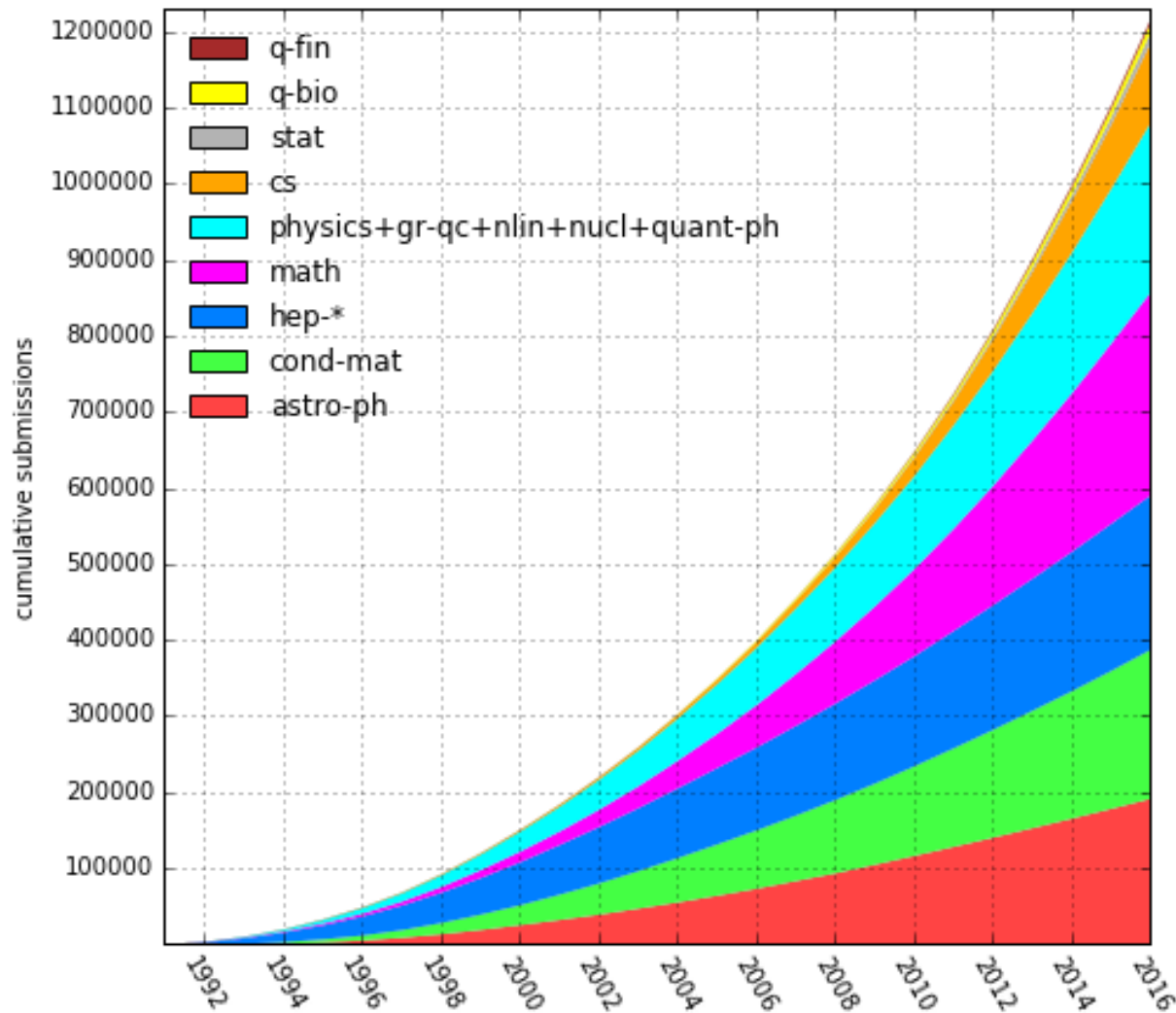


Sub-exponentiality: knowledge

arXiv

- Highly-automated electronic archive and distribution server for research articles
- Open access to e-prints in Physics, Mathematics, Computer Science, Quantitative Biology, Quantitative Finance and Statistics
- 1.2M+ papers in 127 thematic areas
- 162M downloads in 2016

