



Advanced Systems Architecture

Final Report – 11 May 2006

Team: Joao Castro, Nirav Shah, Robb Wirthlin
Faculty supervisor: Chris Magee

ESD.342

Defining the problem

- **Hypothesis:** Systems that are structured or centrally designed are **different** than those that are unstructured or emerge in an evolutionary fashion
- **Approach:** Observe transportation networks and knowledge networks with network analysis tools for comparison between types of systems



**Mark Avnet
Slide**

Centralized

Decentralized

Knowledge

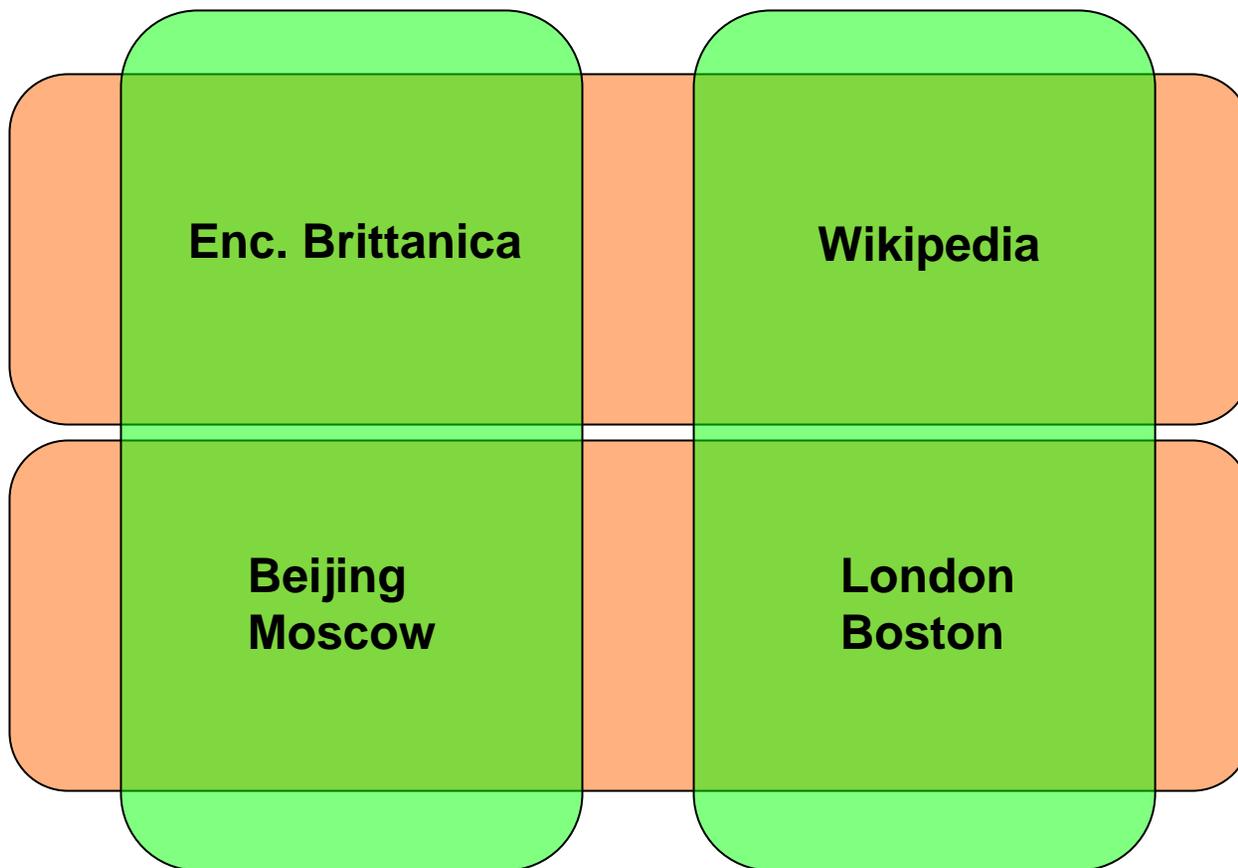
Enc. Brittanica

Wikipedia

Transportation

**Beijing
Moscow**

**London
Boston**



Bottom-line

Structured vs. Unstructured Planned vs. Evolved

- Information Networks are different:
 - Different path lengths
 - Different depth of information
 - Evolving to a common structure(?)
- Transportation Networks:
 - No common structure among each class
 - Without constraints migrates to common structure(?)

Outline

- Organization structure
- Product
- Analysis & Conclusions

Organizations

	Wikipedia	Encyclopedia Britannica	Online E. B.
Date Established	2001	1768	1994
Staff	1 ruling body 1 tech support body >1 million editors	1 mgmt body 1 scientific body 4000 editors	
Funding	Donation	For-profit	
Accessibility	Free	Purchase	Range of access: Free limited use up to full-access memberships
Peer Review	Little; becoming more frequent	Yes	

	Subways
Owner	Public authorities
Staff	Private/semi-private operations
Funding	Public service (non-profit)

Outline

- Organization structure
- **Product**
- Analysis & Conclusions

Wikipedia (product)

- Top 10 Editions user space

Edition	# Edits [1]	# Articles [1]	# Users [1]	# Admins [1]	% Visitors [2]	Internet users [4]	Lang. Ranking [3]
1- en	45587927	1026855	1091498	496	65	285.0M	4
2- de	14419657	358441	188709	155	10	53.3M	11
3- fr	6028079	245437	77197	55	3	26.2M	18
4- pl	2711067	217146	35504	48	2	10.6M	24
5- ja		192000			6	86.3M	9
6- sv	1750535	141060	12068	61	<1	6.8M	68
7- it	2384853	140725	45873	28	1	28.8M	21
8- nl	3351953	137797	28781	52	1	10.8M	40
9- pt	1639353	118589	48028	31	1	32.0M	6
10- es	2721590	96349	102130	40	3	45.2M	3

[1] - download.wikipedia.org

[2] - alexa.com

[3] - wikipedia

[4] - internetworldsats.com

Wikipedia (product)

- Wikipedia

Language edition	Date	Articles	Page table	Pagelinks table	Revision table	Text table
English	2006-03-03	1002326	255 MB	1.5 GB	-	-
Portuguese	2006-03-01	118589	20 MB	114 MB	-	-
Simple English	2006-03-02	7633	1.3 MB	8.5 MB	6.74 MB	224 MB

Source: download.wikipedia.org

- Full English edition is very big
 - Decompressed pages, text and revision are > 450GB !!

