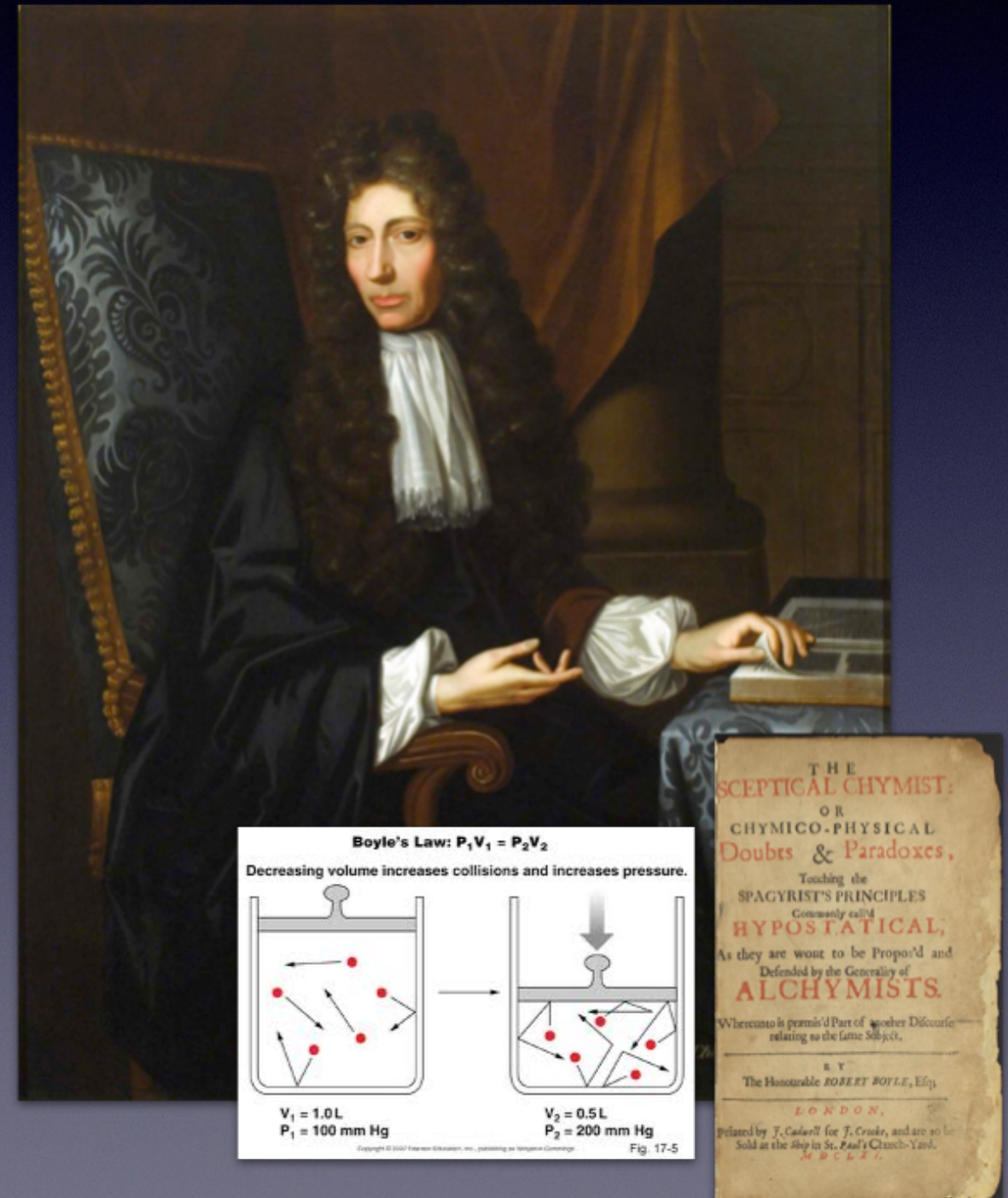
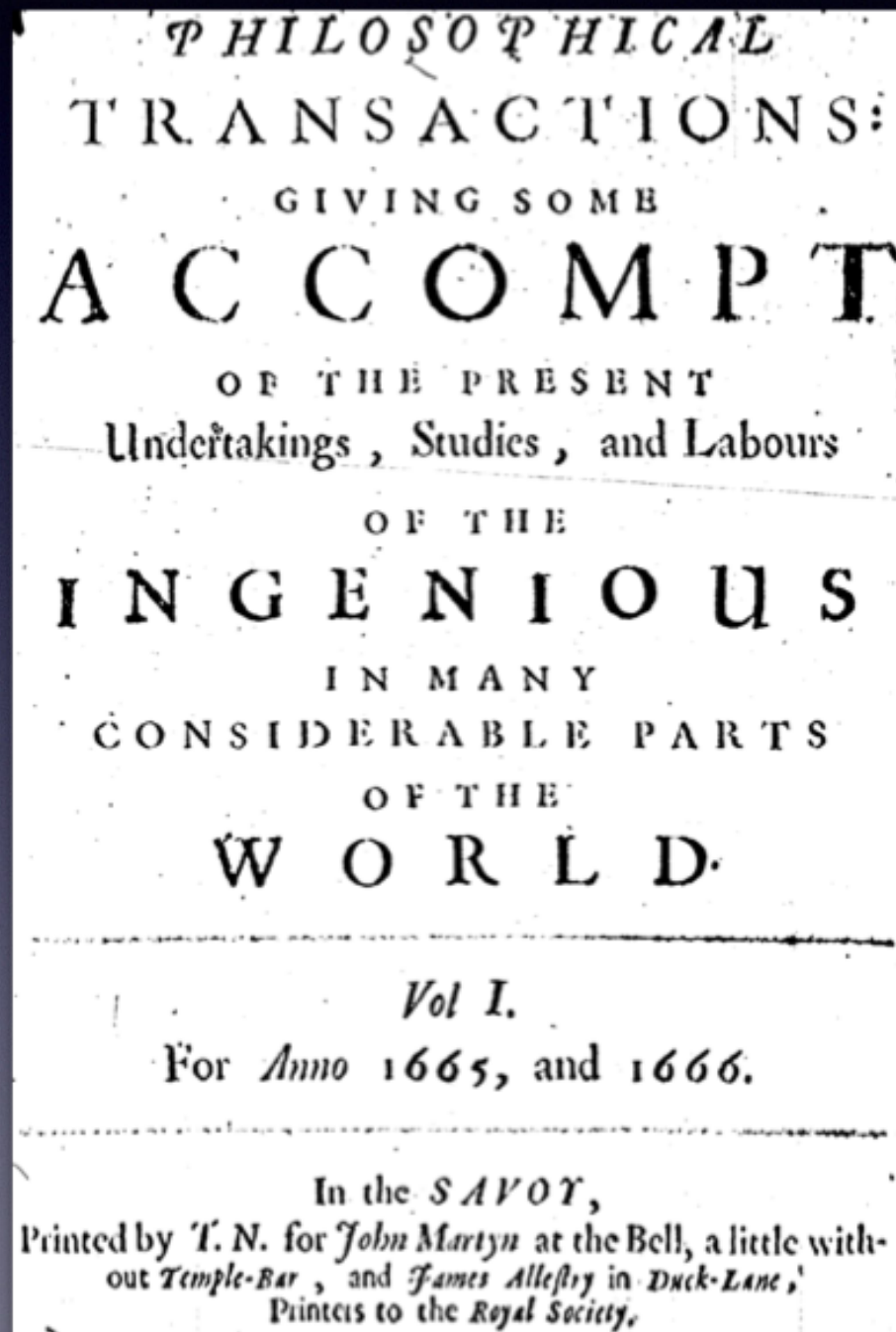