Cumulative submissions

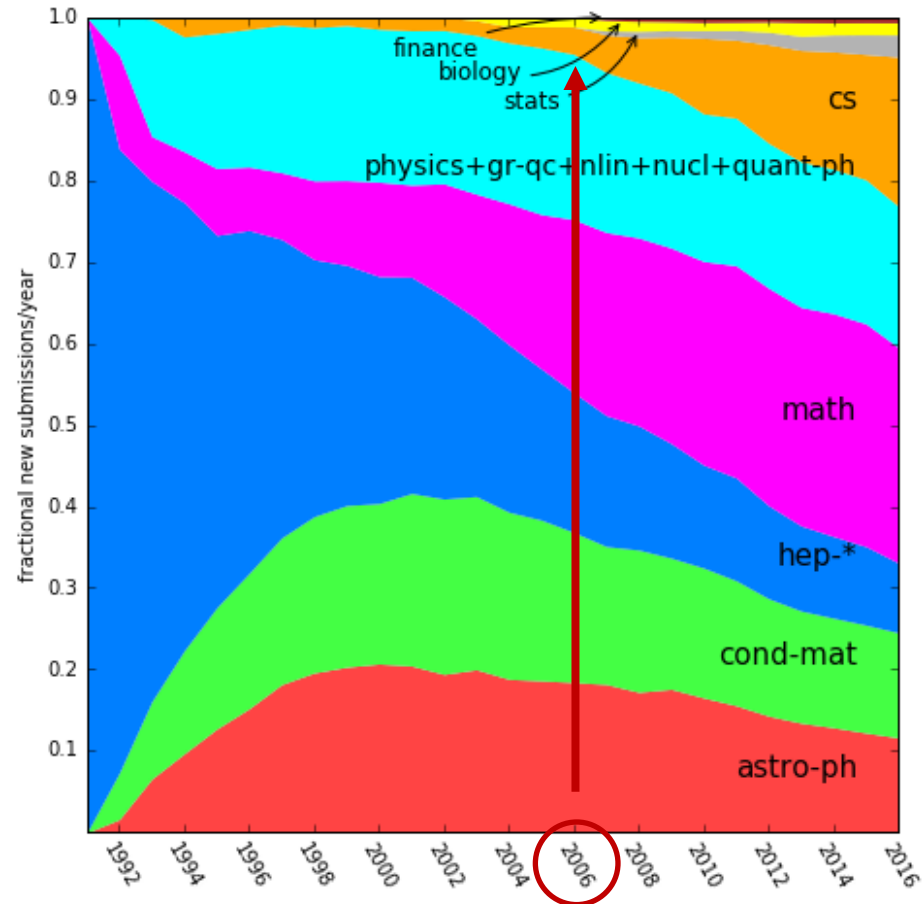
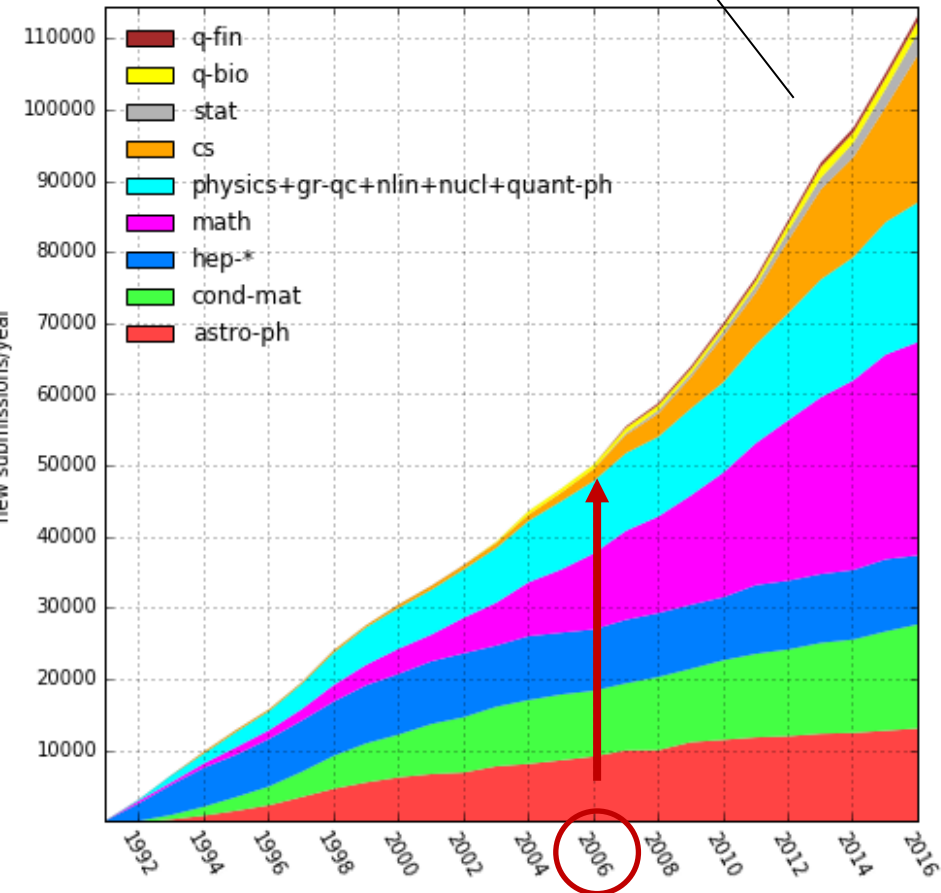


Quadratic scaling

Source: arXiv

New submissions

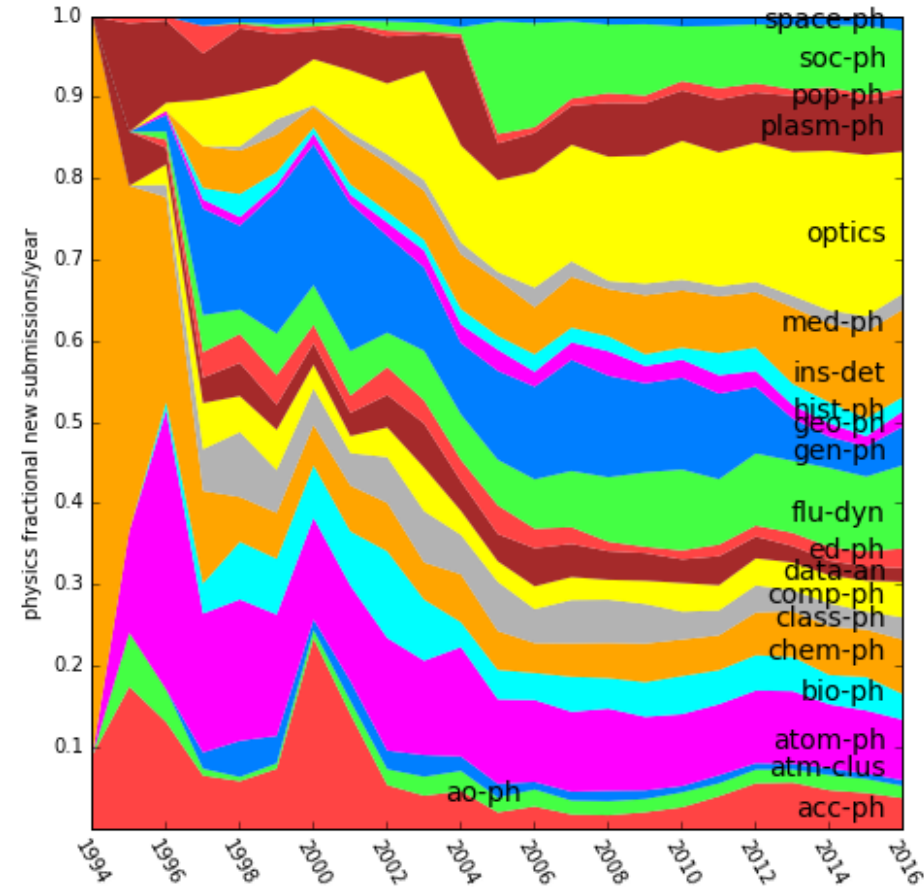
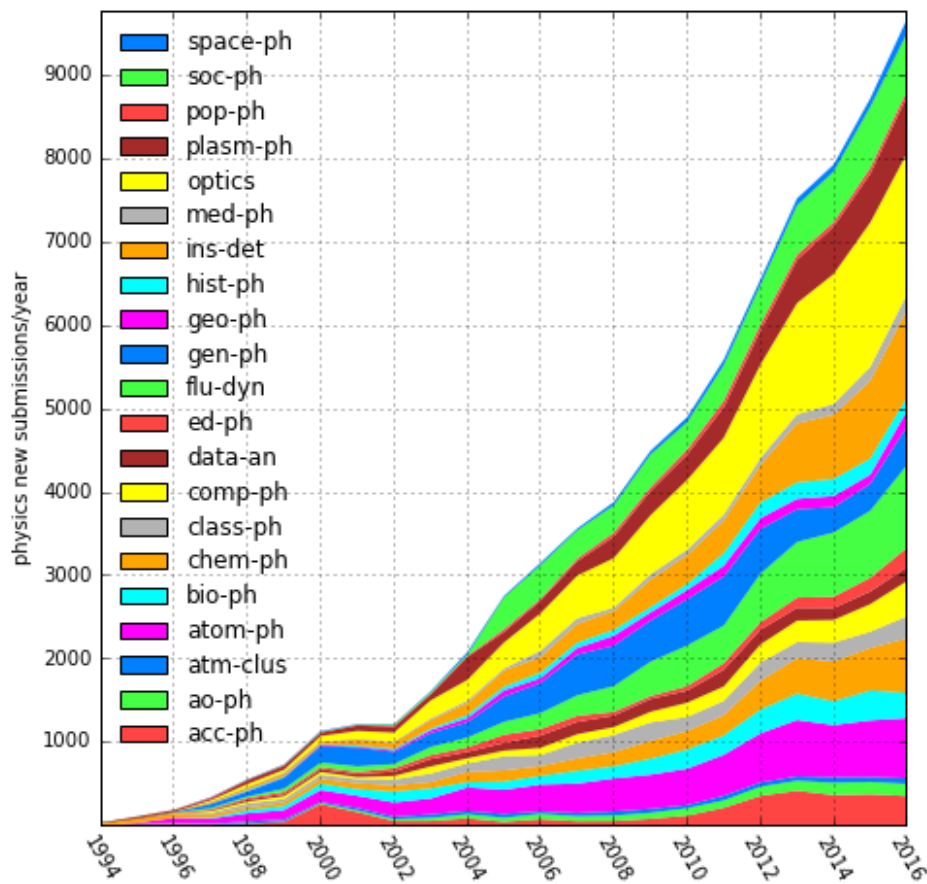
Linear scaling