Encyclopaedia Britannica (product)

- **15 Editions**

- **1st Edition (1768-1771):**

- consolidation of important subjects into lengthy, comprehensive treatises
- inclusion of many shorter, dictionary-type articles on technical terms and other subjects.

- **2nd Edition (1777-1784):**

- inclusion of biographical articles and the expansion of geographic articles to include history.

- **Supplement to the 4th, 5th, & 6th Editions (1815-1824):**

- almost all the articles were original signed contributions.

- **7th Edition (1830-1842):**

- innovation of a general index

- **9th Edition (1875-1889):**

- US ownership

- **11th Edition (1910-11):**

- splitting up of the traditional lengthy, comprehensive treatises into somewhat more particularized articles. (as a result the 11th edition had 40,000 articles—more than double the 9th edition's 17,000—although its total amount of text was not much greater)

Ref:

" Encyclopædia Britannica ." Encyclopædia Britannica. 2006. Encyclopædia Britannica Online. 9 May 2006 <<http://www.search.eb.com/eb/article-2111>>.

Encyclopaedia Britannica (product)

- **15 Editions**

- **14th Edition (1929):**

- Space was found for new articles by cutting down the style and detail of the 11th edition, from which a great deal of material was carried over in shortened form.
- More than 3,500 authors of all nationalities contributed articles.
- Also the 14th Edition initiated an important change in editorial method—continuous revision. the encyclopaedia was revised and reprinted annually.
- Also begun in 1938 was the volume called Britannica Book of the Year, which covered developments of the year preceding publication.

- **15th Edition (1974):**

- new set consisted of 28 volumes in three parts serving different functions: the Micropædia (Ready Reference), Macropædia (Knowledge in Depth), and Propædia (Outline of Knowledge).
- A major revision of the 15th edition in 1985. The Macropædia was greatly restructured, plus a separate two-volume Index; and both the Micropædia and the Propædia were redesigned, reorganized, and revised. The entire set consisted of 32 volumes.
- The company began a massive revision of the encyclopaedia database in 1999.

- **1994 Britannica Online**

- **1999 Britannica.com launched**

Ref:

" Encyclopædia Britannica ." Encyclopædia Britannica. 2006. Encyclopædia Britannica Online. 9 May 2006 <<http://www.search.eb.com/eb/article-2111>>.

Subway Systems (product)

	Year Started	Number of Stations	km of track	Planned vs. Evolved
London	1863	275	415	Evolved
Beijing	1965	138	197.7	Planned
Boston	1897	120	101.5	Evolved
Berlin	1902	170	144.2	Evolved
Moscow	1935	171	278.3	Planned
Tokyo	1927	240	290	Planned

London Underground

Image removed for copyright reasons.

1921 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube21.jpg>

Image removed for copyright reasons.

1938 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube38.jpg>

Image removed for copyright reasons.

1933 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube33.gif>

1938

1933

1921

Image removed for copyright reasons.

1948 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube48.jpg>

1948

Image removed for copyright reasons.

1968 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube68.jpg>

1968

Image removed for copyright reasons.

1977 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube77.jpg>

1977

Image removed for copyright reasons.

1987 map of London subway.

<http://www.clarksbury.com/cdl/maps/tube87.jpg>

1987

Outline

- Organization structure
- Product
- Analysis & Conclusions

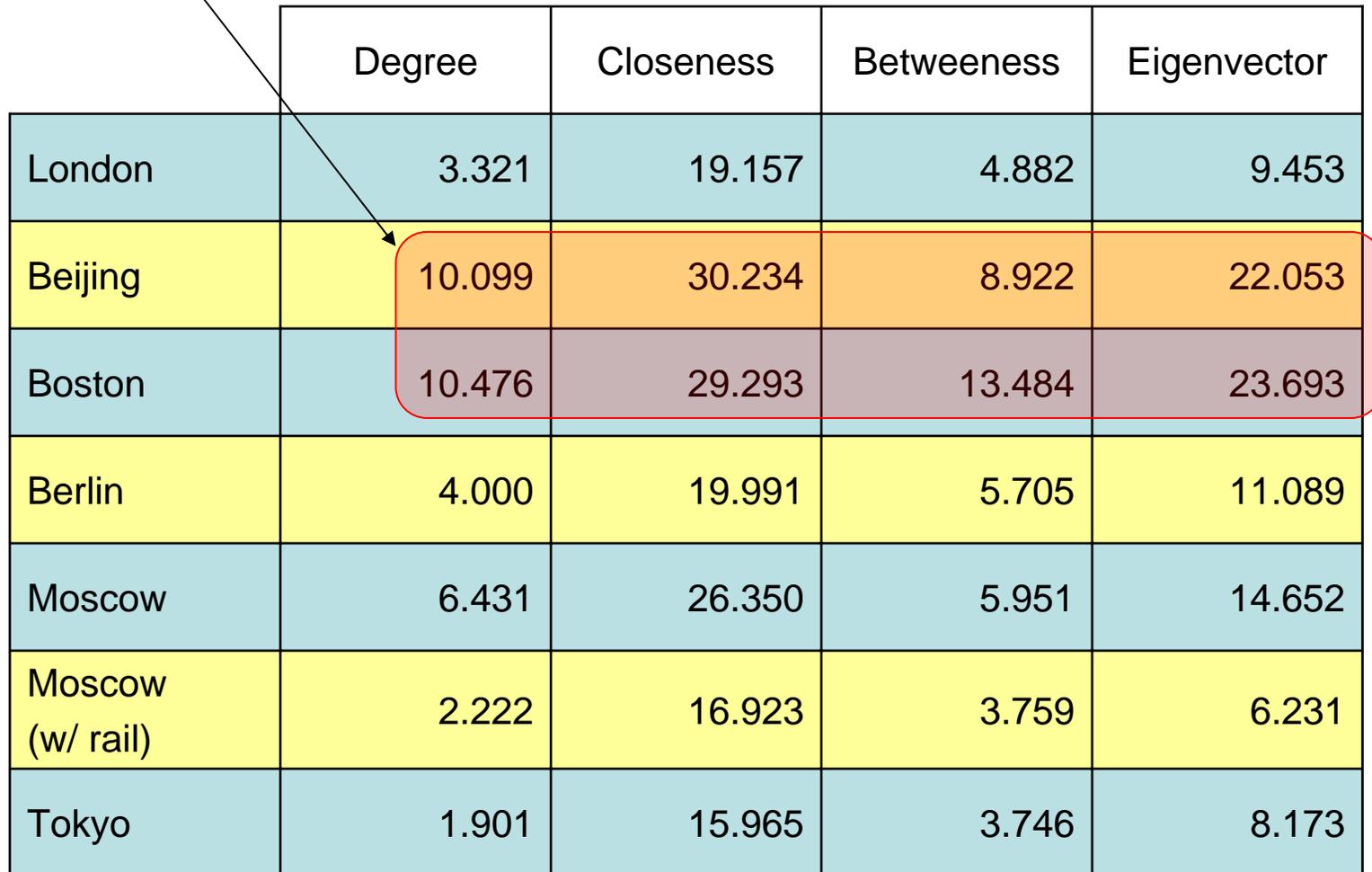
Subway Metrics

Small-worlds ???

