Title
Why Are Scientific Data Rarely Reused? (Keynote)

Author
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Publication Date
2013-09-16

Why are Scientific Data Rarely Reused?

Scientific Information Policies in the Digital Age:
Enabling factors and barriers to Knowledge Sharing

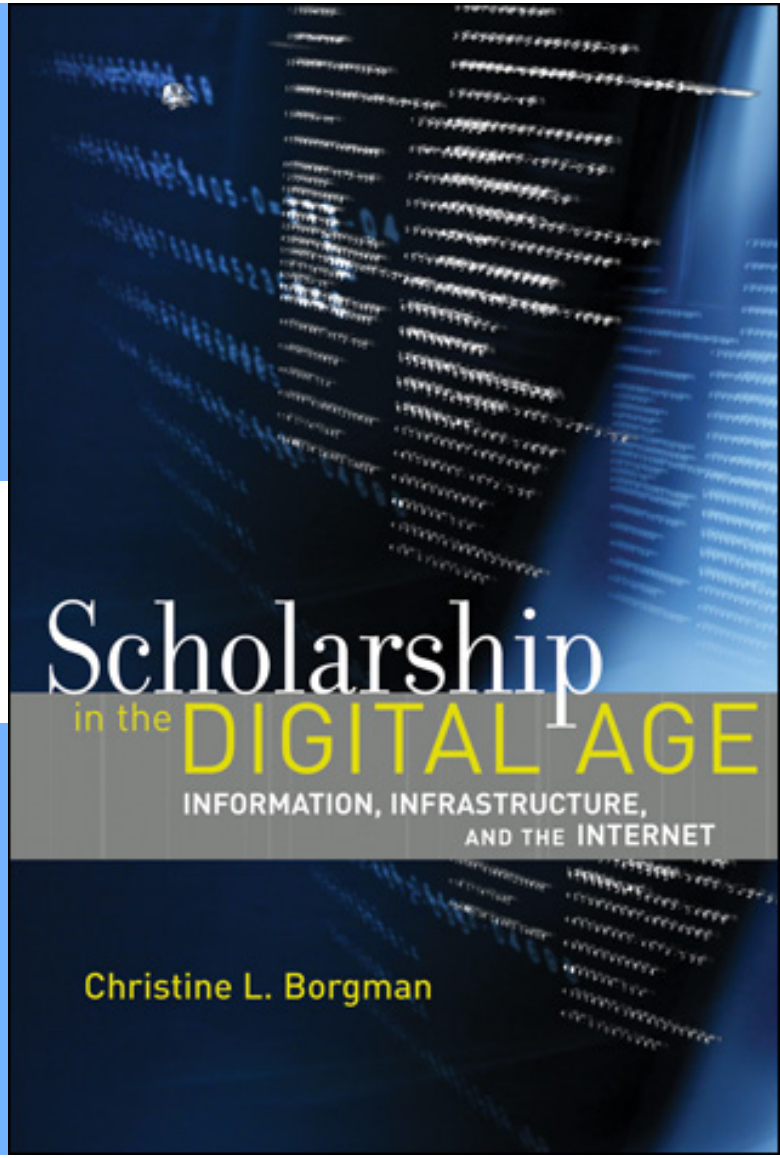
16 September 2013

Italian National Research Council, Rome

Christine L. Borgman

Professor and Presidential Chair in Information Studies

University of California, Los Angeles



The Conundrum of Sharing Research Data

*If the rewards of the data deluge are to be reaped, then researchers who produce those data must share them, and do so in such a way that the data are interpretable and reusable by others.**

*Borgman, C.L. (2012). The Conundrum of Sharing Research Data. *Journal of the American Society of Information Science and Technology*, 63(6):1059–1078

http://www.tzanis.org/tzanisblog/archives/images/push-pull-thumb.jpg

Overview

- Paradigm shift
- Arguments for sharing data
- Science friction, data friction
- Requirements for reusing data

http://inventionmachine.com/the-Invention-Machine-Blog/bid/51703/Three-Key-Challenges-to-Entering-New-Markets


Science
12 September 2008 | $10
AAAS


Science
11 February 2011 | $10
scientific
data
research
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AAAS

Data sharing imperatives

- European Union
  - European Open Data Challenge
  - Policy RECommendations for Open Access to Research Data in Europe
  - Riding the wave: How Europe can gain from the rising tide of scientific data
  - OpenAIRE
- Research Councils of the UK
  - Open access publishing requirements
  - Provisions for access to data
- Wellcome Trust
  - Open access publishing
  - Data sharing requirements
- National Science Foundation
  - Data sharing requirements
  - Data management plans
- U.S. Federal policy-2013
  - Open access to publications
  - Open access to data