Source: arXiv

Complexity: growing nr of fields

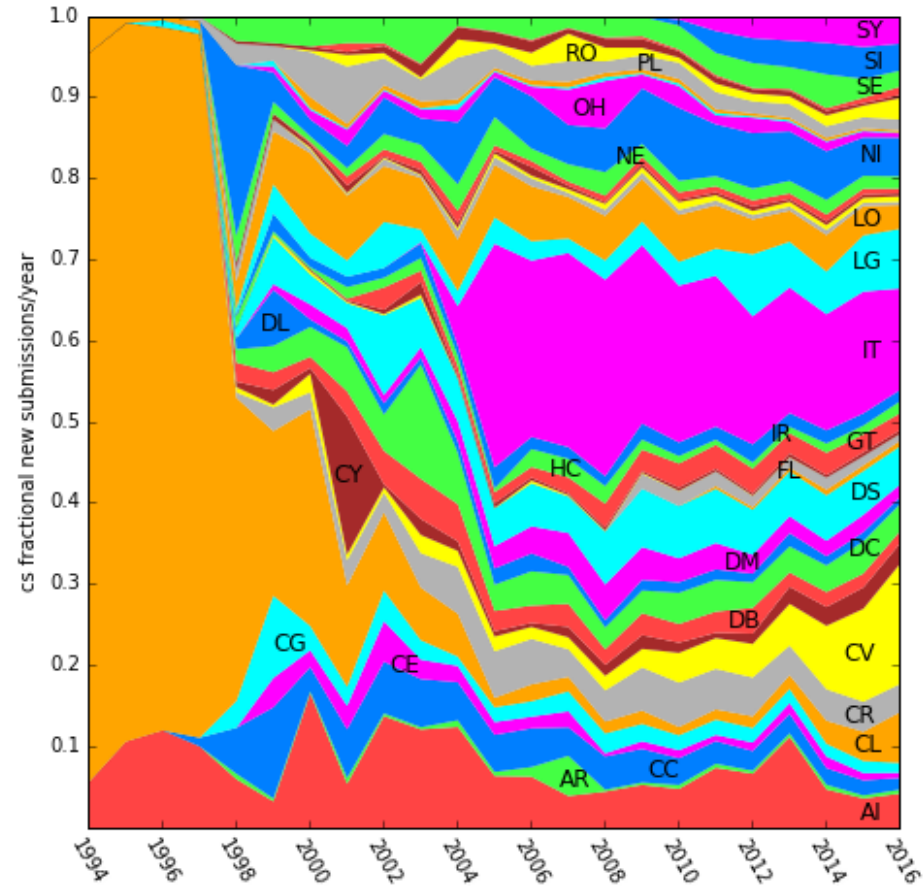
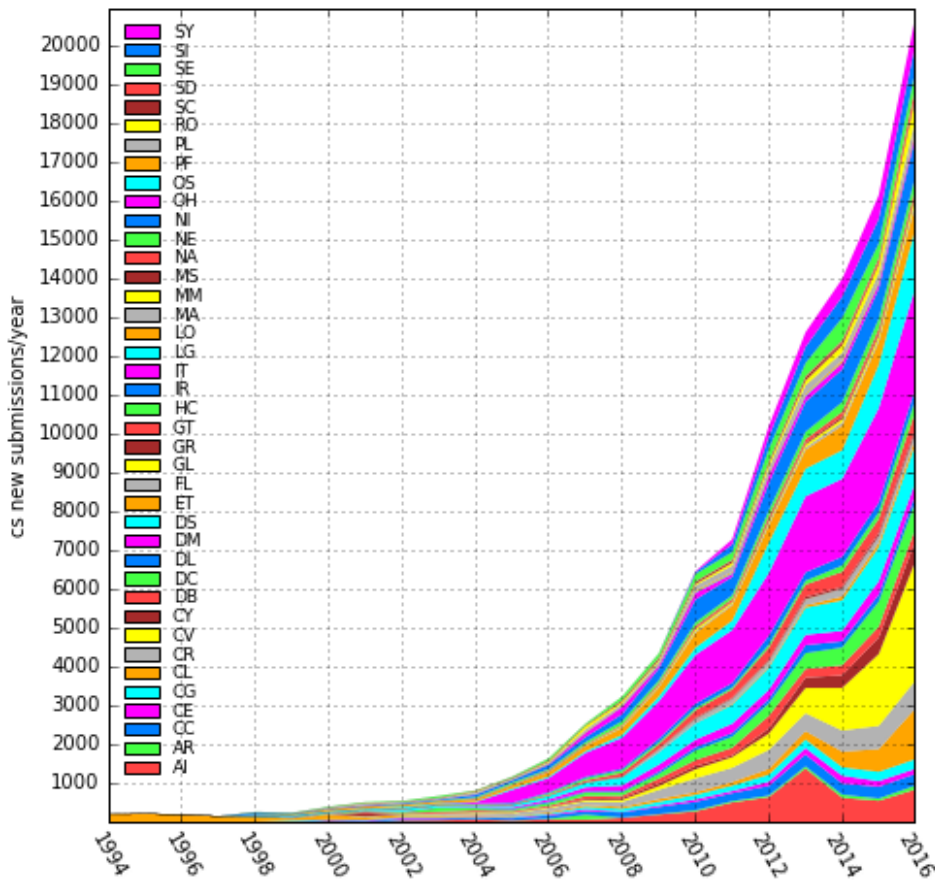
Physics