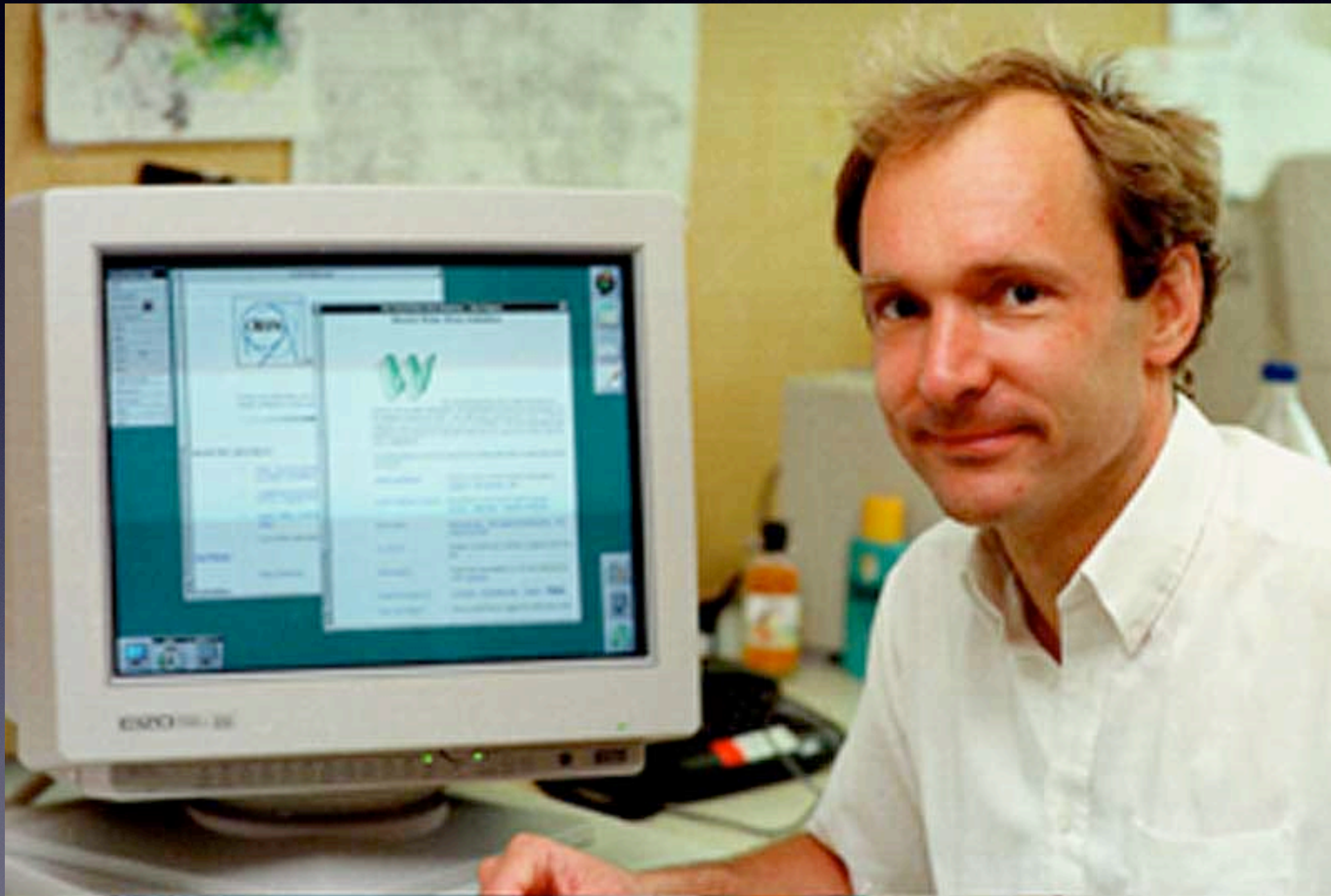
The Evolution of Scholarly Communication

Timo Hannay
Digital Science

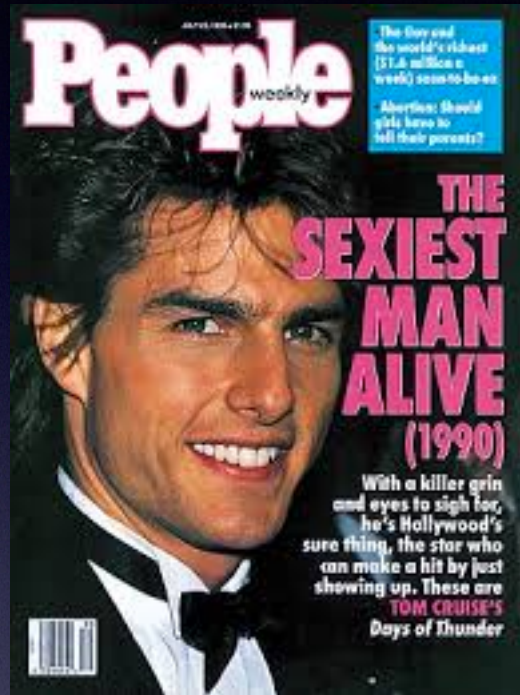
17th-century beginnings



21st-century revolution



A lot has happened in 25 years



Experiments in web publishing



Computers change everything

“About twenty years ago people noticed computers and TV were on a collision course and started to speculate about what they'd produce when they converged. We now know the answer: computers.”

Paul Graham



Even phones have become computers



+



=



And software changes everything too

ESSAY

Why Software Is Eating The World

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A

A

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By MARC ANDREESSEN

August 20, 2011

This week, Hewlett-Packard (where I am on the board) announced that it is exploring jettisoning its struggling PC business in favor of investing more heavily in software, where it sees better potential for growth. Meanwhile, Google plans to buy up the cellphone handset maker Motorola Mobility. Both moves surprised the tech world. But both moves are also in line with a trend I've observed, one that makes me optimistic about the future growth of the American and world economies, despite the recent turmoil in the stock market.



In an interview with WSJ's Kevin Delaney, Groupon and LinkedIn investor Marc Andreessen insists that the recent popularity of tech companies does not constitute a bubble. He also stressed that both Apple and Google are undervalued and that "the market doesn't like tech."

In short, software is eating the world.

More than 10 years after the peak of the 1990s dot-com bubble, a dozen or so new Internet companies like Facebook and Twitter are sparking controversy in Silicon Valley, due to their rapidly growing private market valuations, and even the occasional successful IPO. With scars from the heyday of Webvan and Pets.com still fresh in the investor psyche, people are asking, "Isn't this just a dangerous new bubble?"

Science is changing too

- More collaborative and global
- More automated and digital
- More data- and software-driven