E·S·R·C
ECONOMIC
& SOCIAL
RESEARCH
COUNCIL

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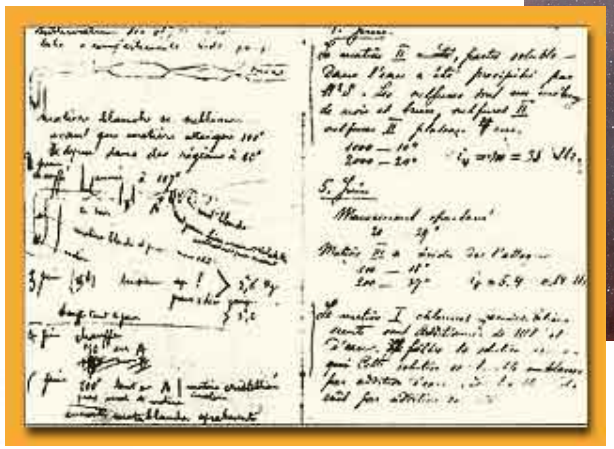
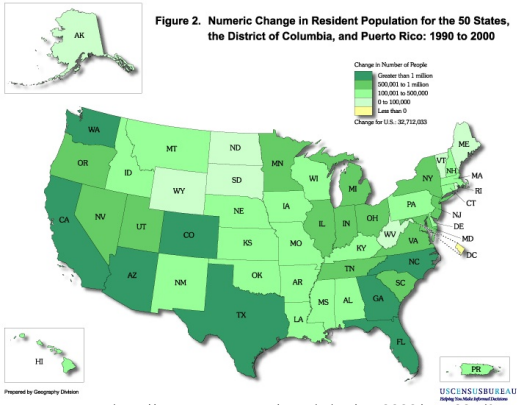
wellcome trust

What are data?

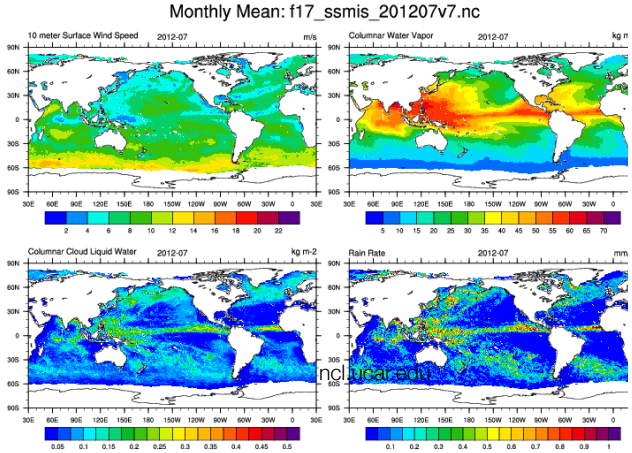
hudsonalpha.org



Marie Curie's notebook aip.org



http://www.census.gov/population/cen2000/map02.gif

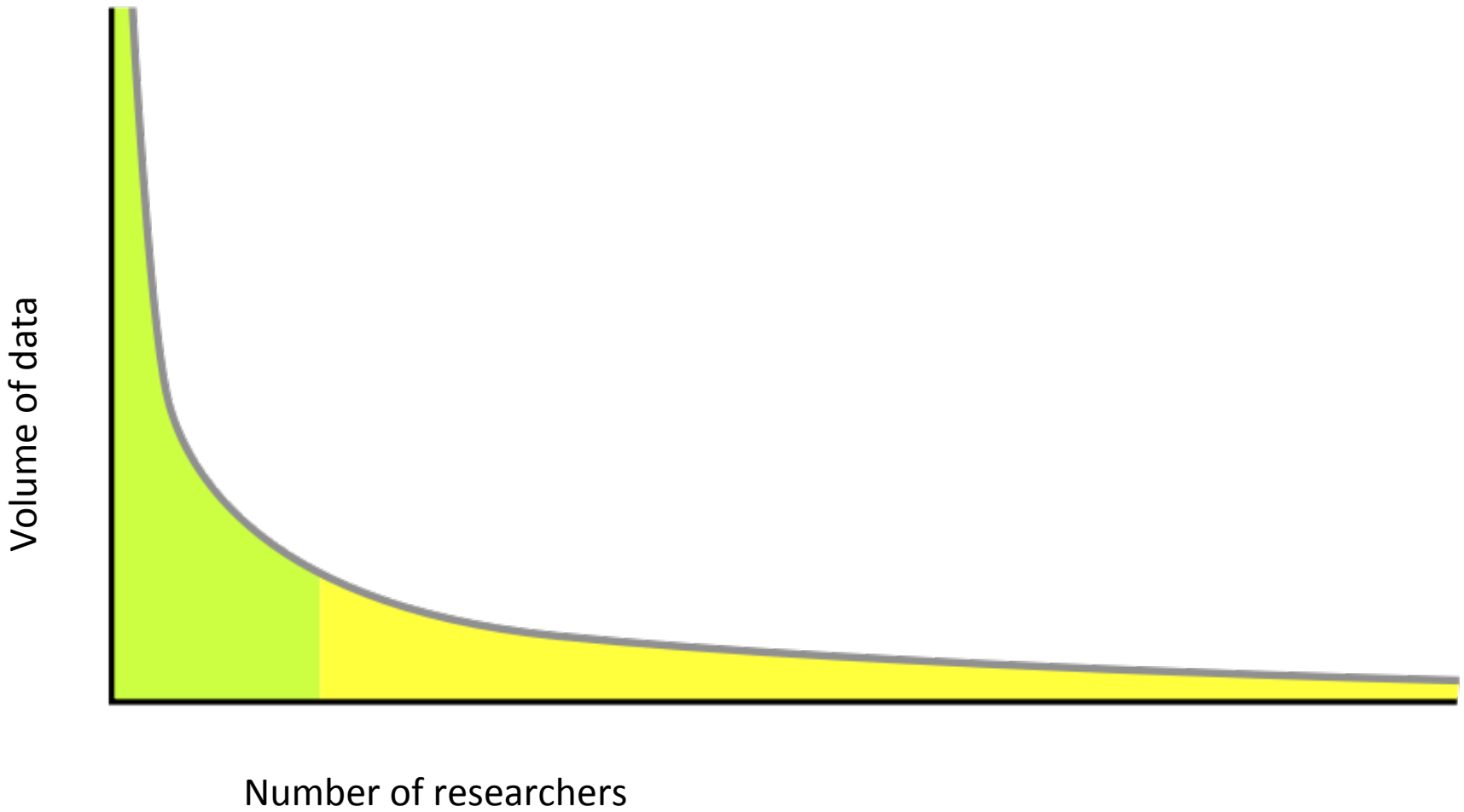


Date:1/2.07.75 Place:Sakaltutan
Zafor
He will grow old in his present house; new house is for sons - 5 sons. Not sure they want to live in village. He will only build another if they want him to. eS came from Germany and did the plastering. He arranged the carpentry in Kayseri. Çok para gitti. {much money went} Has a tractor.