	n	m	$\langle k \rangle$	C1	C2	l	r
London	92	139	3.02	0.222	0.1595	5.394	0.0997
Beijing	29	82	2.83	0.237	0.0667	3.409	-0.1053
Boston	21	44	2.09	0.074	0.0317	3.562	-.3011
Berlin	75	222	2.96	0.117	0.0812	5.164	0.0957
Moscow	51	164	3.21	0.106	0.0791	3.916	0.1846
Moscow (w/ rail)	136	408	3.00	0.080	0.0591	6.037	0.2601
Tokyo	147	204	2.77	0.078	0.0522	6.432	-0.0911

Subway measures for Centrality

One planned, one evolved
both have high centrality???

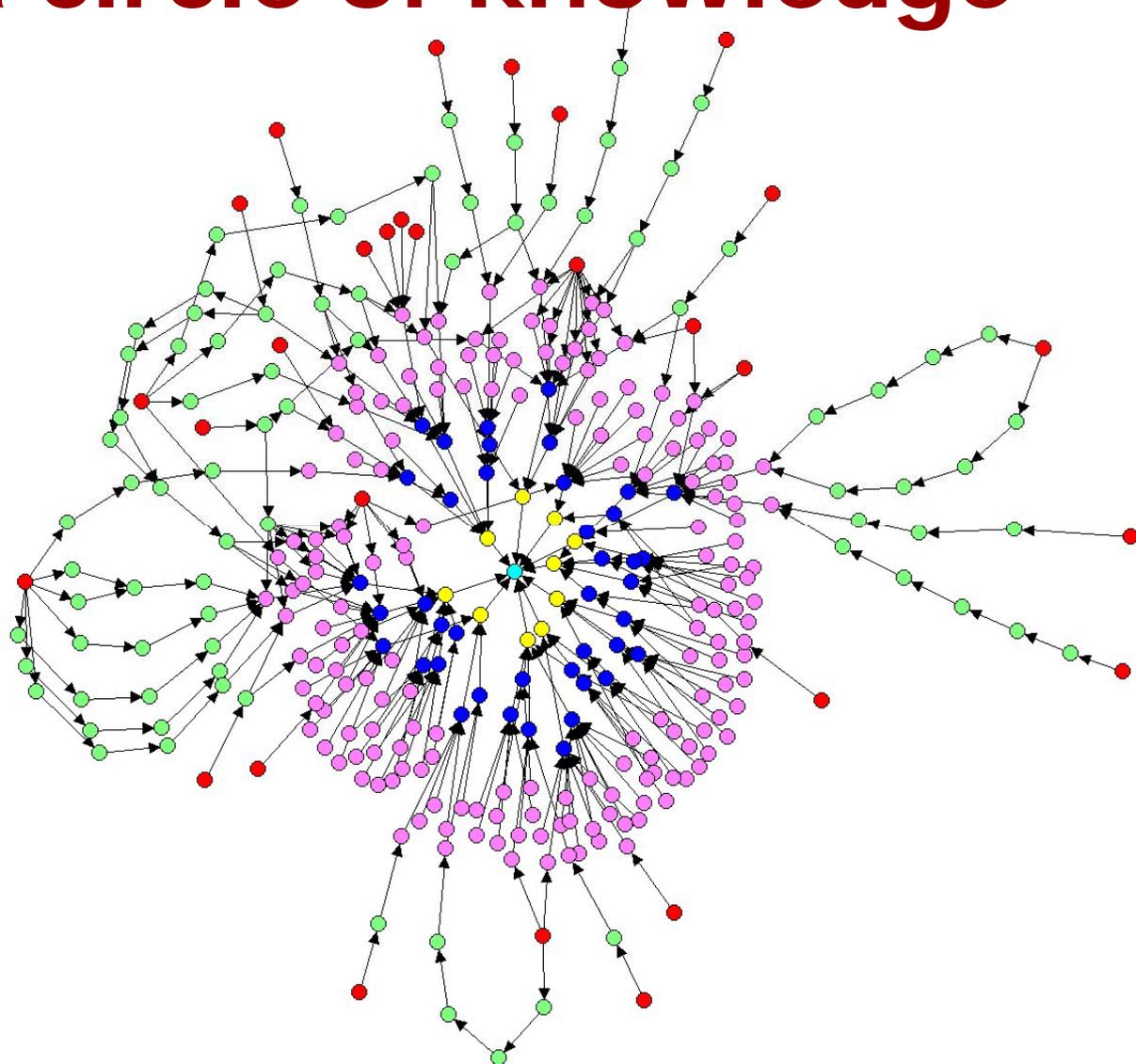


	Degree	Closeness	Betweenness	Eigenvector
London	3.321	19.157	4.882	9.453
Beijing	10.099	30.234	8.922	22.053
Boston	10.476	29.293	13.484	23.693
Berlin	4.000	19.991	5.705	11.089
Moscow	6.431	26.350	5.951	14.652
Moscow (w/ rail)	2.222	16.923	3.759	6.231
Tokyo	1.901	15.965	3.746	8.173