Increasing collaboration

Cottage-industry
science



Industrial-scale
science



Increasing collaboration

THE BRAIN INITIATIVESM



The ENCODE Project: ENCyclopedia Of DNA Elements



CFG functionalglycomicsgateway

Cell Migration Consortium cellmigrationgateway

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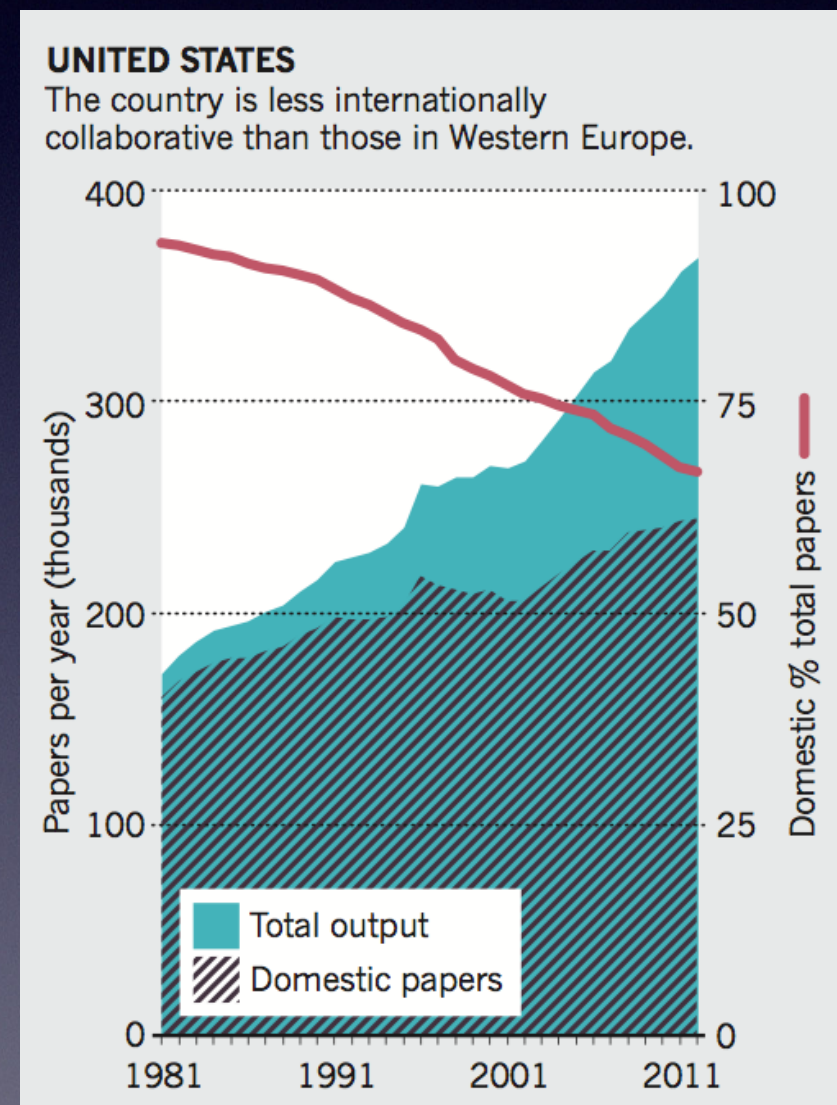
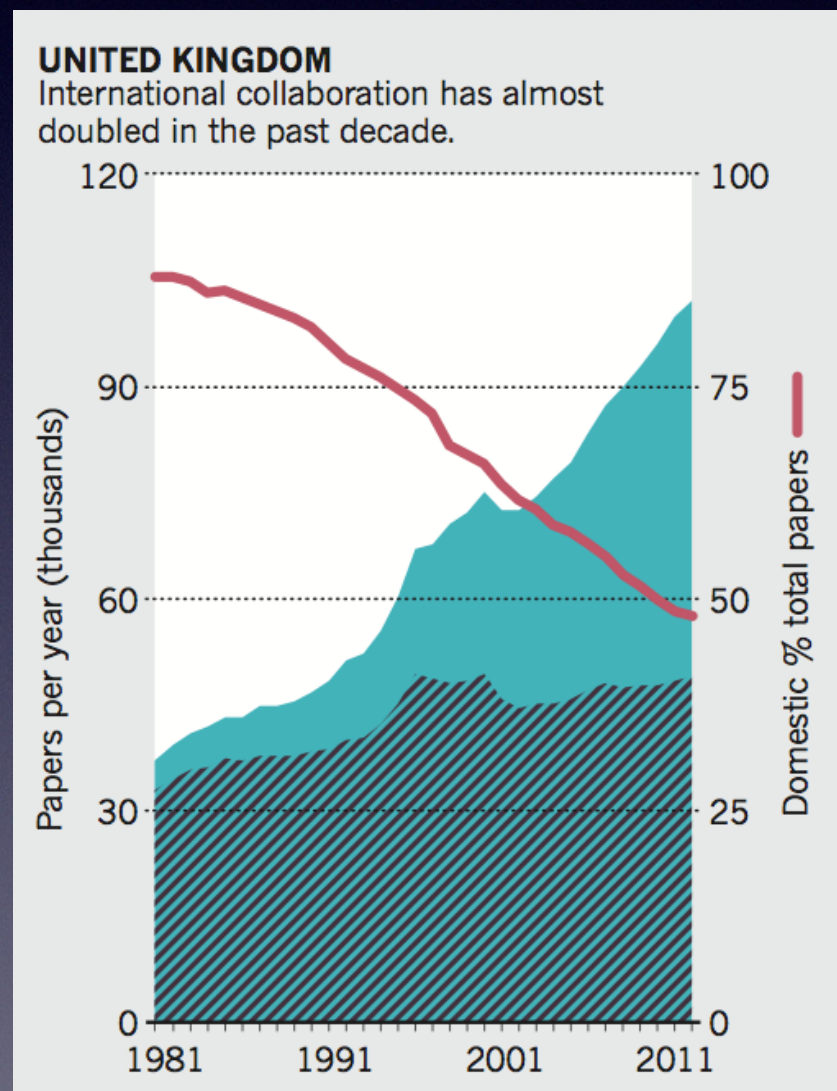
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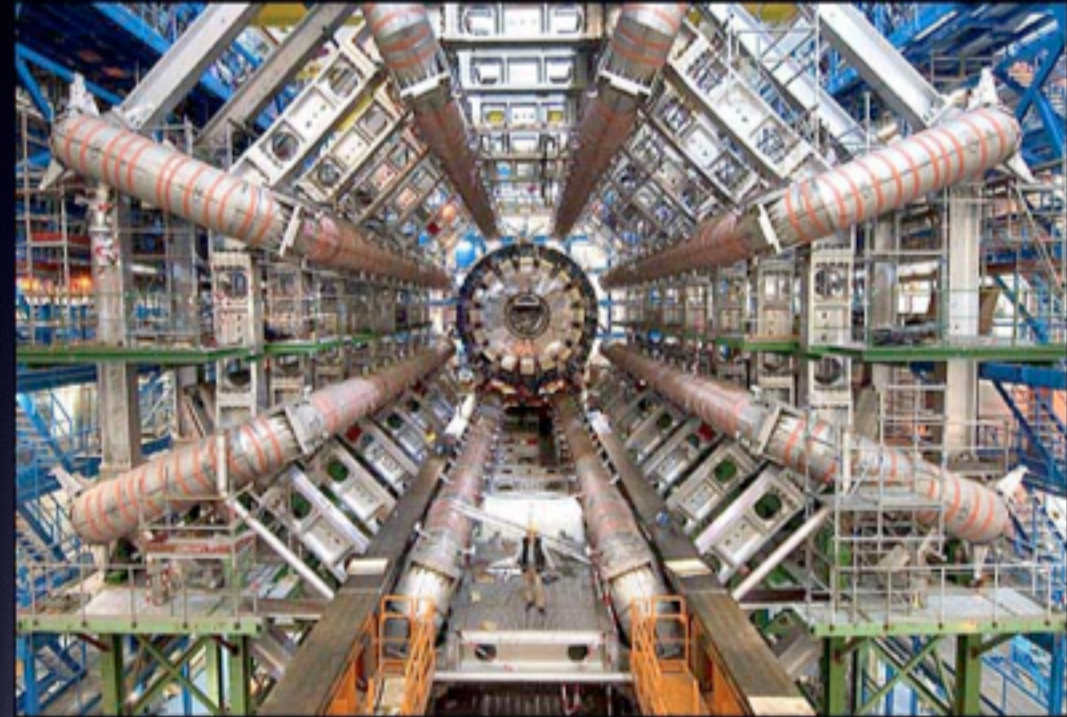
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Nature | 01 June 2015
2. **Sawfish spawn without sex**
Nature | 01 June 2015
3. **Mysterious die-off sparks race to save saiga antelope**
Nature | 01 June 2015
4. **Nigeria's new leadership raises hopes for science**

Increasing globalisation

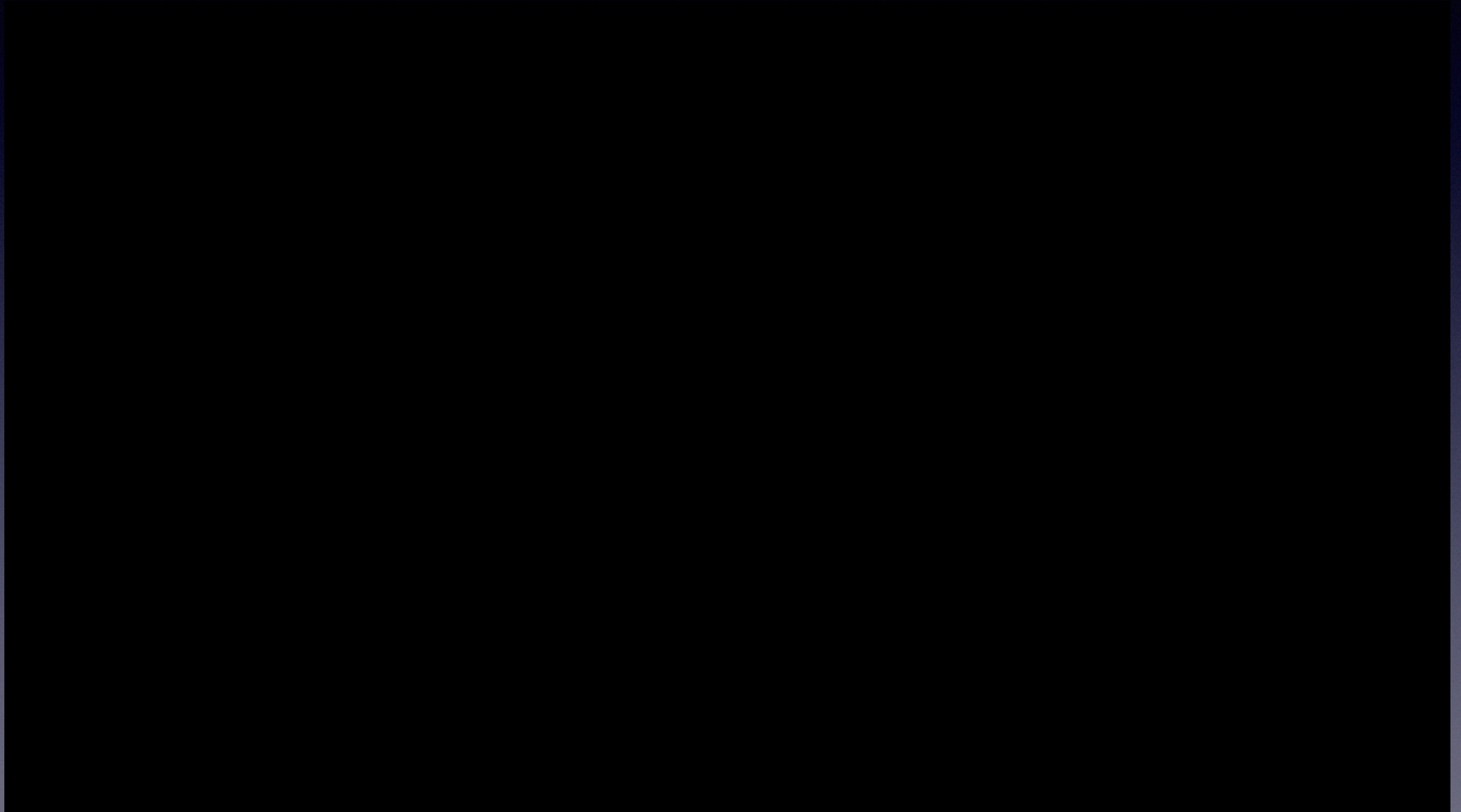


Source: 'The Fourth Age of Research' by Jonathan Adams, Nature 497, 557-560 (2013)

Increasing automation



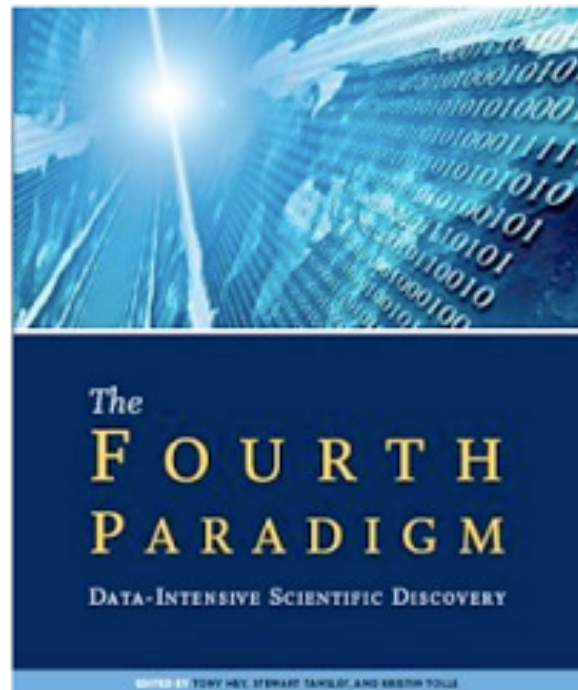
Increasing digitisation



More data, more software

The Fourth Paradigm: Data-Intensive Scientific Discovery

Presenting the first broad look at the rapidly emerging field of data-intensive science



Increasingly, scientific breakthroughs will be powered by advanced computing capabilities that help researchers manipulate and explore massive datasets.