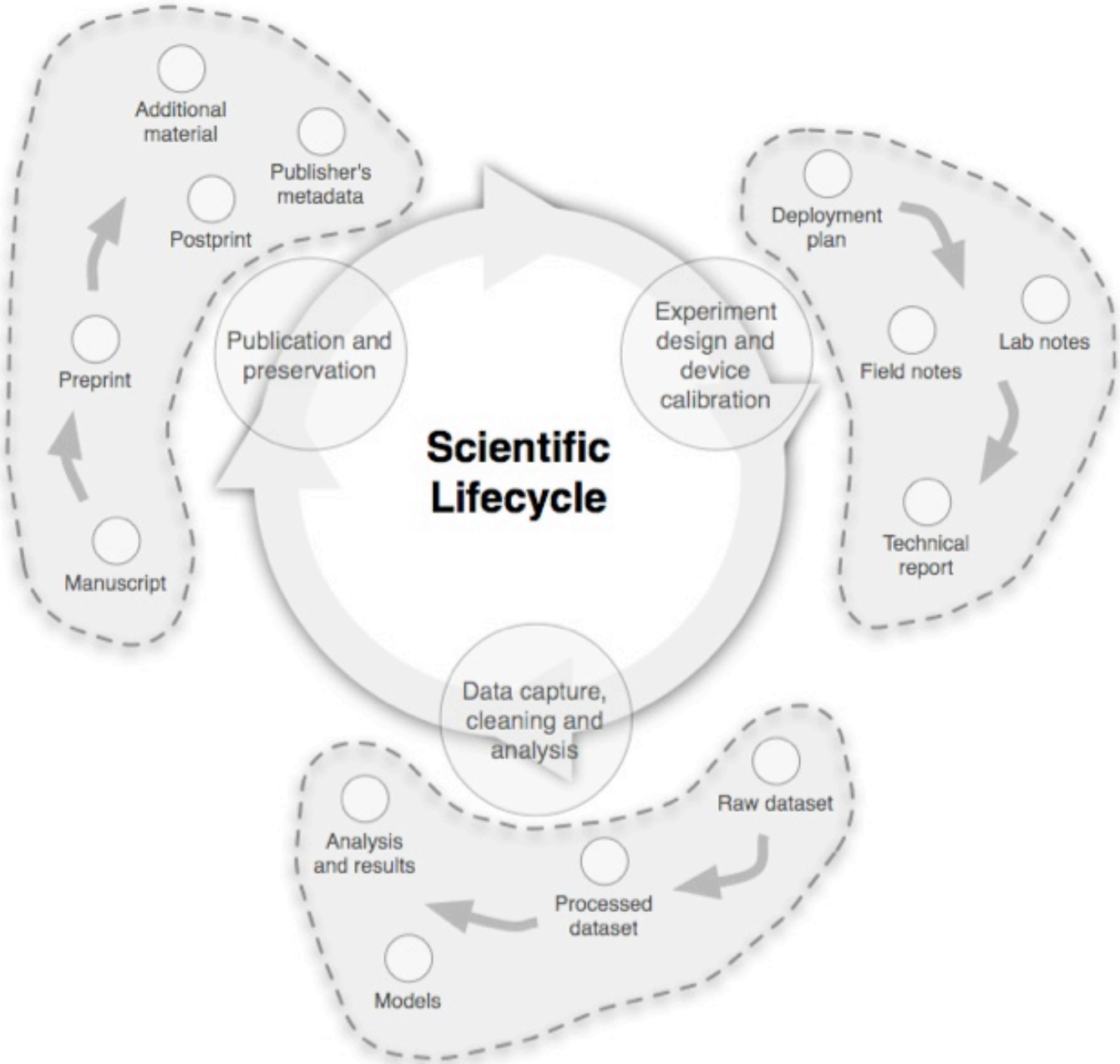
Date:July1980 Place:Sakaltutan
Zafor:
Household now Zafor and wife; Nazif Unal and wife and youngest son, still a boy. They run two dolmuß; one with a driver from Süleymanli. Goes in and out once a day. He gets 8,000 a month. Zafor then said, keskin de©il. { not sharp - i.e.? not profitable} I said he did very well on 8,000 TL with only two journeys a day. Nazif Unal has "bought" a Durak {dolmuß stop} from Belediye and works all day in Kayseri.

http://onlineqda.hud.ac.uk/Intro_QDA/Examples_of_Qualitative_Data.php

The long tail of data



Slide: The Institute for Empowering Long Tail Research



Pepe, A., Mayernik, M. S., Borgman, C. L. & Van de Sompel, H. (2010). From Artifacts to Aggregations: Modeling Scientific Life Cycles on the Semantic Web. Journal of the American Society for Information Science and Technology, 61(3): 567–582.