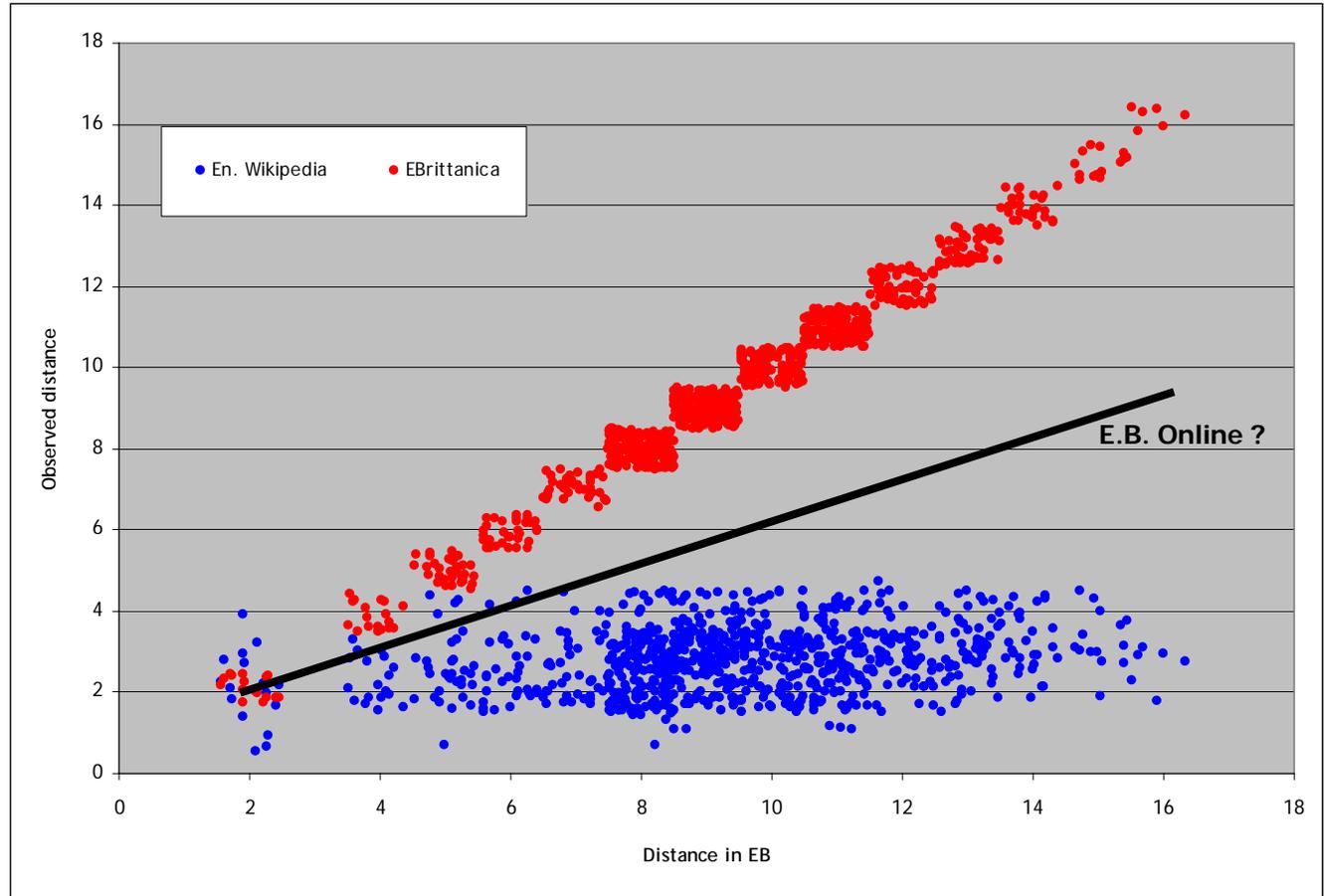
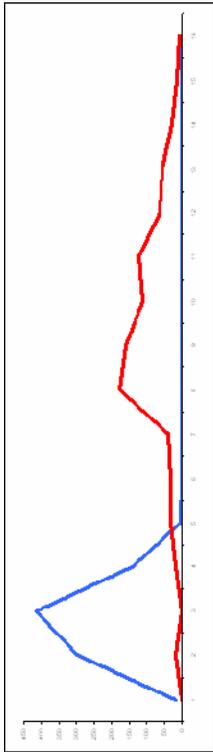
Britannica circle of knowledge

Terms:

Adenomyosis
Algebra
Aluminium
Baseball
Basketball
Beekeeping
Brigadier
Cellular_automaton
Christmas
Colonization_of_Africa
Color_photography
Criminology
Design
DNA
Elisabeth_of_Bavaria
Entrepreneur
Francisco_Franco
Golf
Hans_Christian_Andersen
History_of_Manchester
Ice_cream
India
Industrial_Revolution
James_Chaney
Locomotive
Massari
Meditation
Moscow
Nobel_Peace_Prize
Paris
Politics
Population
Radio
Stradivarius
World_war_II