Source: arXiv

Complexity: growing nr of fields

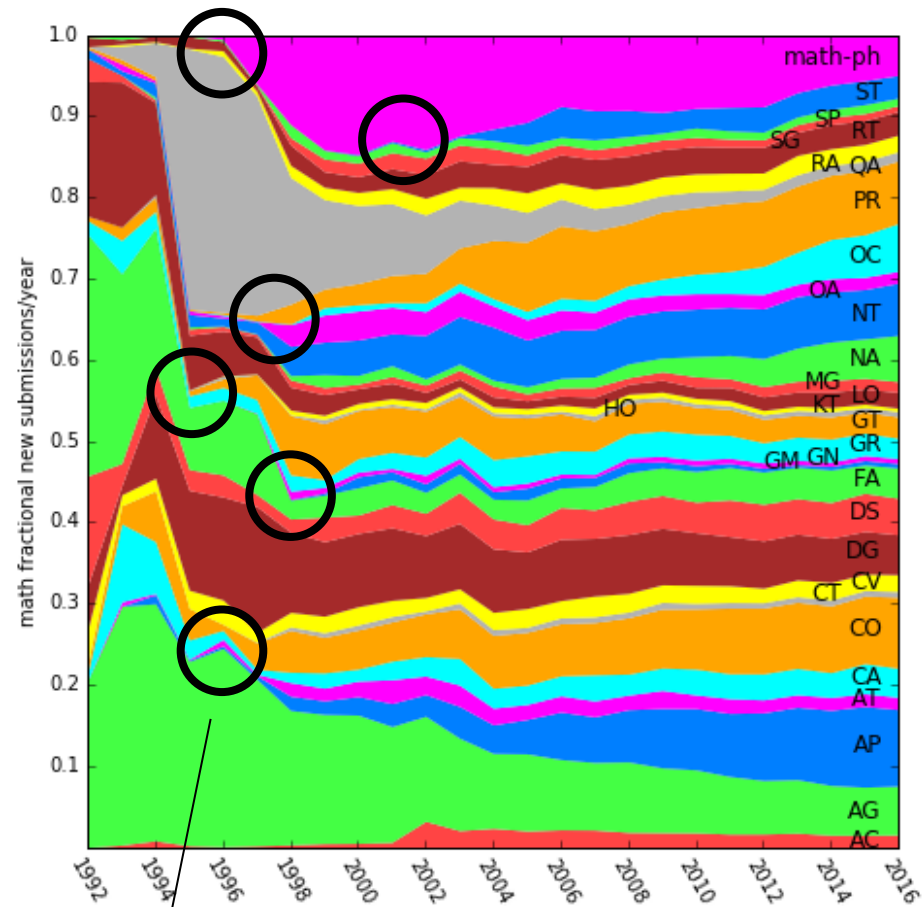
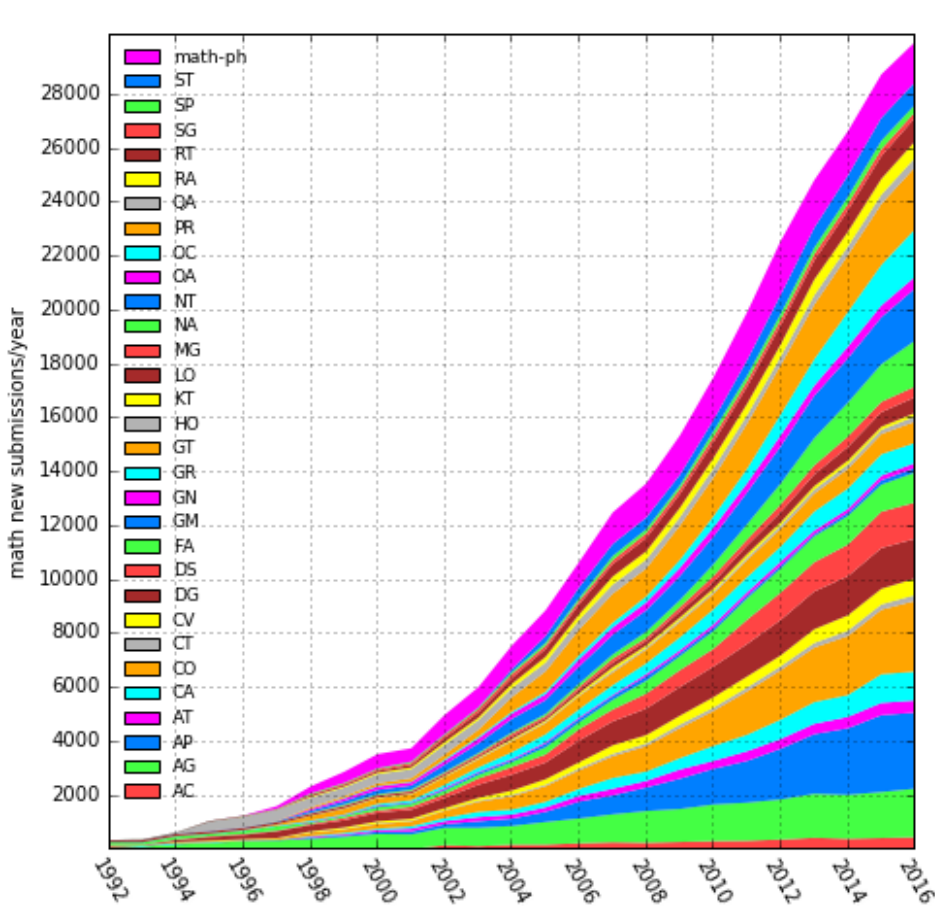
Computer Science