Overview

- Paradigm shift
- Arguments for sharing data
- Science friction, data friction
- Requirements for reusing data

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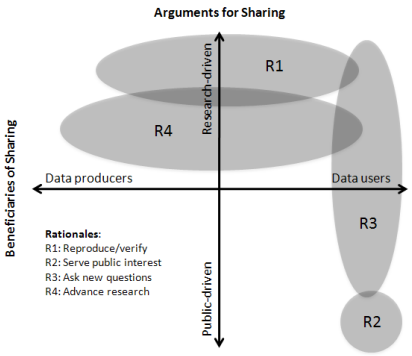
Why share research data?



Rationales

1. To reproduce research
2. To make public assets available to the public
3. To leverage investments in research data
4. To advance research and innovation

Borgman, C.L. (2012). The Conundrum of Sharing Research Data. JASIST, 63(6):1059–1078
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Borgman, C.L. (forthcoming): Big Data, Little Data, No Data: Scholarship in the Networked World. MIT Press

1. To reproduce research

http://chemistry.curtin.edu.au/research/index.cfm

Benzoic Acid	% yield		IR Peaks (cm^{-1})		Solid (C) or Oil (O) Product	Mp (°C)
	Gross	Recrystallization	N-H	C=O		
Sodium benzoate		2.58	3327	1638	White C	79-89
Sodium benzoate			3337	1640&1600	O	
Sodium benzoate			3326	1642&1601	O	
Sodium benzoate	37.8		3274	1640	O	
p-nitro	51.84	10.59	3423	1693	Yellow C	152-157
m-nitro	37.38	5.43	3334	1694	Green C	152-157
Benzoic acid		7.44	3293	1642	White C	152-154
m-bromo		47.4	3316	1702	Green paste	
p-bromo		14.53	3344	1638	Pink C	164-166
p-chloro		29.69	3340	1638	Yellow C	
m-chloro		74.53	3410	1637	tan paste	
o-chloro		17.31	3422	1654	Tan C	
3,5-dinitro		44.53	3297	1647	Tan C	139-141
p-hydroxy		3.751	3401	1643	yellow/green C	210
p-amino		8.475	3411	1645	Dark O	
o-methoxy		42.49	3412	1646	Yellow O	

http://serc.carleton.edu/cismi/broadaccess/groupwork.html

Scientific Gold Standard

REPLICATION—THE CONFIRMATION OF RESULTS AND CONCLUSIONS FROM ONE STUDY obtained independently in another—is considered the scientific gold standard.

Jasny, B. R., Chin, G., Chong, L. & Vignieri, S. (2011). Again, and again, and again. Science, 334(6060): 1225.

Victoria Stodden, Columbia

Reproducibility?

- Deductive sciences
  - Check the proof
- Experimental sciences
  - Redo the field work
- Computational sciences
  - Start with the dataset
  - Reconstruct workflow

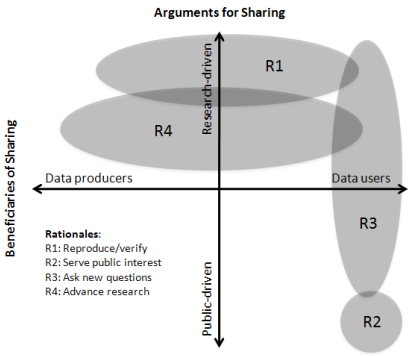
Analytic validity	Do different labs, techniques, and platforms measure the same thing?
Repeatability	Can other scientists access the data and protocols, repeat the analyses, and get the same results?
Replication	Do many different data sets and their combination (meta-analysis) get consistent results?
External validation	Do different data sets by different teams, preferably prospectively and with large-scale evidence, get consistent results?
Clinical validity	Does the discovered information predict clinical outcomes?
Clinical utility	Does the use of the discovered information improve clinical outcomes?

Science AAAS

Published by AAAS

J P A Ioannidis, M J Khoury Science 2011;334:1230-1232

Why share research data?



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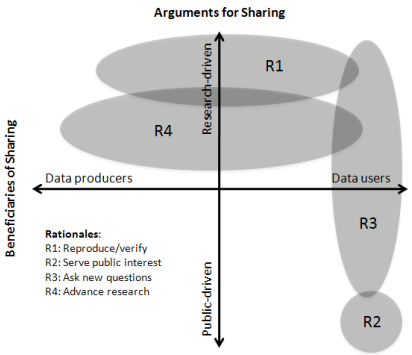

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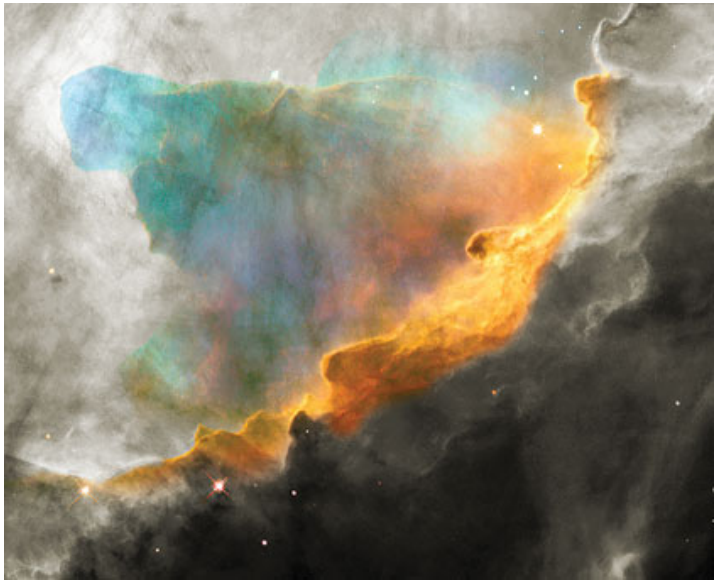
3. To leverage investments in research data