Path length compared



Average Path Length

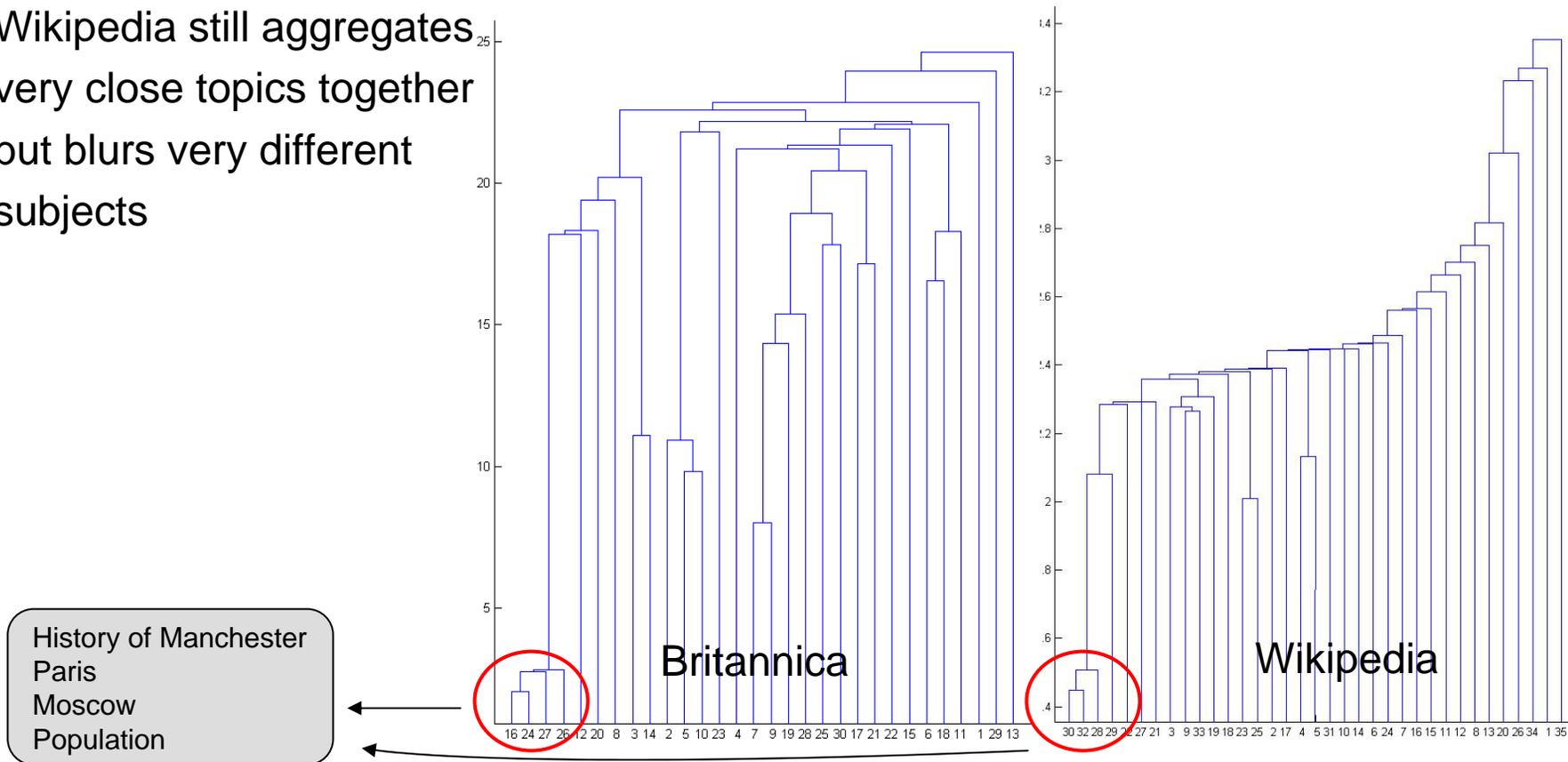
Wikipedia: 2.8

Britannica: 9.4

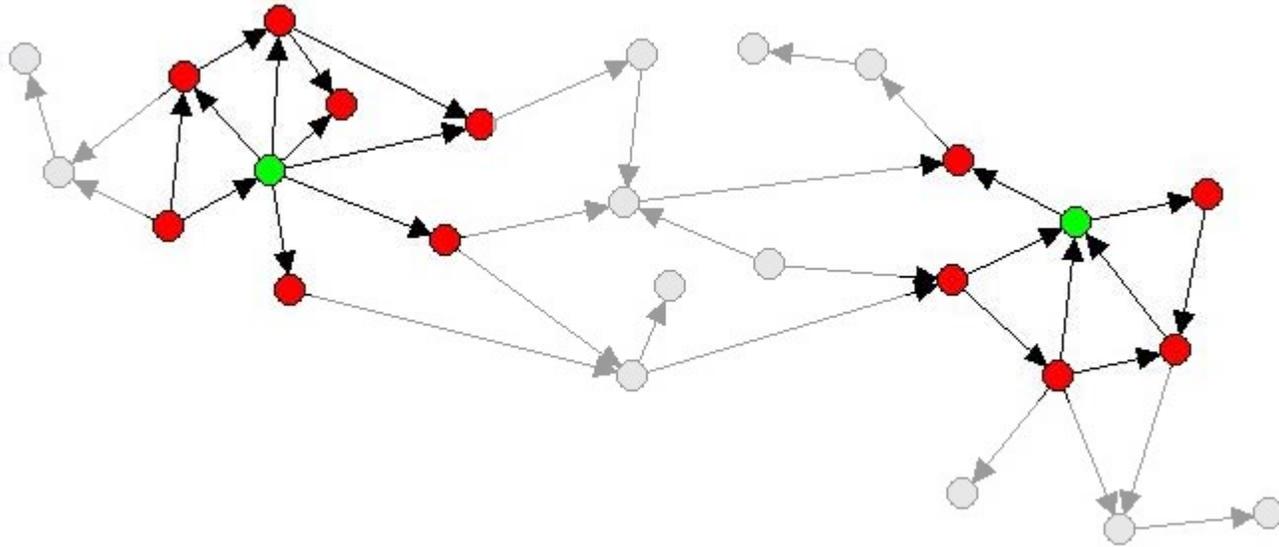
Impact of hierarchy

This illustrates the difference that a hierarchy makes

- Hierarchy pushes unrelated topics away
- Wikipedia still aggregates very close topics together but blurs very different subjects



Example of horizons

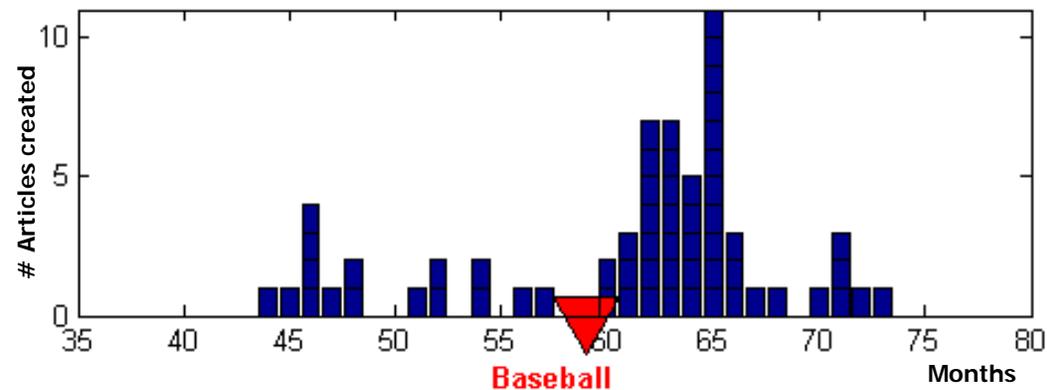
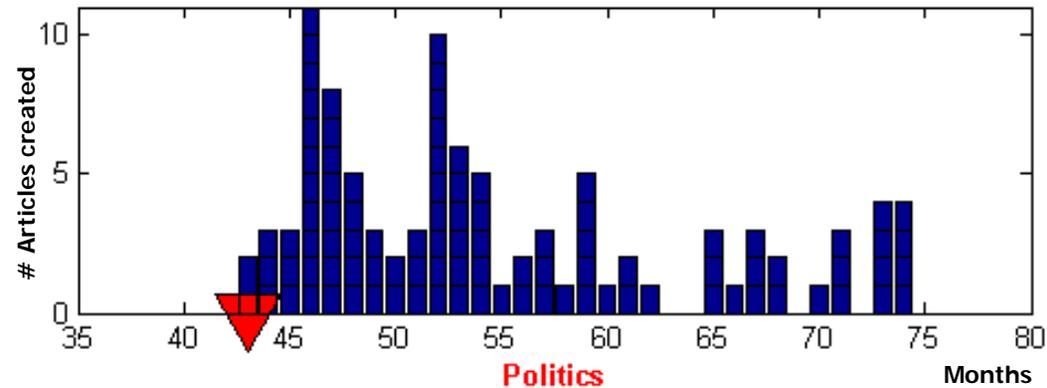