Source: arXiv

Complexity: growing nr of fields

Mathematics

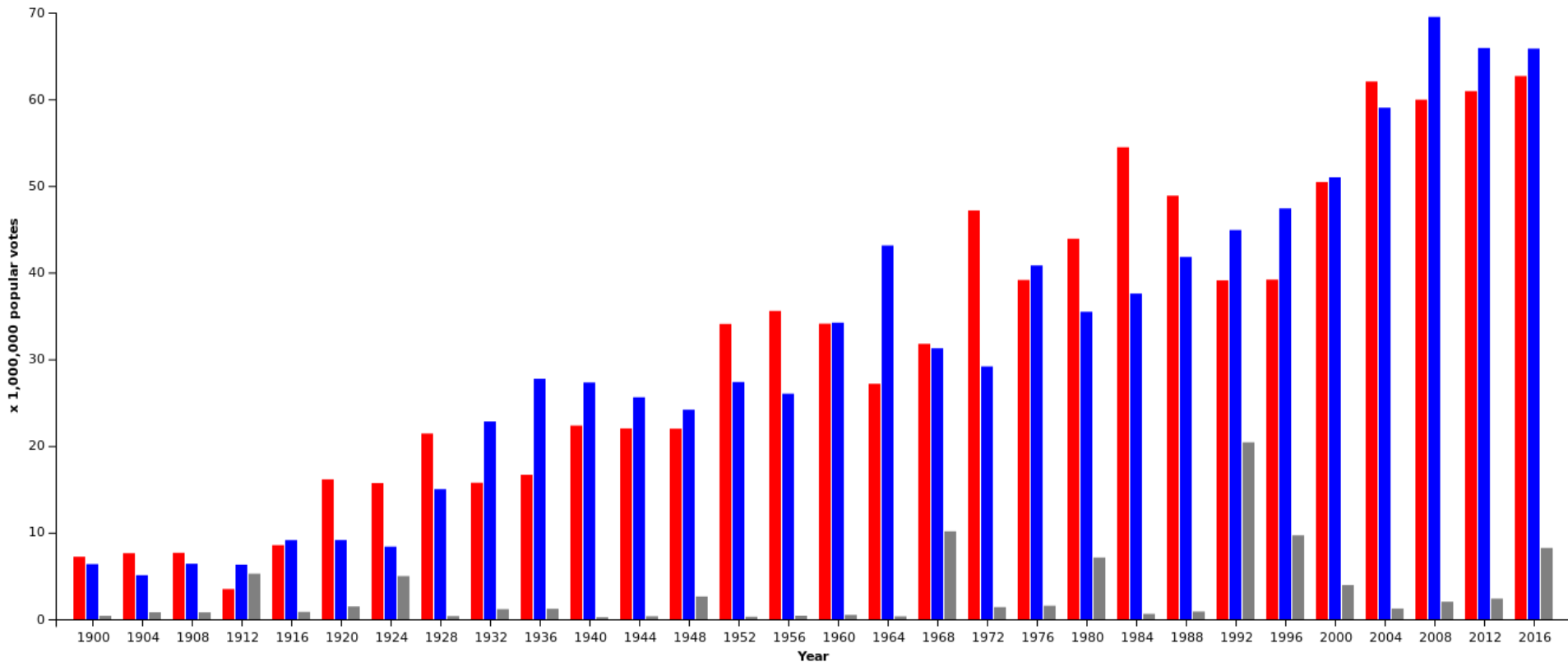


Splitting points

Source: arXiv

Non-exponentiality: democracy

US Presidentials popular vote



Source: US Election Atlas

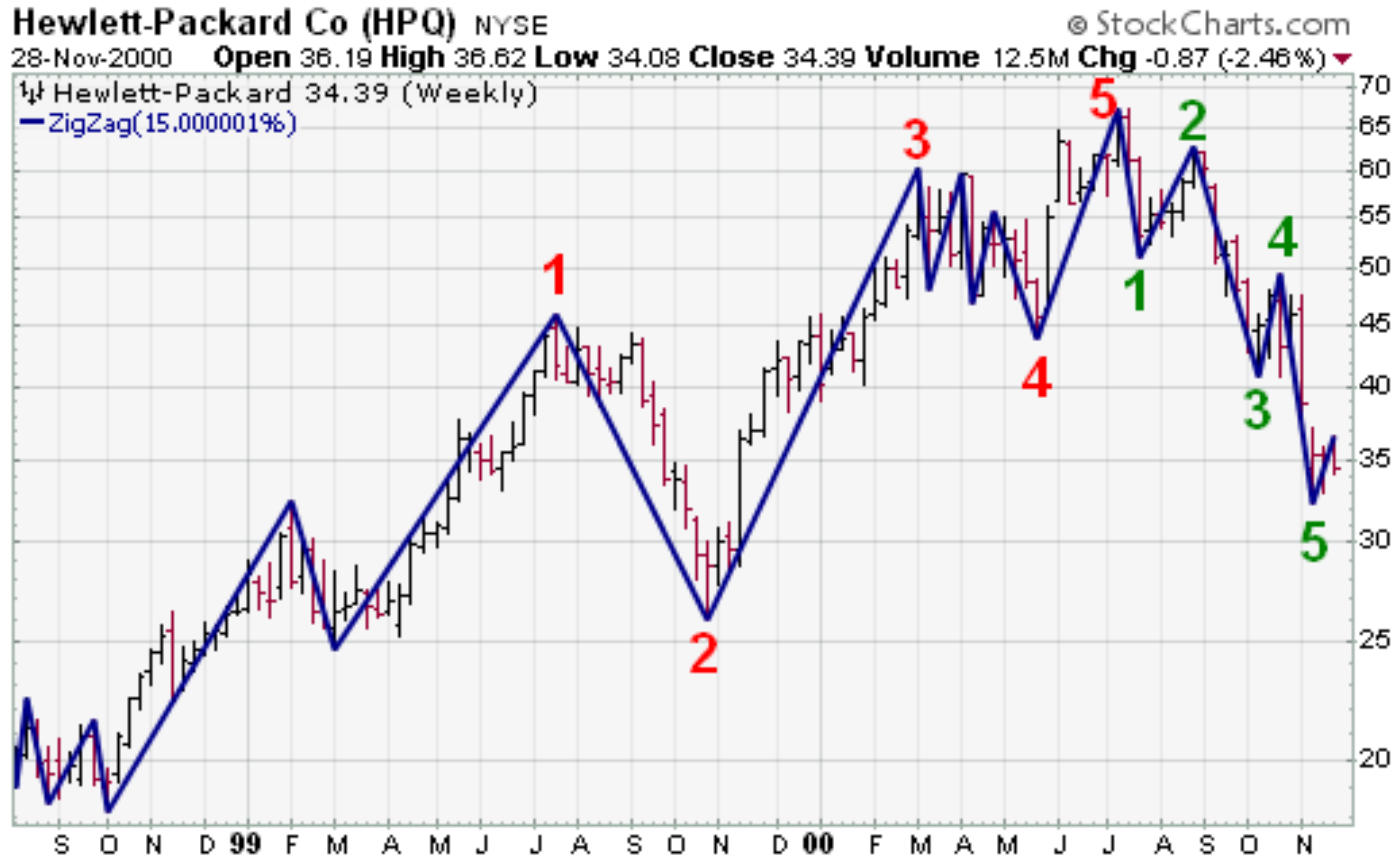
Non-exponentiality: stock exch

Elliott waves



Non-exponentiality: stock exch

Elliott waves



Non-exponentiality: stock exch

Fractal Elliott waves

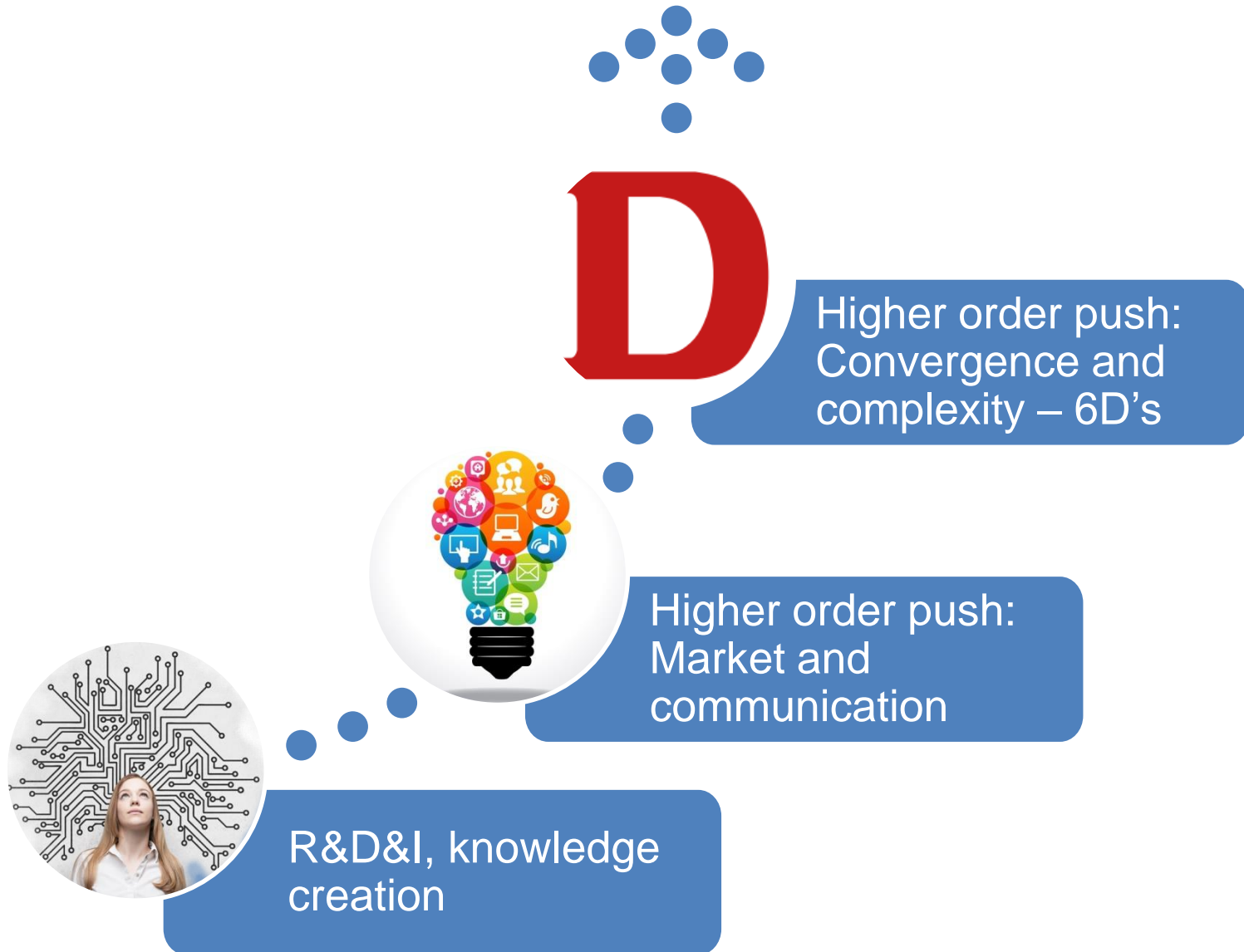


Non-exponentiality: stock exch

Fractal Elliott waves



Drivers towards exponentiality



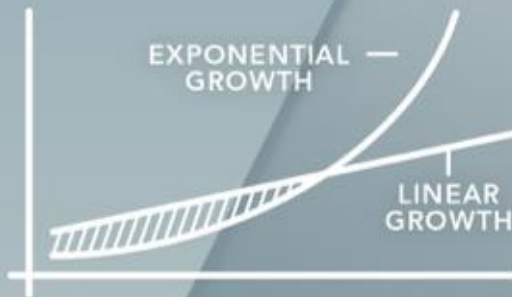
Diamandis' 6Ds – SU

DIGITIZED

Anything that becomes digitized enters the same exponential growth we see in computing. Digital information is easy to access, share, and distribute. It can spread at the speed of the internet. Once something can be represented in ones and zeros—from music to biotechnology—it becomes an information-based technology and enters exponential growth.



DECEPTIVE

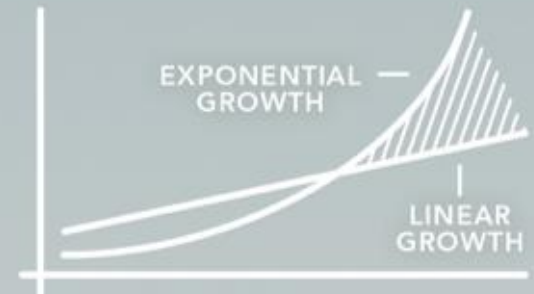


When something starts being digitized, its initial period of growth is deceptive because exponential trends don't seem to grow very fast at first. Doubling .01 only gets you .02, then .04, and so on. Exponential growth really takes off after it breaks the whole-number barrier. 2 quickly becomes 32, which becomes 32,000 before you know it.