data

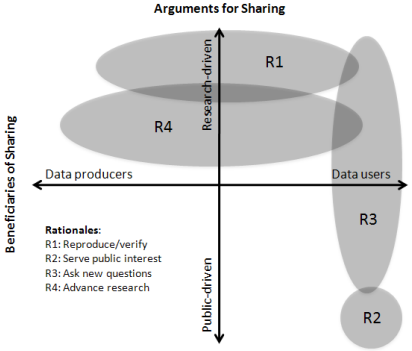


discovery

http://annualreport.ucdavis.edu/2008/images/photos/discovery.jpg

http://digitalassetmanagement.org.uk/2010/02/01/the-winds-of-change-are-blowing-in-the-clouds-favor/

Why share research data?



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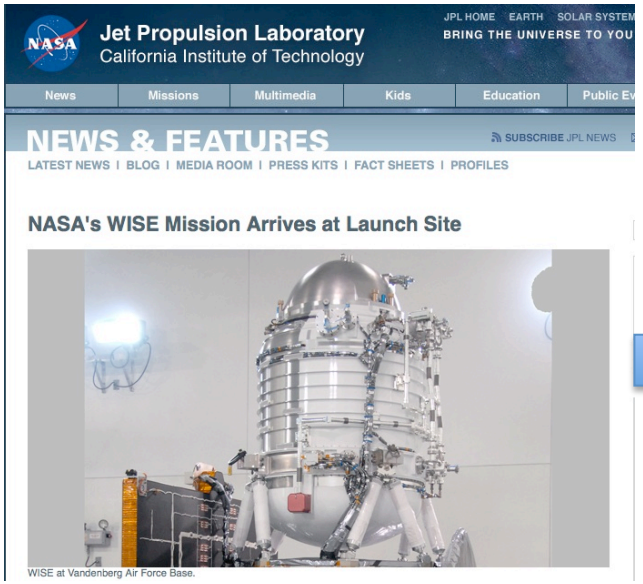

International Virtual Observatory Alliance

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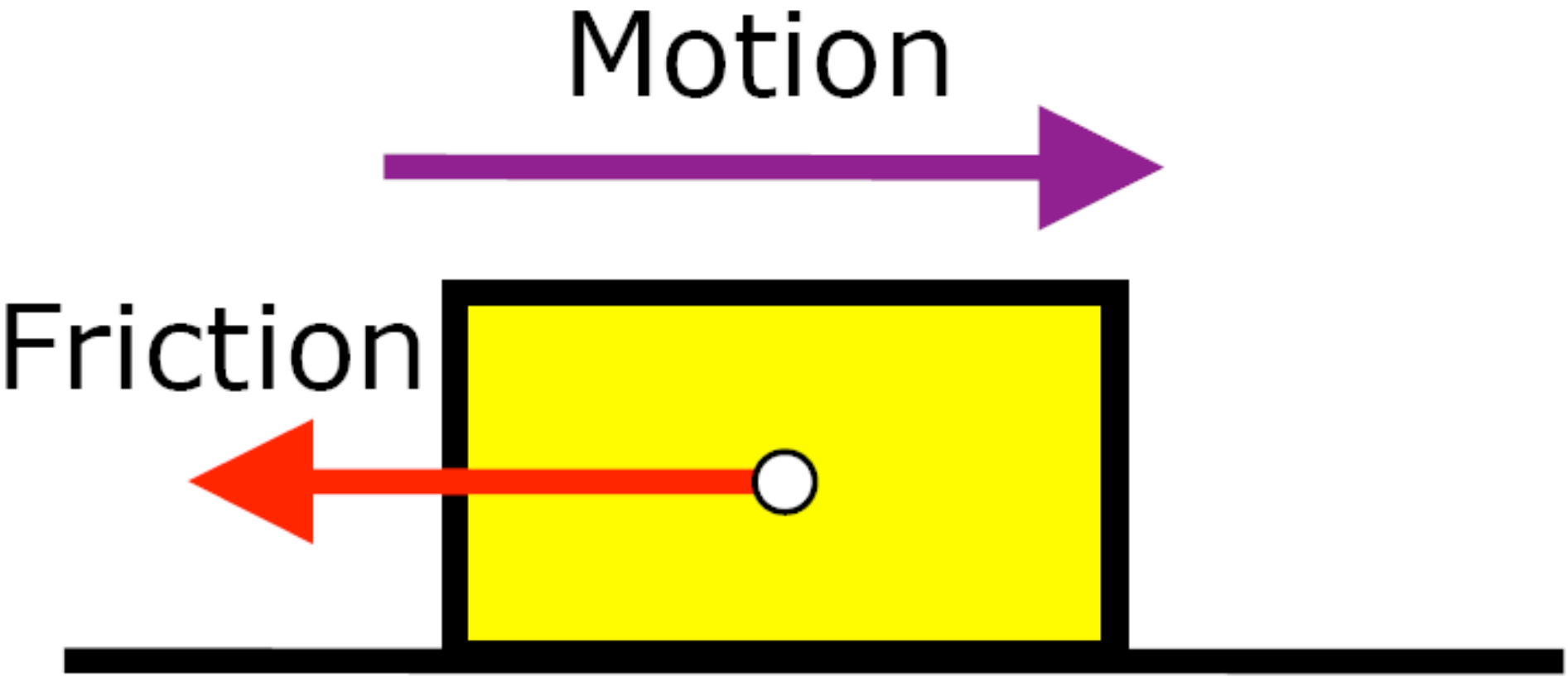