The speed at which any given scientific discipline advances will depend on how well its researchers collaborate with one another, and with technologists, in areas of eScience such as databases, workflow management, visualization, and cloud computing technologies.

In *The Fourth Paradigm: Data-Intensive Scientific Discovery*, the collection of essays expands on the vision of pioneering computer scientist Jim Gray for a new, fourth paradigm

of discovery based on data-intensive science and offers insights into how it can be fully realized.

Download *The Fourth Paradigm*

- [Full text, low resolution](#) (6 MB)
- [Full text, high resolution](#) (93 MB)
- [By chapter and essay](#)

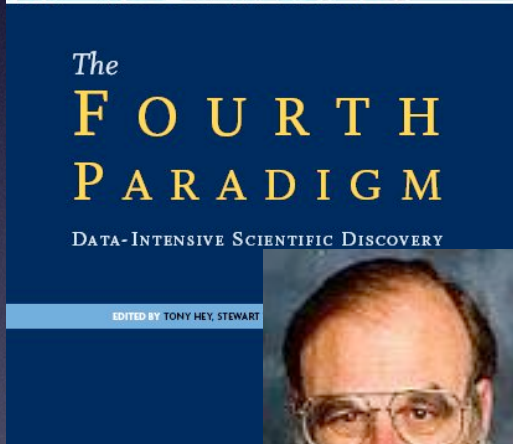
Related Resources

- [Microsoft Research collaborative projects](#)
- [eScience Workshop 2009](#)

Scientific paradigms 500BC - 2010AD

1. Empirical: describe natural phenomena
2. Theoretical: use equations and generalisations
3. Computational: simulate complex phenomena
4. eScience: data capture, processing and analysis

A vision for data-intensive science



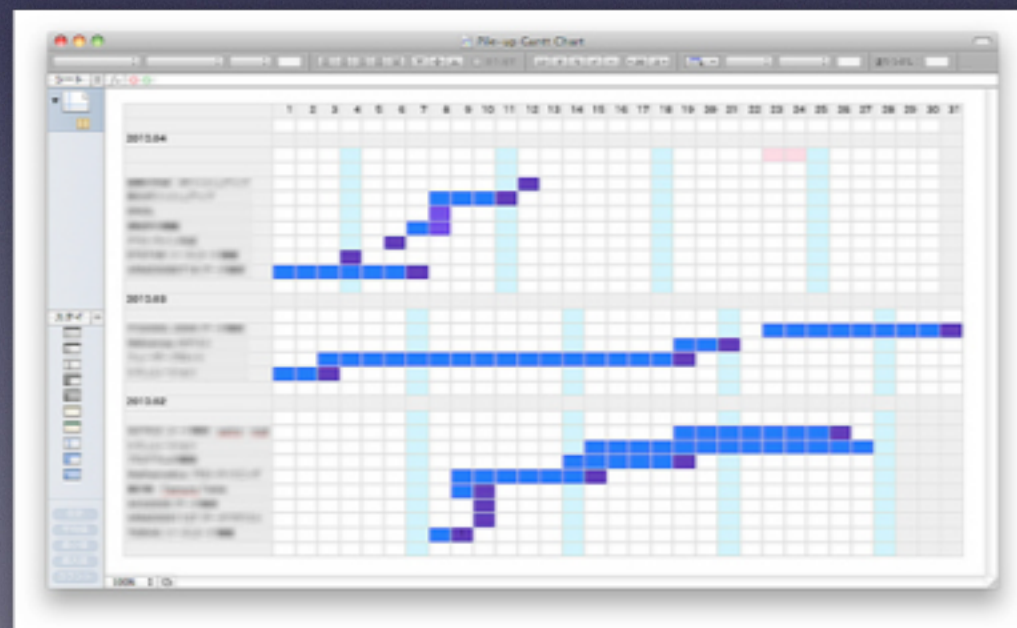
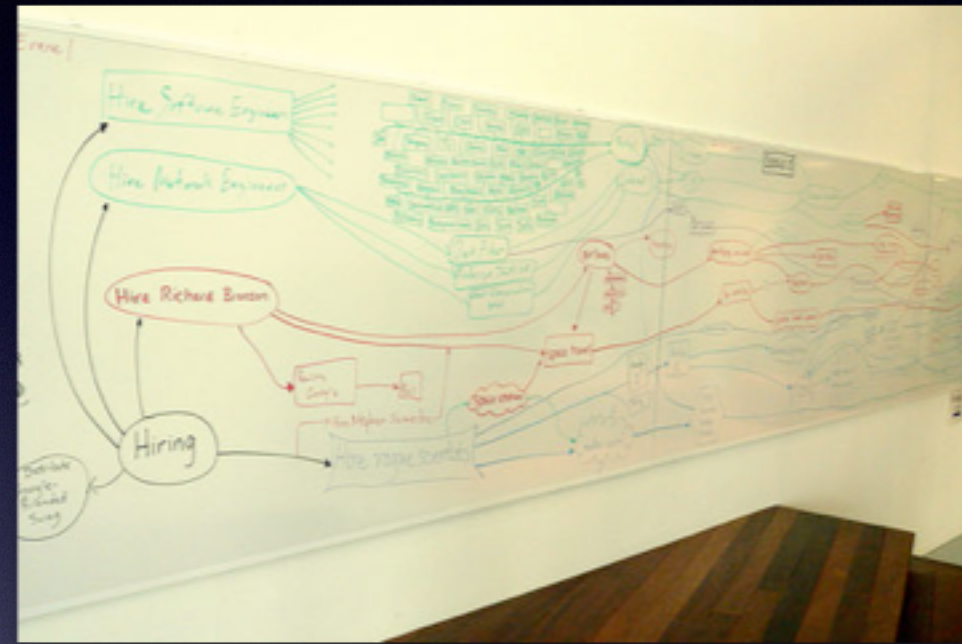
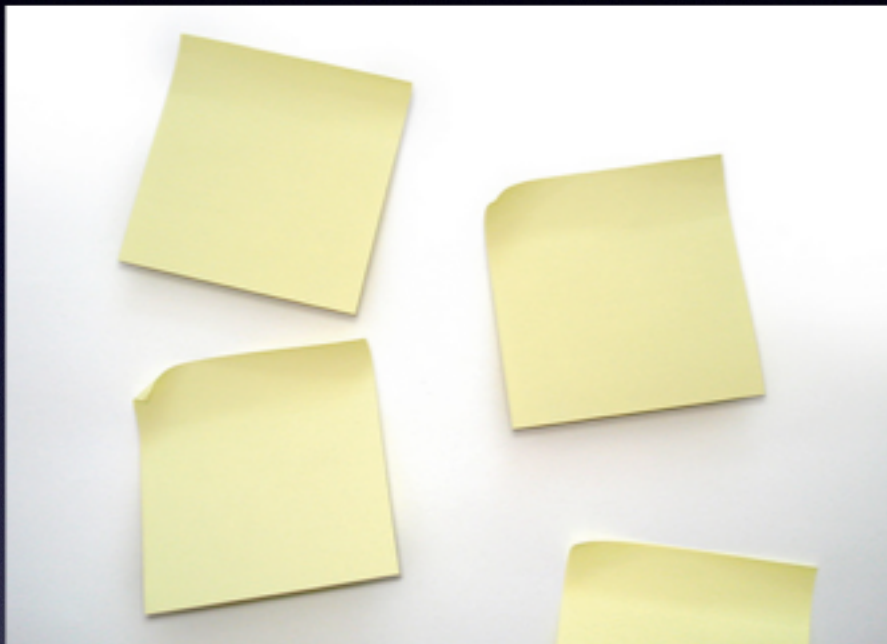
1. Foster both the development of software tools and support for these tools.
2. Invest in tools at all levels of the funding pyramid.
3. Foster the development of generic Laboratory Information Management Systems (LIMS).
4. Foster research into scientific data management, data analysis, data visualization, and new algorithms and tools.
5. Establish digital libraries that support other sciences in the same way the National Library of Medicine supports the bio-sciences.
6. Foster the development of new document authoring tools and publication models.
7. Foster the development of digital data libraries that contain scientific data (not just the metadata) and support integration with published literature.