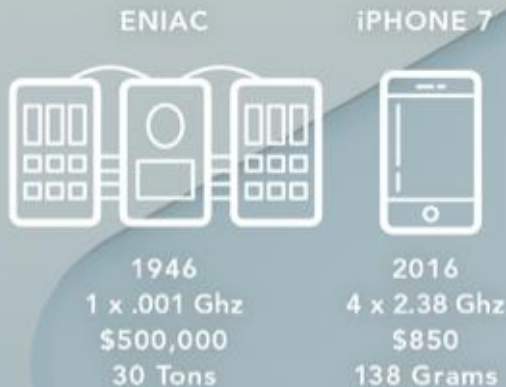
Diamandis' 6Ds – SU

DISRUPTIVE

The existing market for a product or service is disrupted by the new market the exponential technology creates because digital technologies outperform in effectiveness and cost. Once you can stream music on your phone, why buy CDs? If you can also snap, store, and share photographs, why buy a camera and film?



DEMONETIZED



Money is increasingly removed from the equation as the technology becomes cheaper, often to the point of being free. Software is less expensive to produce than hardware and copies are virtually free. You can now download any number of apps on your phone to access terabytes of information and enjoy a multitude of services at costs approaching zero.

Diamandis' 6Ds – SU

DEMATERIALIZED

Separate physical products are removed from the equation. Technologies that were once bulky or expensive—radio, camera, GPS, video, phones, maps—are now all in a smartphone that fits in your pocket.



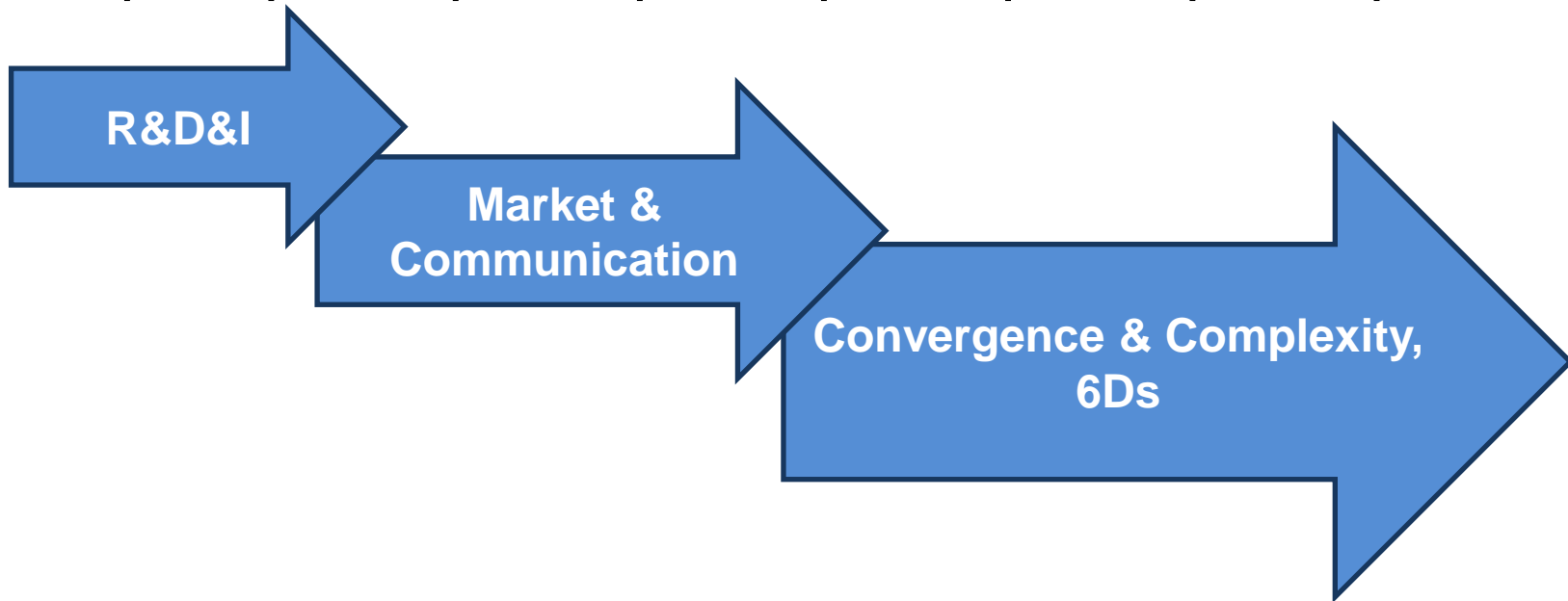
DEMOCRATIZED

Once something is digitized, more people can have access to it. Powerful technologies are no longer only for governments, large organizations, or the wealthy.