*Edwards, P. N., Mayernik, M. S., Batcheller, A. L., Bowker, G. C., & Borgman, C. L. (2011). Science Friction: Data, Metadata, and Collaboration. *Social Studies of Science*, *41*, 667–690. doi:10.1177/0306312711413314

http://www.stmary.ws/highschool/physics/home/notes/dynamics/friction/imgE2.gif

Data are unruly objects*

- Poorly bounded
- Malleable, mutable, mobile (Latour)
- Dynamic, evolving
- Signal to noise varies by use

*Wynholds, L. A. (2011). Linking to Scientific Data: Identity Problems of Unruly and Poorly Bounded Digital Objects. International Journal of Digital Curation, 6(1), DOI: 10.2218/ijdc.v6i1.183

www.zazzle.com

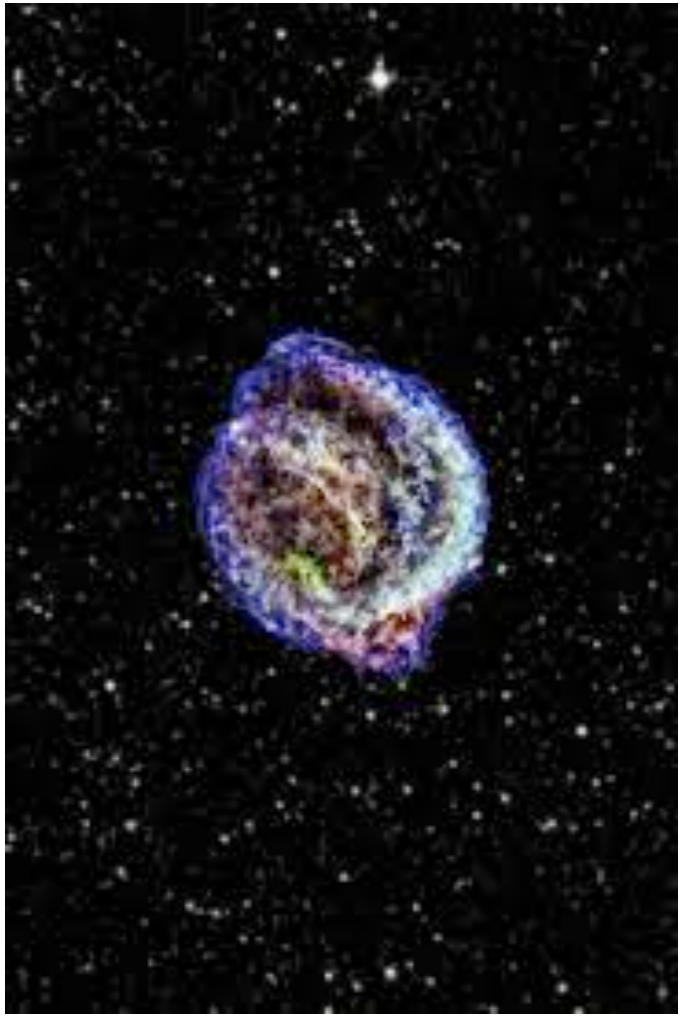
Data do not stand alone

- Data are inseparable
  - Code
  - Technical standards
  - Documentation
  - Instrumentation
  - Calibration
  - Provenance
  - Workflows
  - Local practices
  - Physical samples

http://peacetour.org/sites/default/files/code4peace-logo2-v3-color-sm.jpg

Data reuse is a function of distance from origin

- Reuse by investigator
- Reuse by collaborators
- Reuse by colleagues
- Reuse by unaffiliated others
- Reuse at later times
  - Months
  - Years
  - Decades
  - Centuries



http://chandra.harvard.edu/photo/2013/kepler/kepler_525.jpg

Intractable problems

- Confidentiality
- Anonymization
- Reidentification
- Intellectual property
- Economics

http://fyi.uiowa.edu/wp-content/uploads/2011/10/utopia_in_four_movements_filmstill5_utopiasign.jpg

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http://www.tzanis.org/tzanisblog/archives/images/push-pull-thumb.jpg

How to share data

- Make data publicly available
  - Curated data archive: NASA, UKDA, ICPSR…
  - Author curated data archive
  - University repository
  - Personal website
  - ftp site
- Release upon request*

*Wallis, J. C., Rolando, E., & Borgman, C. L. (2013). If We Share Data, Will Anyone Use Them? Data Sharing and Reuse in the Long Tail of Science and Technology. *PLoS ONE*, *8*(7), e67332. doi:10.1371/journal.pone.0067332

http://www.zippykidstore.com/

10 Simple Rules for the Care and Feeding of Scientific Data*

1. Love your data, and let others love it too.
2. Share your data online, with a permanent identifier.
3. Conduct science with data reuse in mind.
4. Publish workflow as context
5. Link your data to your publications as early as possible.
6. Publish your code (even the small bits).
7. Say how you want to get credit for your data (and software).
8. Foster and use data repositories.
9. Reward colleagues who share their data properly.
10. Help establish "Data Science" and "Data Scientists" as vital.