Visualizing growth in wikipedia

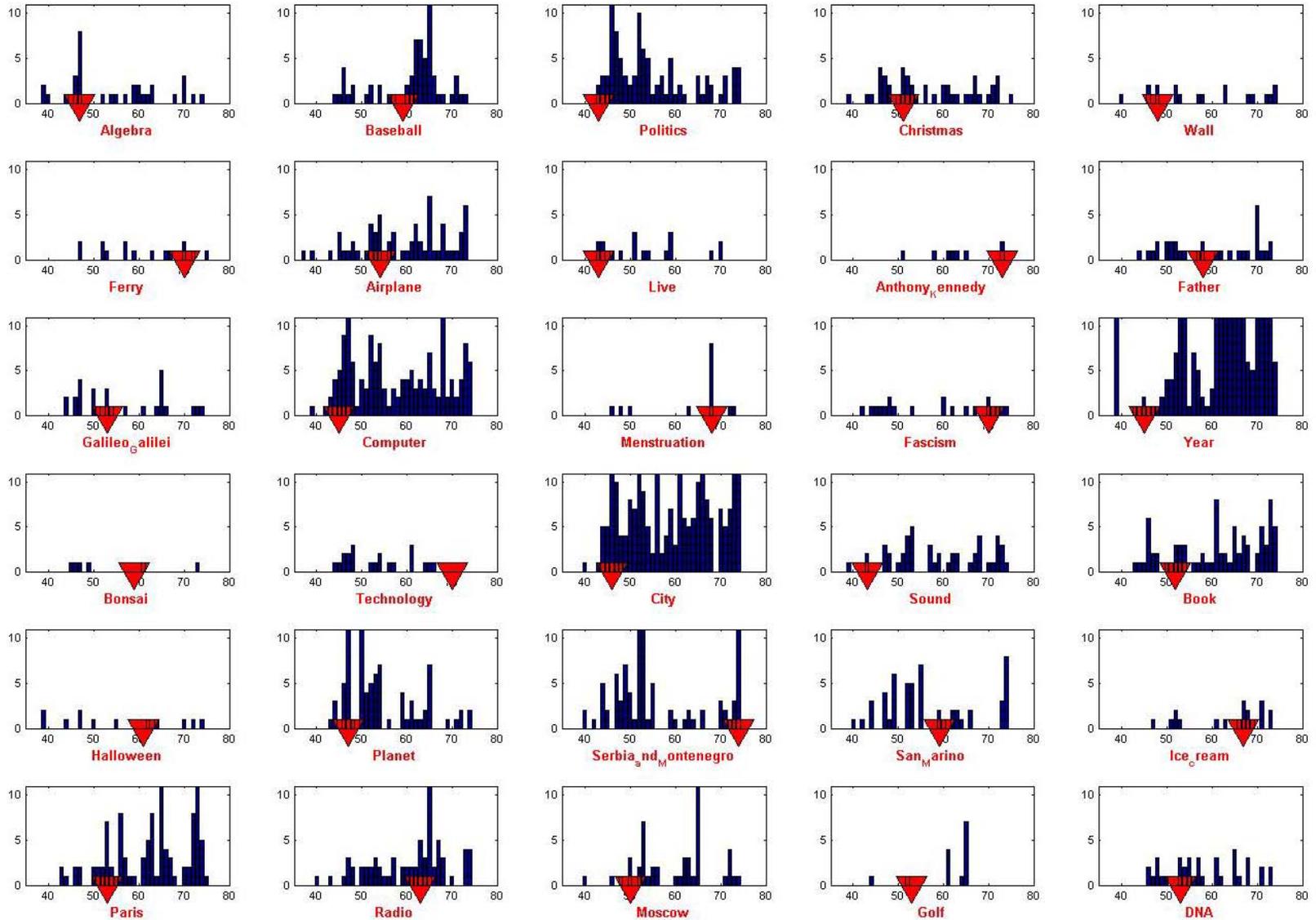
“Historygrams”

Requires rich data set. Only wikipedia had it.