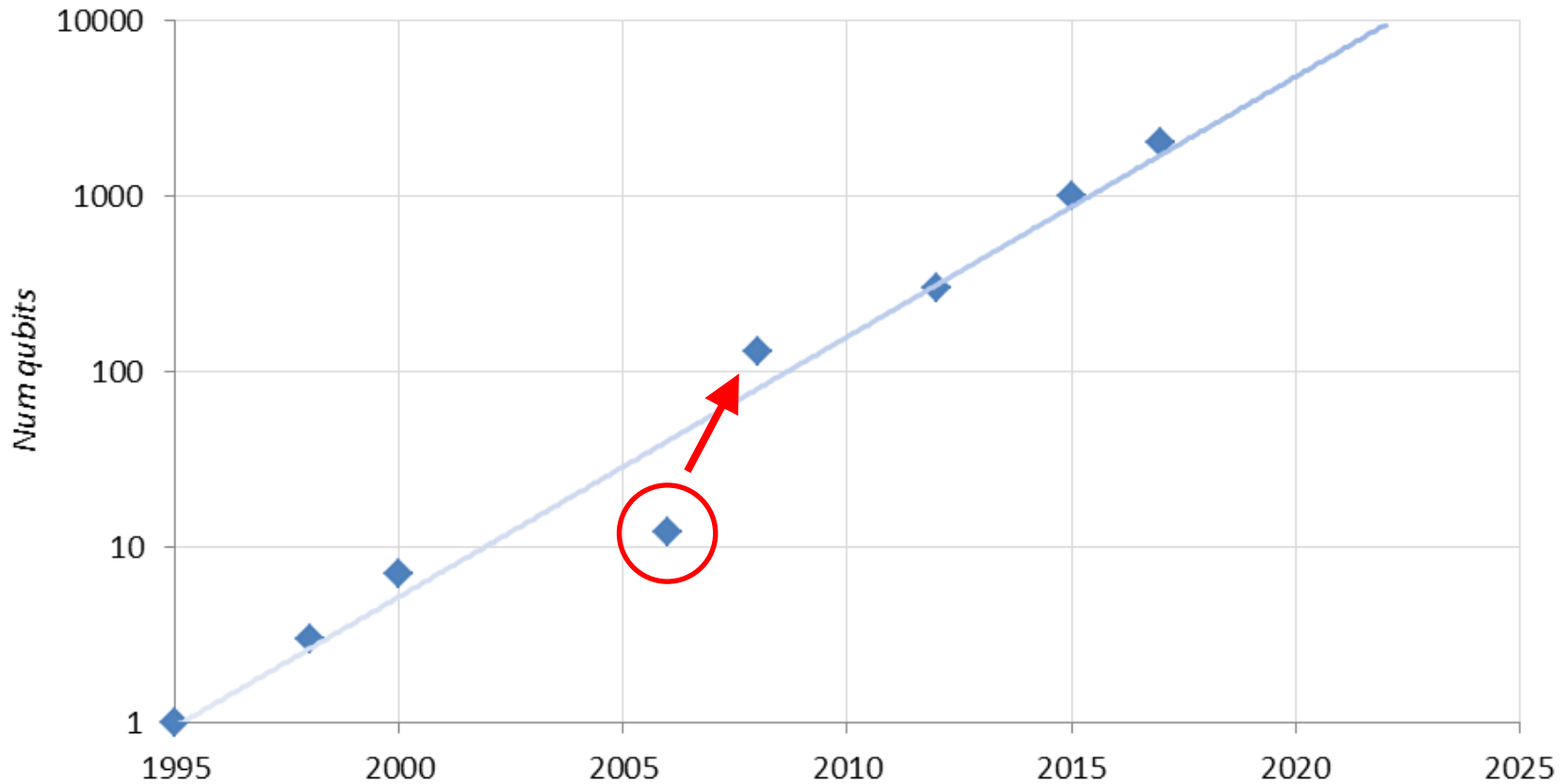
Exponential drive breakdown

$$e^x = 1 + x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7 + \dots$$



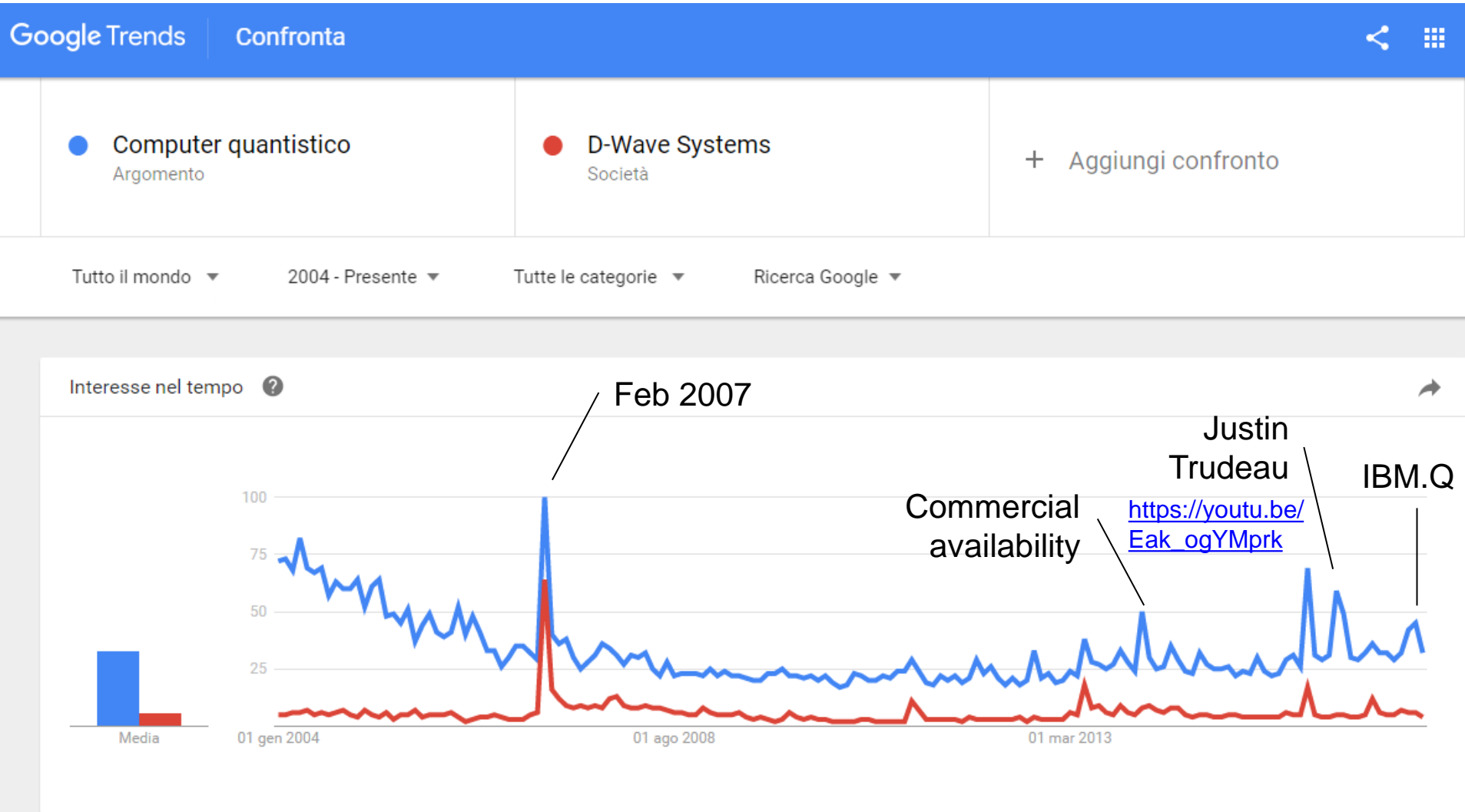
Example of regime shift

Quantum computing



Source: Multiple open / Wikipedia

Market & Communication



Source: Google

Also: remember 2006 exponential drive in CS...?



Thank you

Gabriele Rizzo

gabriele.rizzo@leonardocompany.com