**Goodman, A.; Pepe, A.; Blocker, A.; Borgman, C.L., et al, (in review), PLOS Computational Biology*

Conclusions

- Data sharing is a paradigm shift
  - Conducting research with reuse in mind
  - Managing data for reuse
- Data are not journal articles
- Data do not stand alone
- Data friction is part of scholarship
- Data reuse depends on
  - Context of research
  - Conditions of sharing
  - Conditions of reuse

http://www.tzanis.org/tzanisblog/archives/images/push-pull-thumb.jpg

Data Citation and Attribution

For Attribution—
Developing Data Attribution and Citation Practices and Standards

Summary of an International Workshop

Uhlir, P. F. (Ed.). (2012). *For Attribution -- Developing Data Attribution and Citation Practices and Standards: Summary of an International Workshop*. Washington, D.C.: The National Academies Press. Retrieved from http://www.nap.edu/catalog.php?record_id=13564

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

OUT OF CITE, OUT OF MIND:

THE CURRENT STATE OF PRACTICE, POLICY, AND TECHNOLOGY FOR THE CITATION OF DATA

CODATA-ICSTI Task Group on Data Citation Standards and Practices

Edited by Yvonne M. Socha

Data Science Journal, Volume 12,
13 September 2013

Acknowledgements

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  - *CENS*: Cooperative Agreement #CCR-0120778, D.L. Estrin, UCLA, PI.
  - *CENS Education Infrastructure*: #ESI- 0352572, W.A. Sandoval, PI; C.L. Borgman, co-PI.
  - *Towards a Virtual Organization for Data Cyberinfrastructure*, #OCI-0750529, C.L. Borgman, UCLA, PI; G. Bowker, Santa Clara University, Co-PI; T. Finholt, University of Michigan, Co-PI.
  - *Monitoring, Modeling & Memory: Dynamics of Data and Knowledge in Scientific Cyberinfrastructures*: #0827322, P.N. Edwards, UM, PI; Co-PIs C.L. Borgman, UCLA; G. Bowker, SCU; T. Finholt, UM; S. Jackson, UM; D. Ribes, Georgetown; S.L. Star, SCU)
  - *Data Conservancy*: OCI0830976, Sayeed Choudhury, PI, Johns Hopkins University.
  - Knowledge and Data Transfer: the Formation of a New Workforce. # 1145888. C.L. Borgman, PI; S. Traweek, Co-PI.
- Microsoft External Research: Tony Hey, Lee Dirks, Catherine van Ingen, Catherine Marshall
- Sloan Foundation: The Transformation of Knowledge, Culture, and Practice in Data-Driven Science: A Knowledge Infrastructures Perspective. # 20113194. C.L. Borgman, PI; S. Traweek, Co-PI. Joshua Greenberg, program director
- Project website: http://knowledgeinfrastructures.gseis.ucla.edu/index.html
- University of Oxford: Balliol College, Oxford Internet Institute, Oxford eResearch Centre

Big Data

Little Data

No Data

No Data is the Norm

Science friction, data friction*

- Data are unruly objects
- Data do not stand alone
- Data reuse varies by distance from origin
- Intractable problems

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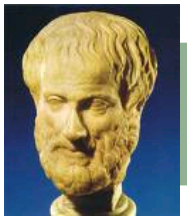
New problem solving methods