A brief reality check

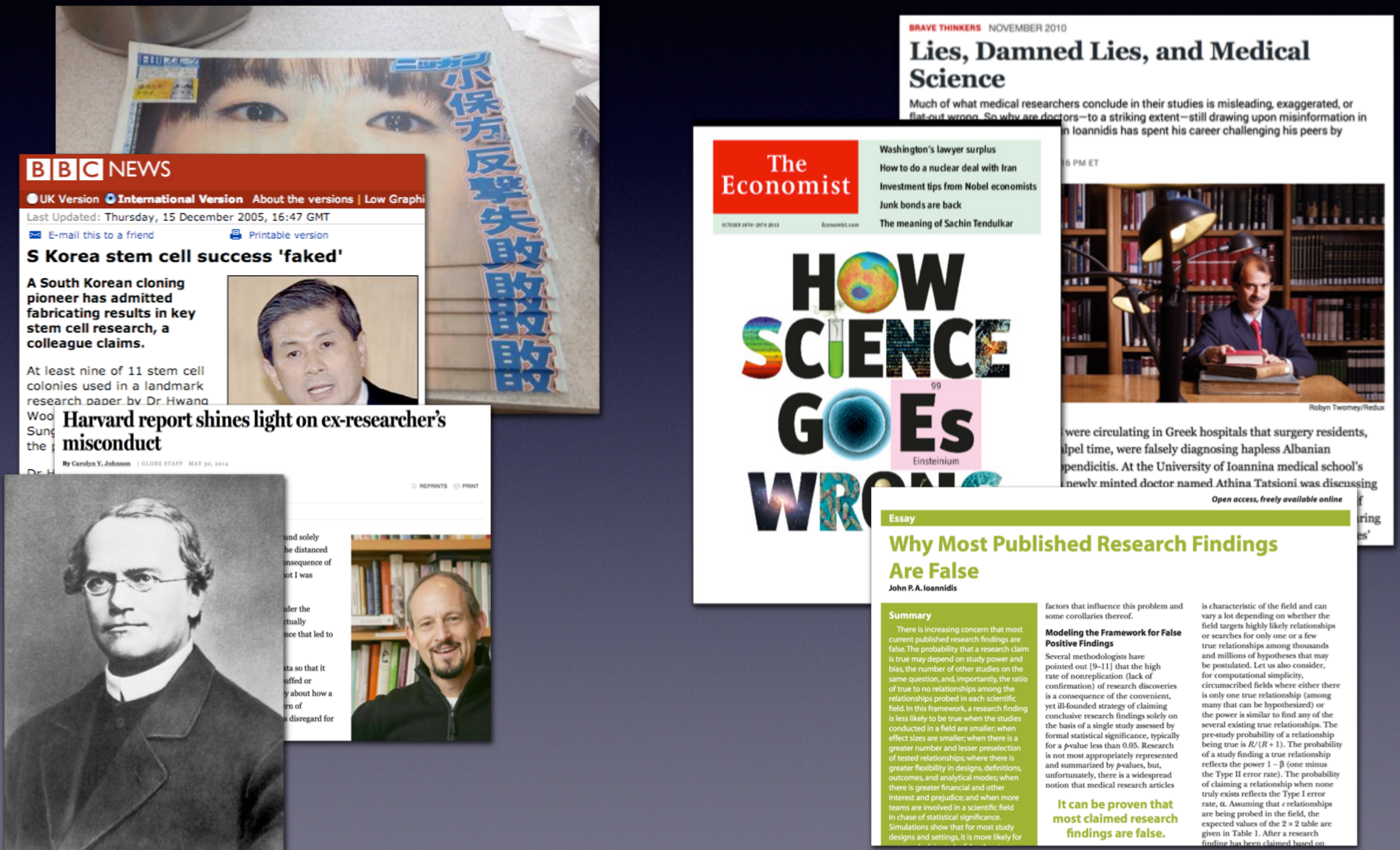


Image: <http://www.flickr.com/photos/duncanmacinnis>

Technologies of choice in the lab



And science has huge challenges



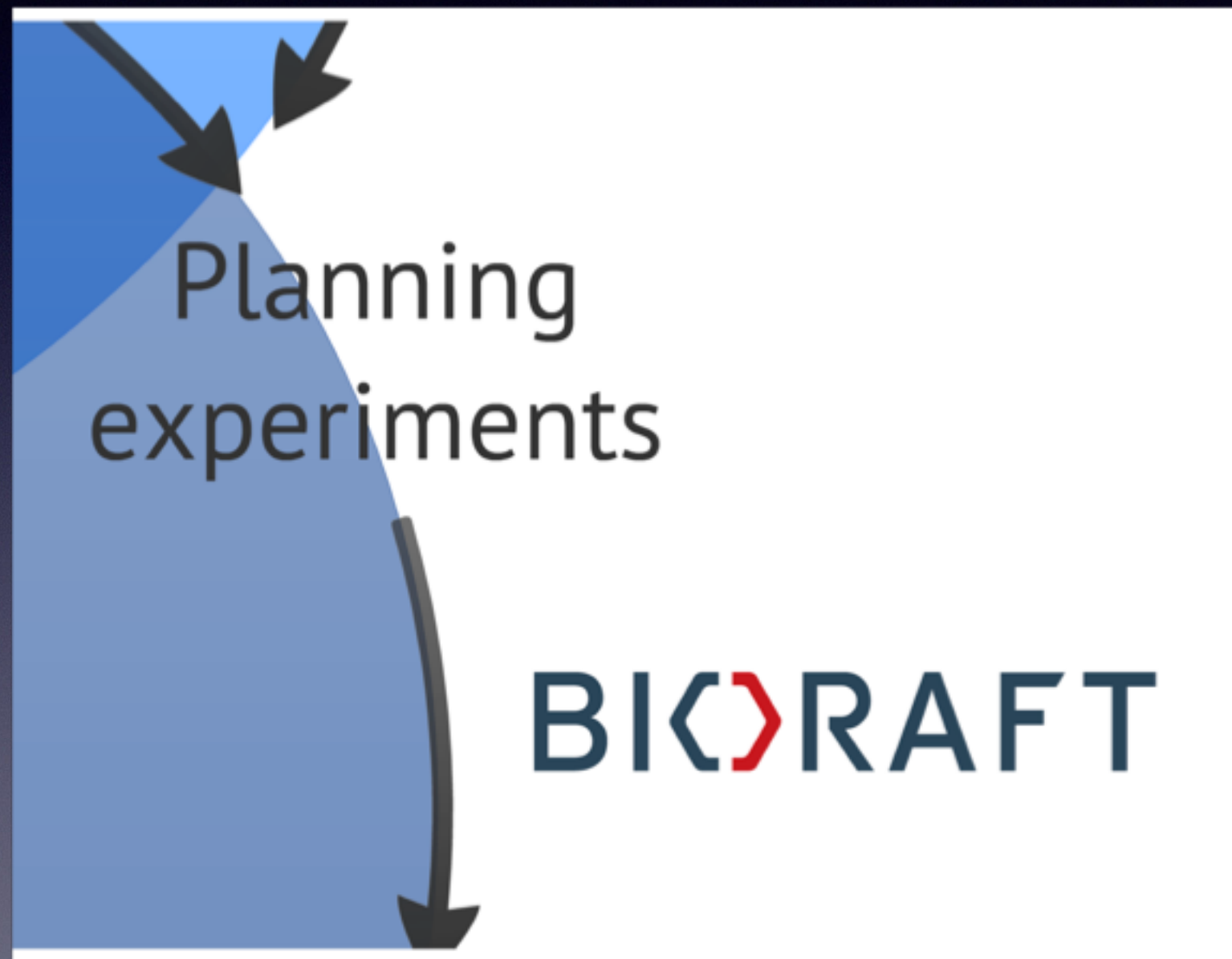