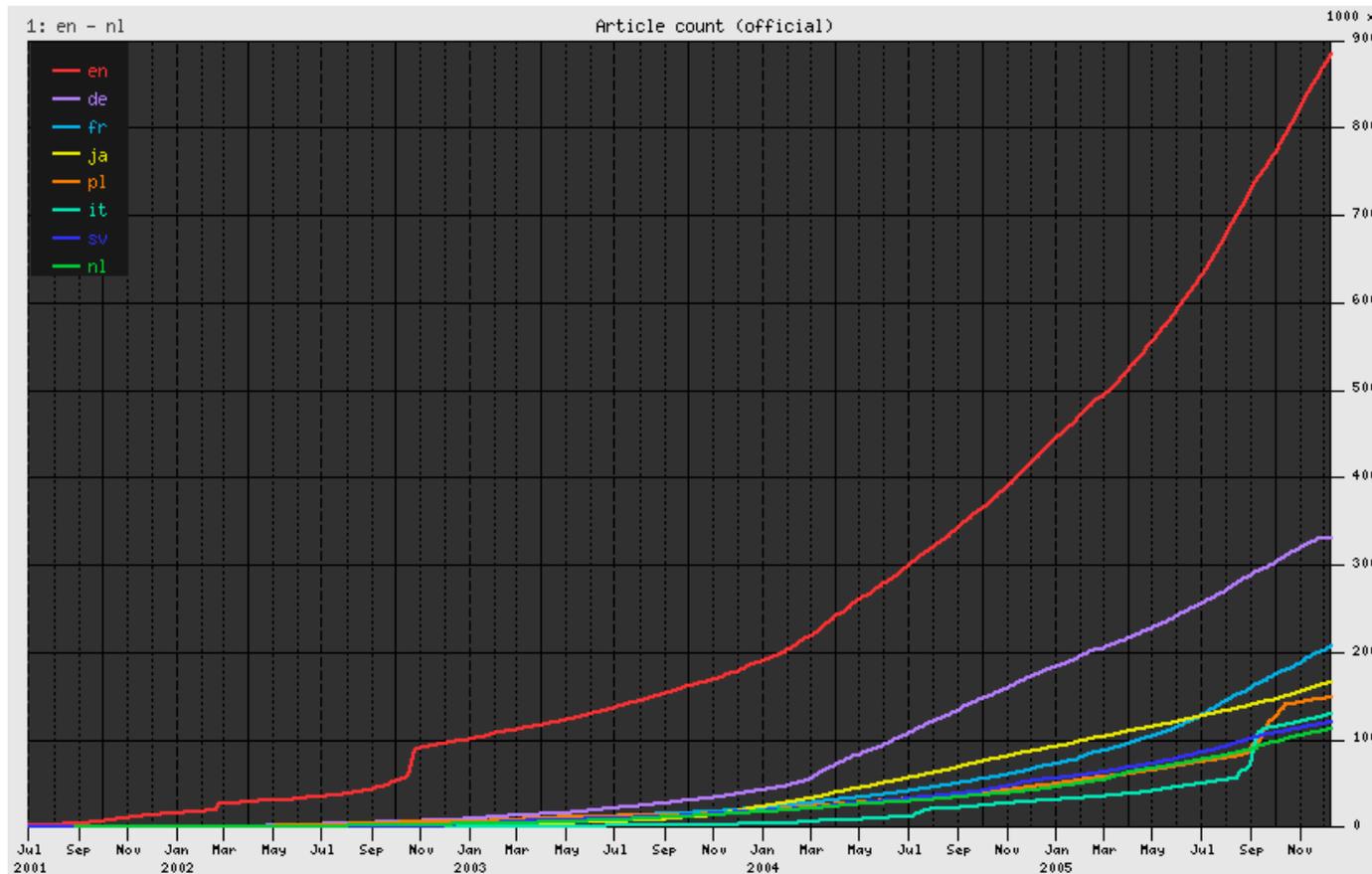
80% (1584 of 1973) of the horizon articles were created after the original article