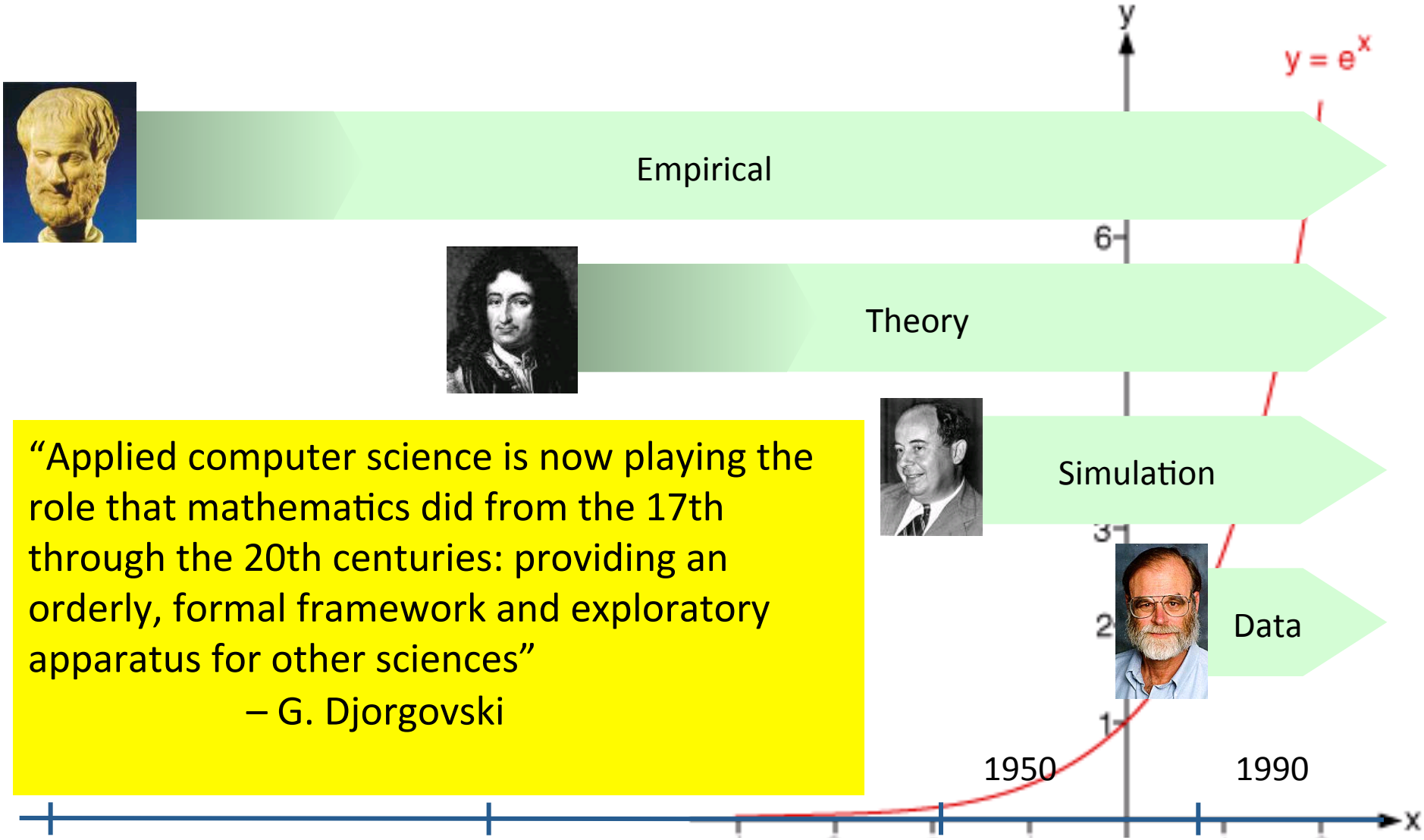


Empirical

Theory

Simulation

Data

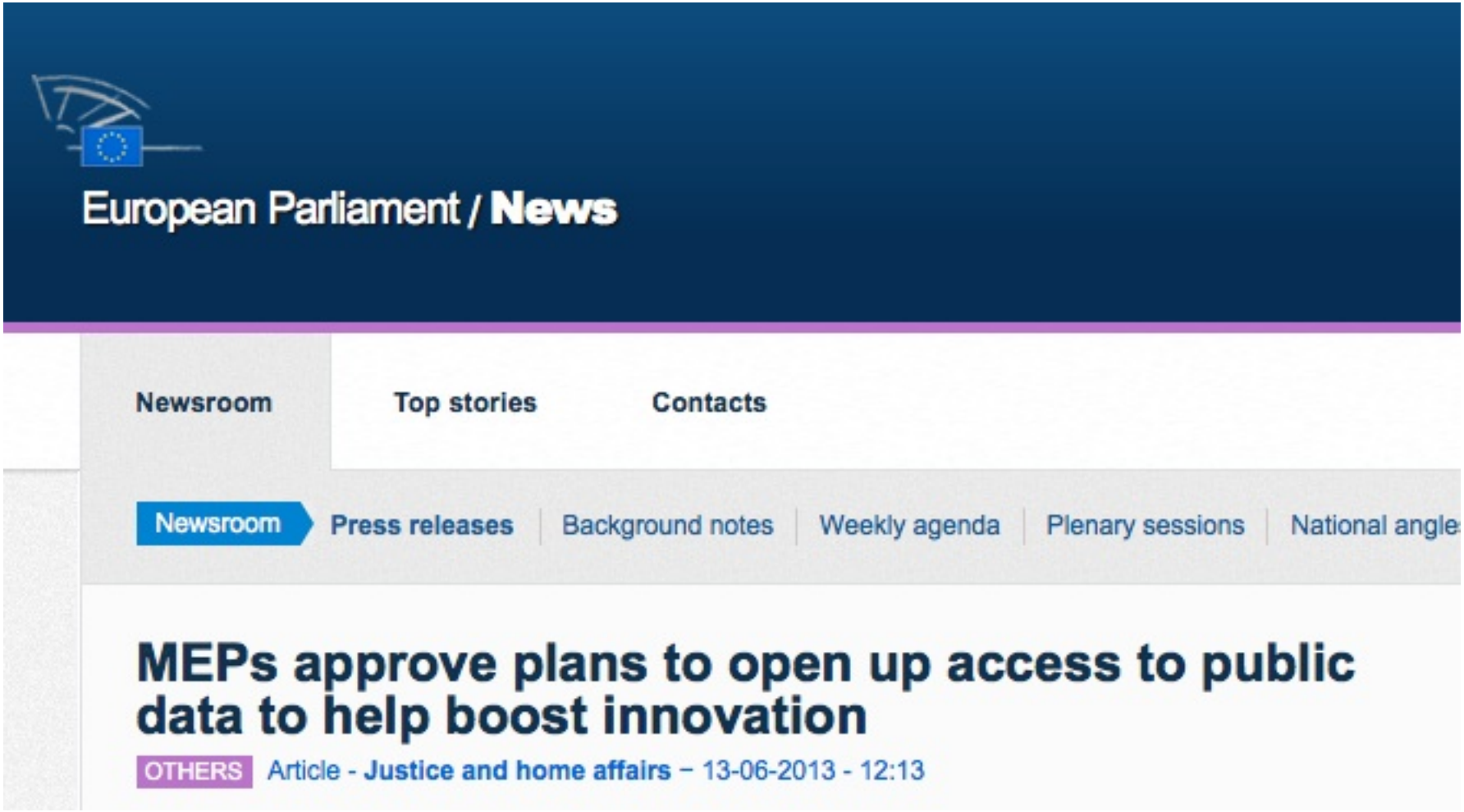


"Applied computer science is now playing the role that mathematics did from the 17th through the 20th centuries: providing an orderly, formal framework and exploratory apparatus for other sciences"

– G. Djorgovski

Slide courtesy Ian Foster, 2009

4. To advance research and innovation



13 June 2013