Digital Science grew out of Nature



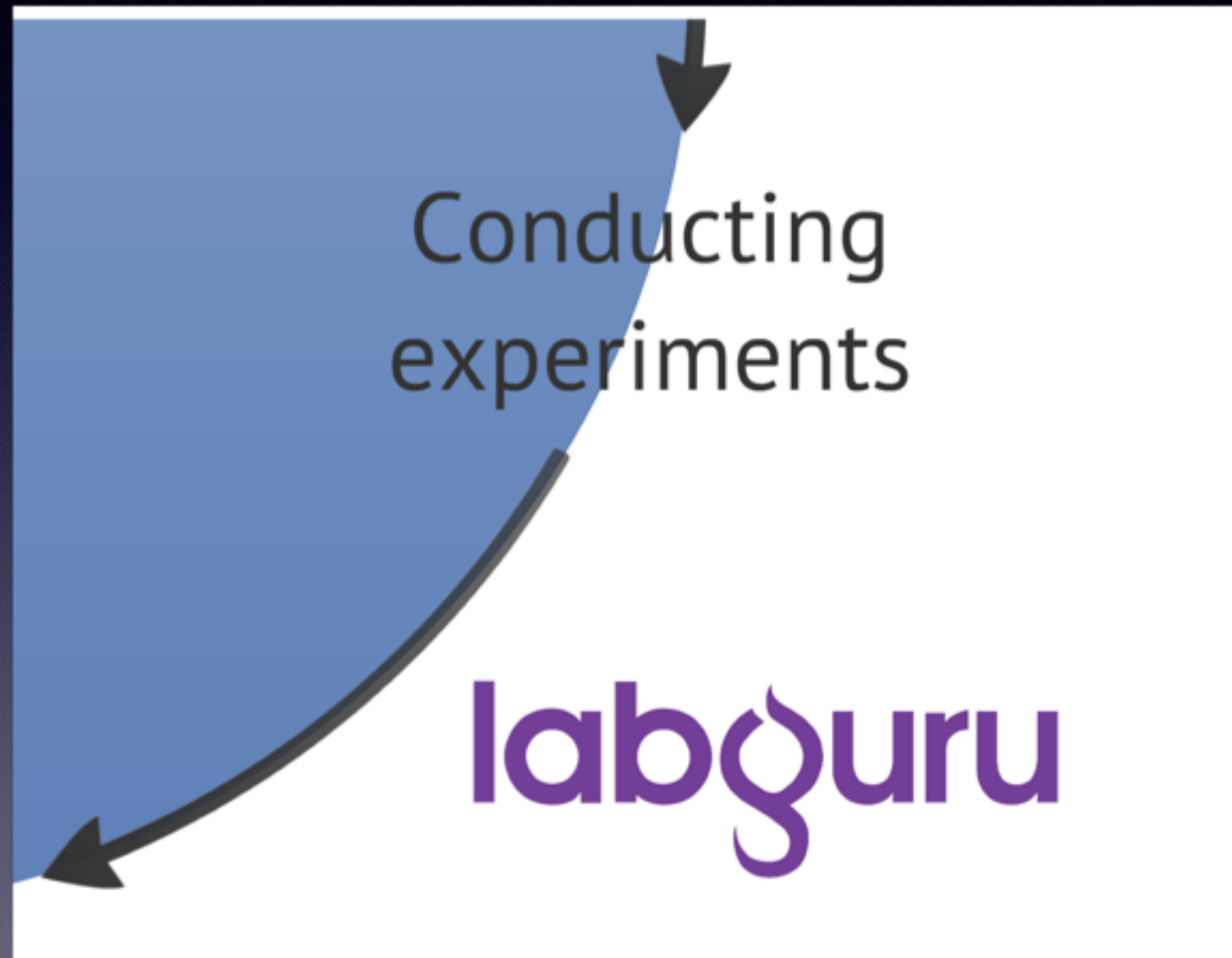
Journals play a key role in research



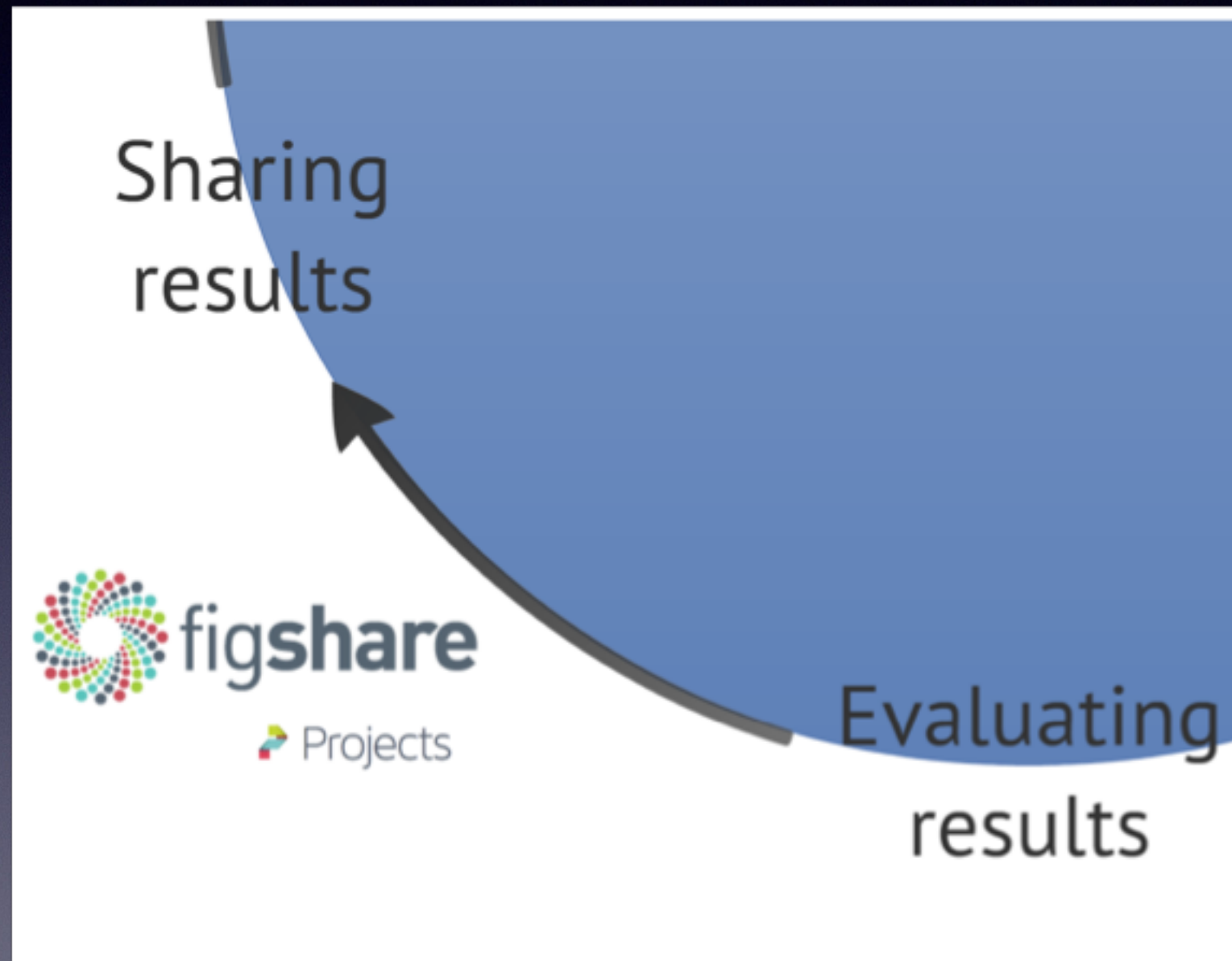
Helping researchers in the lab (1)



Helping researchers in the lab (2)