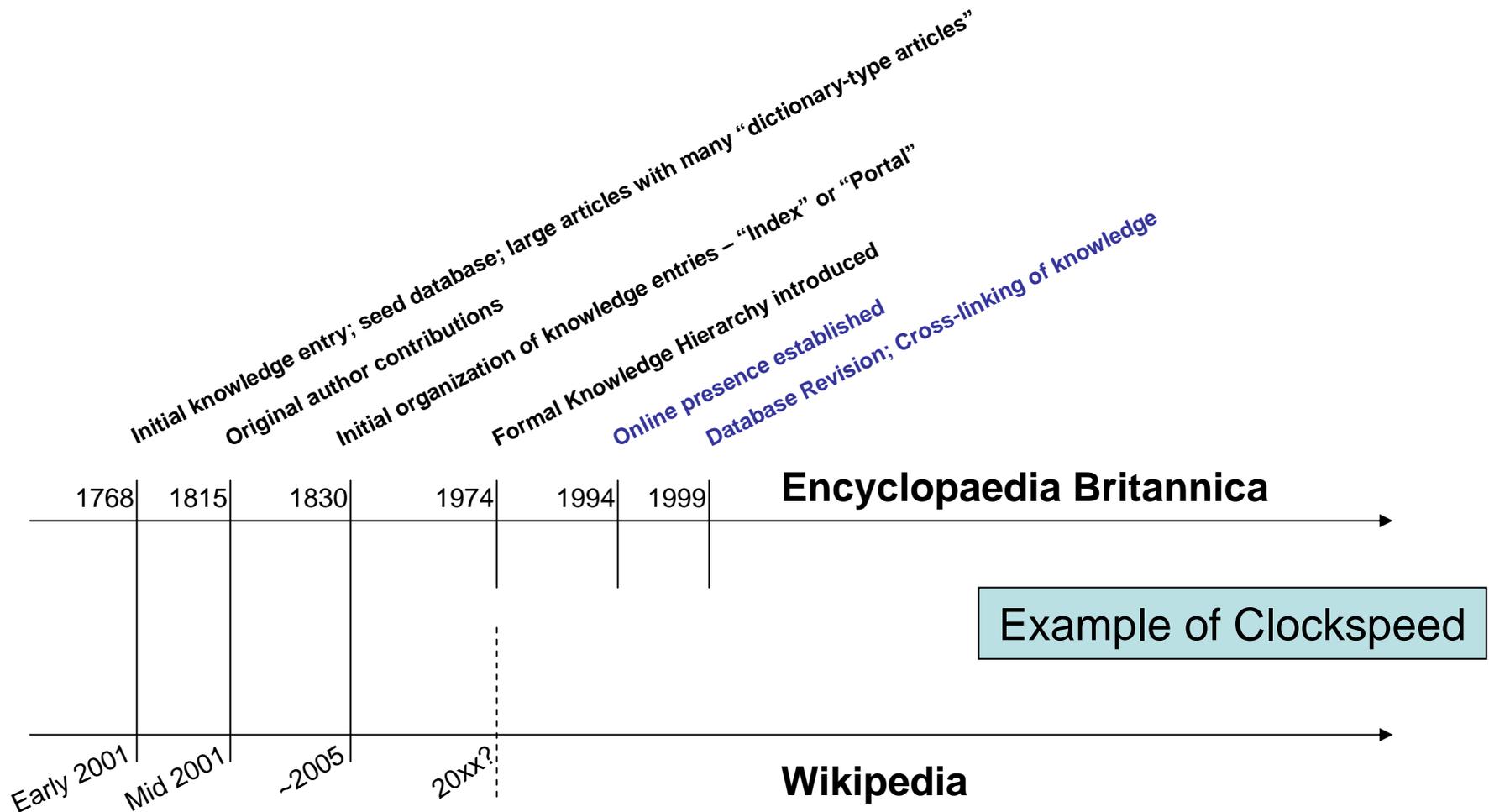
Historygrams



Visualizing growth in wikipedia



Timeline of Knowledge Events

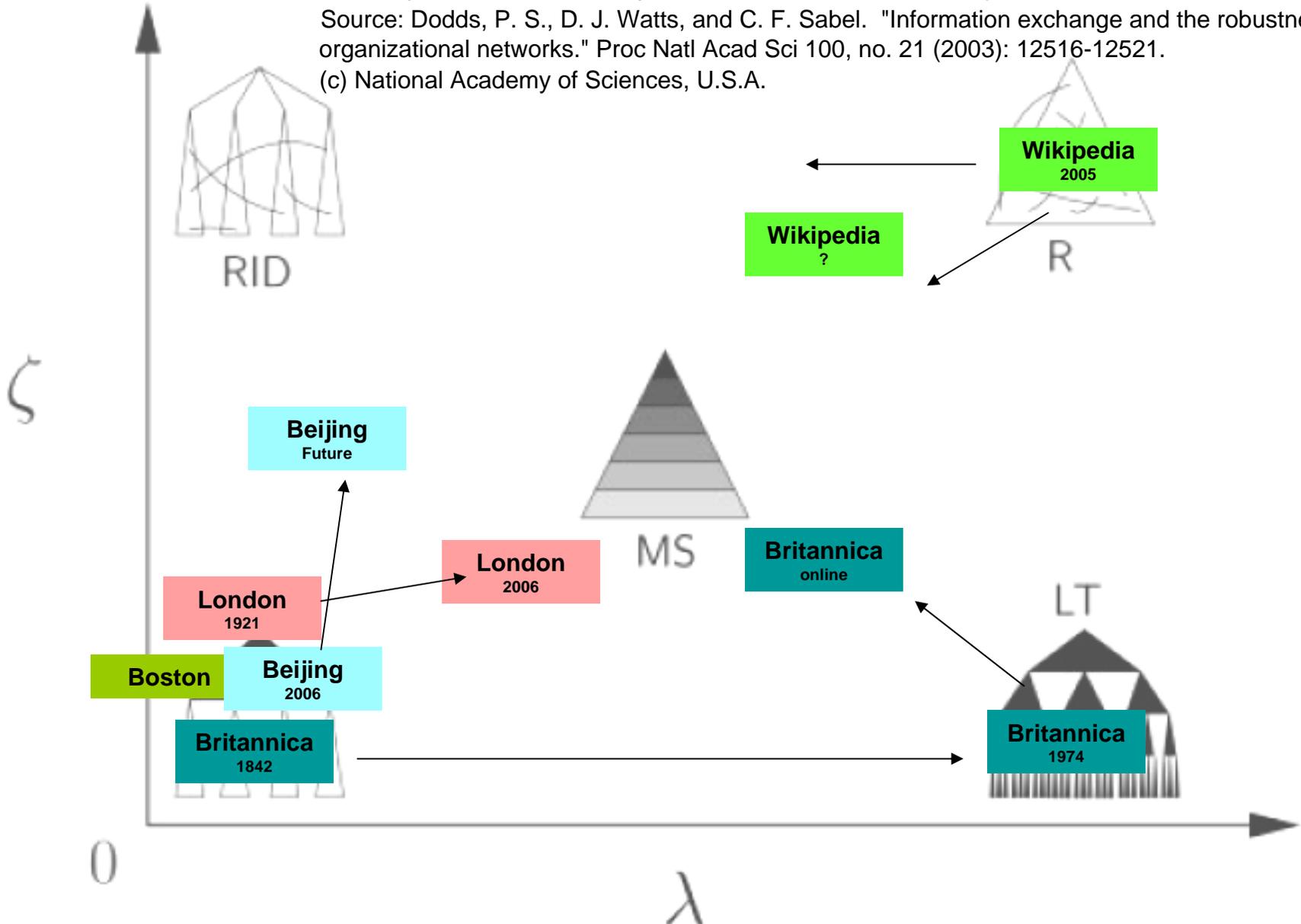


Systems placed in DWS graph

Courtesy of National Academy of Sciences, U.S.A. Used with permission.

Source: Dodds, P. S., D. J. Watts, and C. F. Sabel. "Information exchange and the robustness of organizational networks." Proc Natl Acad Sci 100, no. 21 (2003): 12516-12521.

(c) National Academy of Sciences, U.S.A.



Learning Summary

- There are no obvious visible differences to the End User
 - Knowledge is accessible; transportation between nodes happens
- As expected, a tree structure produces longer paths between articles than one without
 - Online repositories of knowledge mitigate any differences in structure (due to technology).
 - Transportation Systems are subject to long-term constraints such as legacy and geography that make changes slow.
- Convergence to a common structure(??)
 - We believe our initial hypothesis may be challenged as systems evolve to a “multi-scale like” state

Deliverable/We will provide

- Wikipedia
 - How to build a local testbed and integrate with Matlab
- E.Britannica
 - Circle of Knowledge dataset & graph
- Source code
 - Wikipedia Horizon networks (matlab)
 - Wikipedia Historygram (matlab)
 - Wikipedia Distance (python + “6 degrees of wikipedia”)

References

- General
 - “Information Exchange and the robustness of organizational networks”, Dodds, Watts, Sabel, 2003
- Encyclopedias
 - Giles, J., *Internet encyclopaedias go head to head*. NATURE, 2005. Vol 438(15 December 2005): p. 990-901.
- Wikipedia
 - Wikipedia (www.wikipedia.org)
 - Six degrees of wikipedia (tools.wikimedia.de/sixdeg)
 - Larry Sanger. 2005. The Early History of Nupedia and Wikipedia: A Memoir. In *Open Source 2.0*. O'Reilly Media ISBN 0596008023
 - Jakob Voss. Measuring Wikipedia. *10th International Conference of the International Society for Scientometrics and Informetrics 2005*. Stockholm: International Society for Scientometrics and Informetrics. (24th—28th Jul 2005). 221–231.
- Britannica
 - Foreword and Editor's preface to the 1978, 15th edition of Encyclopaedia Britannica
 - E.Britannica Print 15th ed, 1994
 - E.Britannica Online (www.britannica.com)
- Subways
 - Dan Whitney archive
 - Kato, Shinichi, Development of Large Cities and Progress in Railway Transportation, Japanese Railway & Transport Review No. 8 (pp. 44-48)
 - Bodrick, Benson, Labyrinths of Iron: A History of the World's Subways, Newsweek Books, August 1981
 - London Tube Maps (www.clarksbury.com/cdl/maps.html)
 - UrbanRail (www.urbanrail.net)