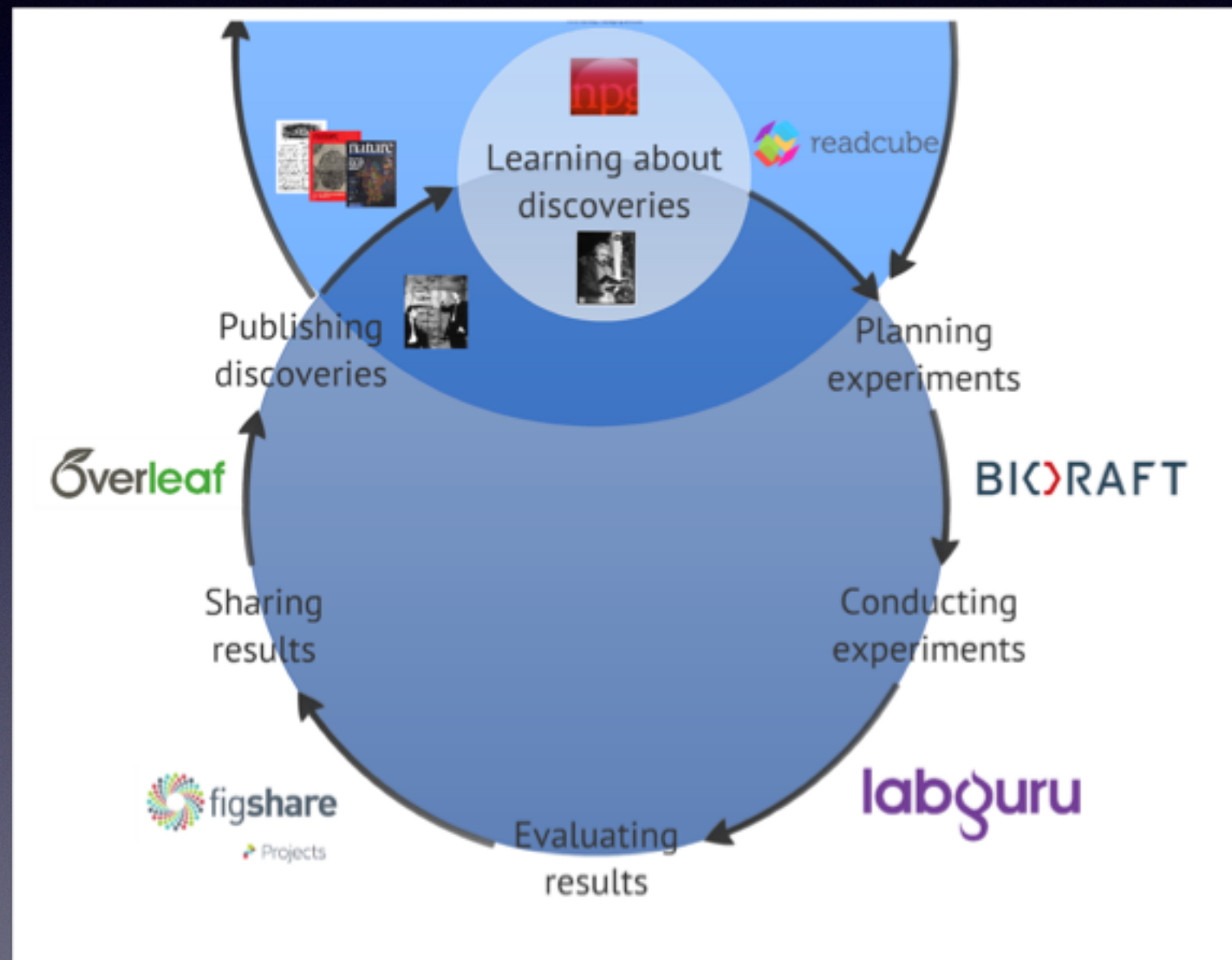
Handling data



Back to publishing



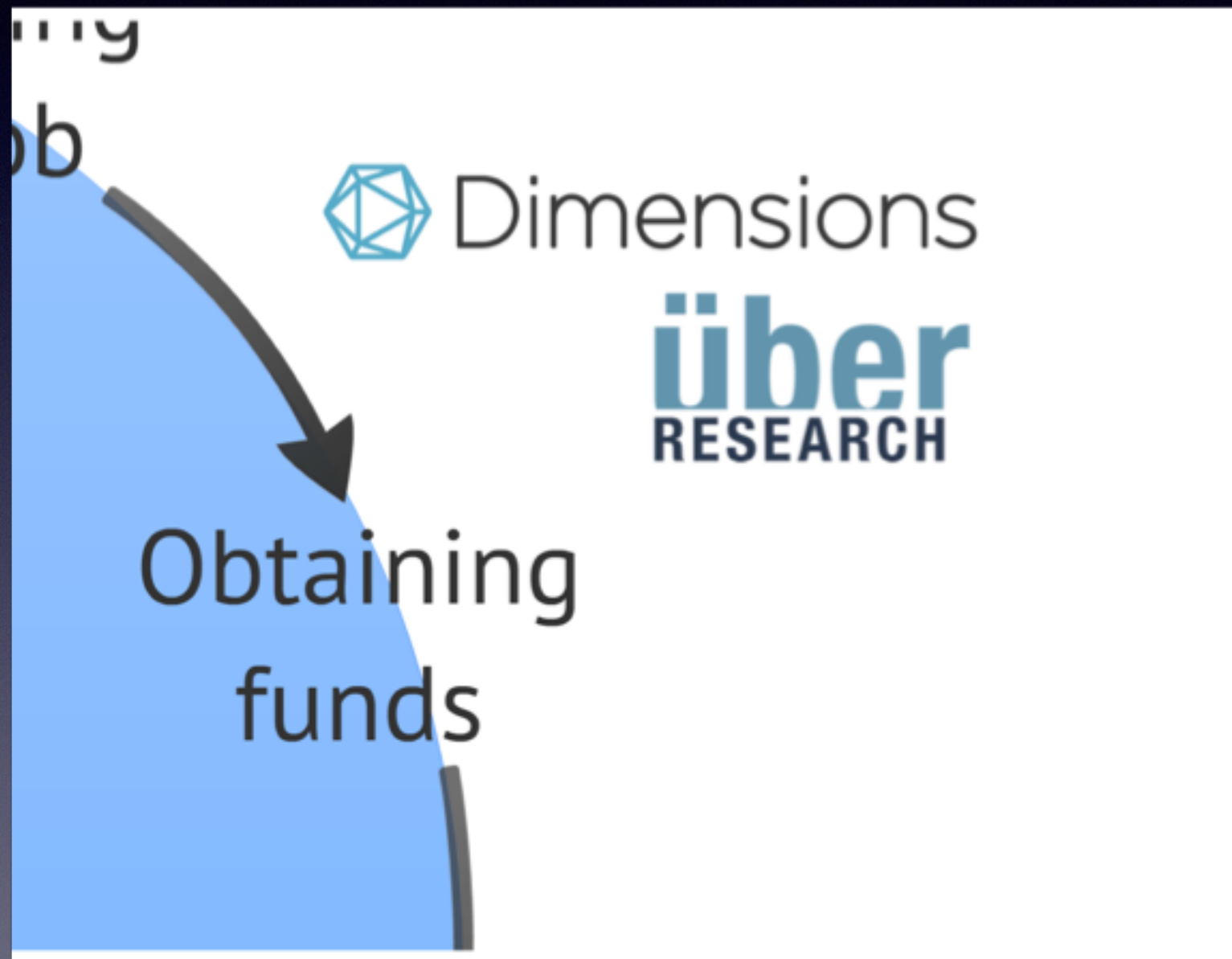
The research cycle



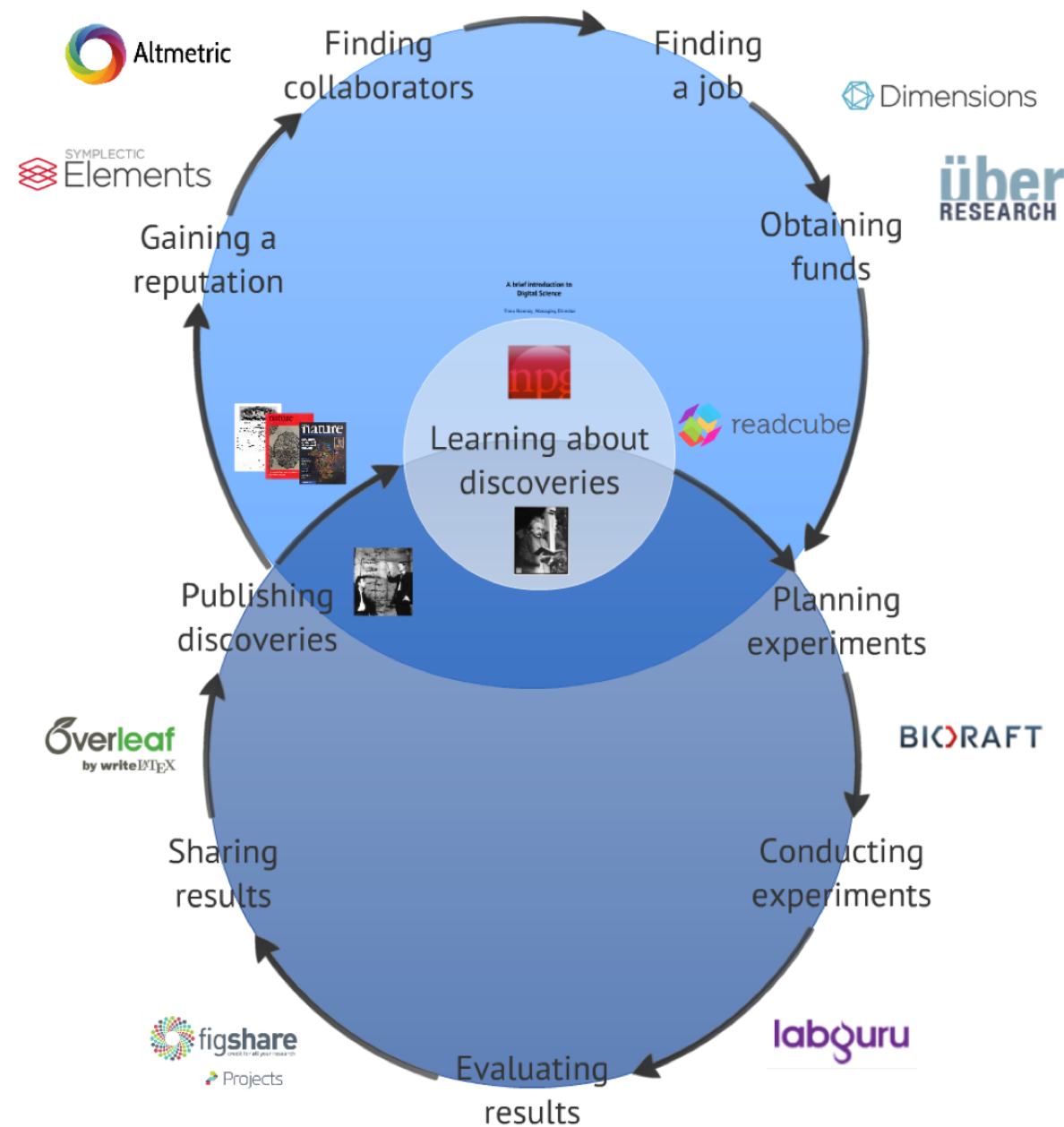
Research outputs and attention



Research inputs (aka grants)



The research and career cycles



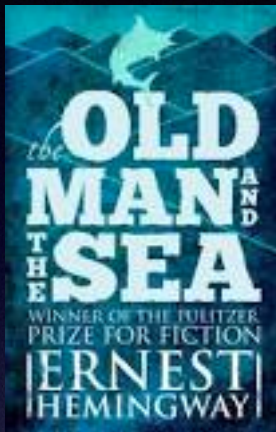
Summary of our approach

- Define your mission broadly
- Separate new activities from established ones
- Start small, stay nimble, build systematically
- Use an organising framework
- Be flexible about how and where you focus

How science communication will change

- Minimum and maximum publishable units
- Journals versus databases
- Research disciplines

Maximum and minimum publishable units

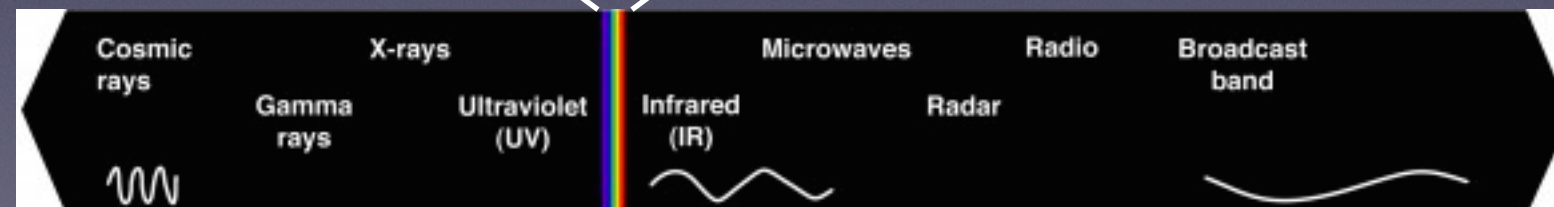


MOLECULAR STRUCTURE OF NUCLEIC ACIDS

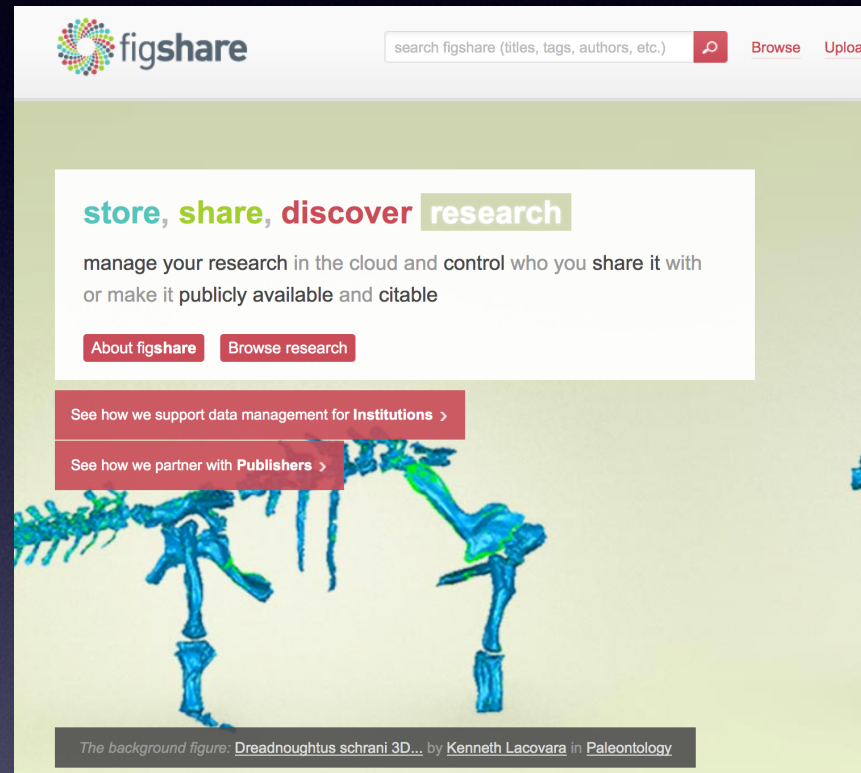
A Structure for Deoxyribose Nucleic Acid

WE wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.


A structure for nucleic acid has already been proposed by Pauling and Corey¹. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons:



Journals and databases

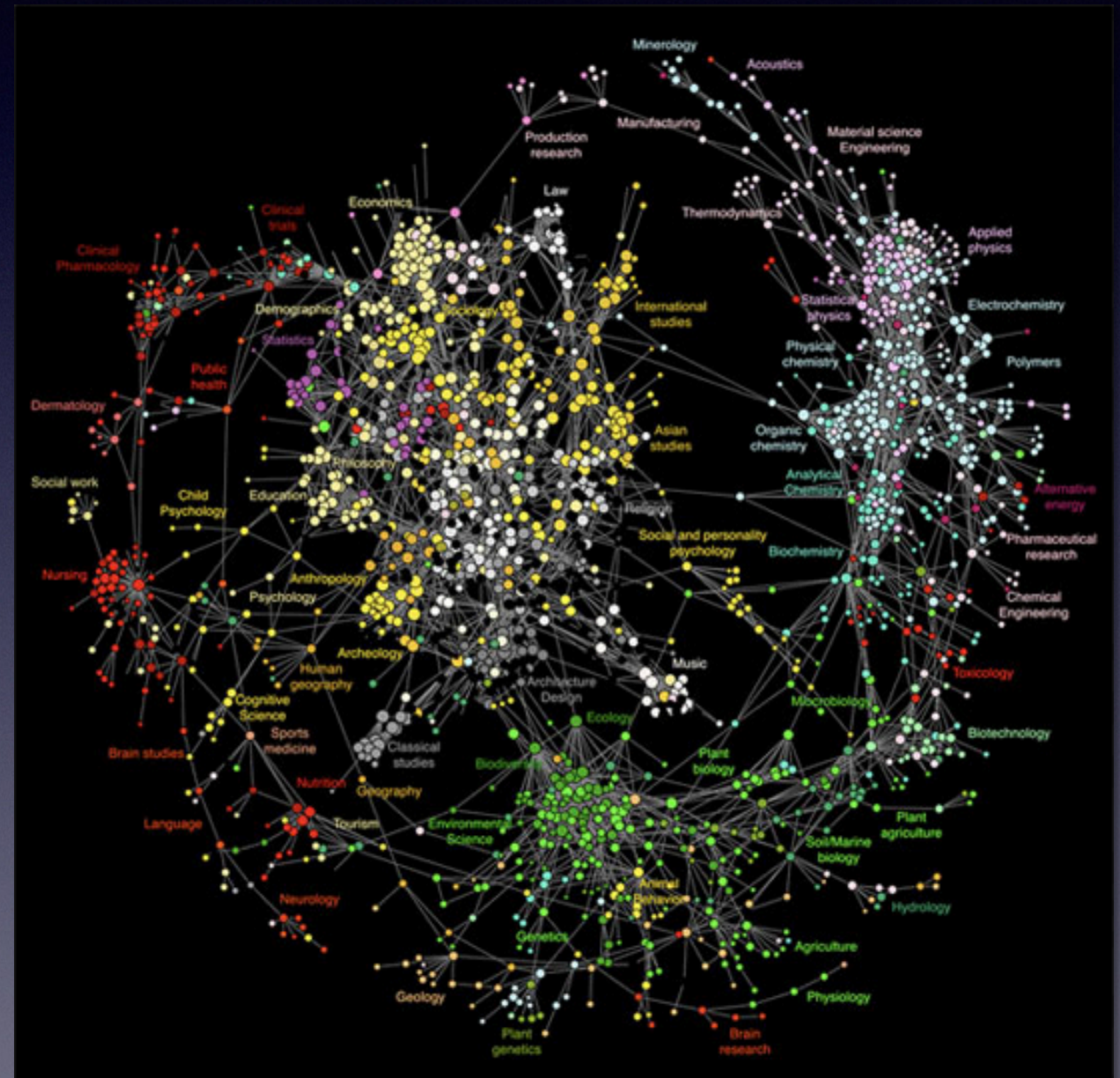


Research disciplines

DDS 	
DEWEY DECIMAL SYSTEM	
The Ten Main Classes	
000 GENERAL WORKS	
100 PHILOSOPHY	
200 RELIGIONS	
300 SOCIAL SCIENCES	
400 LANGUAGES	
500 NATURAL SCIENCE	
600 TECHNOLOGY	
700 ARTS/RECREATION	
800 LITERATURE	

SELECTED TOPICS		
000 GENERAL WORKS		
Encyclopedias	Publishing	
Computers		
General Reference	UFOs	Libraries
100 PHILOSOPHY (Thinking, Ideas)		
Ethics	Learning	ESP
Psychology	Paranormal	Zodiac
200 RELIGIONS		
The Bible	Mythology	
Buddhism		
Christianity	Other Religions	Judaism
300 SOCIAL SCIENCES		
Family Life	Armed Forces	Folk
Tales		
Government	Transportation	Holidays
Laws	Education	
Almanacs		
400 LANGUAGES		
English	Grammar	
Dictionary		
Other Languages	Reading Skills	
Thesaurus		
500 NATURAL SCIENCE		
Mathematics	Chemistry	Rocks
Astronomy	Atoms, Molecules	Animals
Electricity	Weather	Plants
600 TECHNOLOGY (Applied Science)		
Parts of the Body	Medicine	Pets
Foods, Nutrition	Clothing	
Inventions	Motorcycles	Airplanes
Cars		
700 ARTS AND RECREATION		
Painting, Drawing	Arts and Crafts	Music
Sports, Games	Photography	Hobbies

K. Tucker 09/00



Science communication of the future will...

- Encompass a vast range of 'publishable unit' size
- Have the characteristics of both journals and databases
- Blur the distinctions between research disciplines

Back to the future

