What is data?

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Definition of data

> “Data are values of qualitative or quantitative variables, belonging to a set of items.”

http://en.wikipedia.org/wiki/Data

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Set of items: Sometimes called the population; the set of objects you are interested in

Definition of data

> "Data are values of qualitative or quantitative variables, belonging to a set of items."

http://en.wikipedia.org/wiki/Data

Variables: A measurement or characteristic of an item.

Definition of data

> "Data are values of qualitative or quantitative variables, belonging to a set of items."

http://en.wikipedia.org/wiki/Data

Qualitative: Country of origin, sex, treatment

Quantitative: Height, weight, blood pressure

Raw versus processed data

Raw data

- The original source of the data
- Often hard to use for data analyses
- Data analysis *includes* processing
- Raw data may only need to be processed once

http://en.wikipedia.org/wiki/Raw_data

Processed data

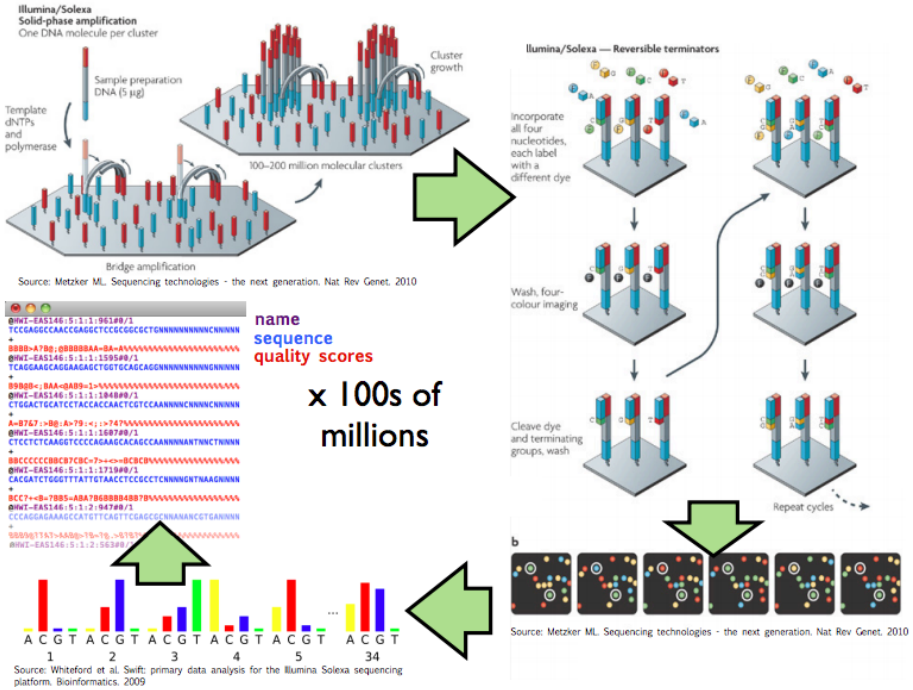
- Data that is ready for analysis
- Processing can include merging, subsetting, transforming, etc.
- There may be standards for processing
- All steps should be recorded

http://en.wikipedia.org/wiki/Computer_data_processing

An example of a processing pipeline

http://www.illumina.com.cn/support/sequencing/sequencing_instruments/hiseq_1000.asp

An example of a processing pipeline



http://www.cbcb.umd.edu/~hcorrada/CMSC858B/lectures/lect22_seqIntro/seqIntro.pdf

What do raw data look like?

```
@HWI-EAS121:4:100:1783:550#0/1
CGTTACGAGATCGGAAGAGCGGTTCAGCAGGAATGCCGAGACGGATCTCGTATGCGGTCTGCTGCGTGACAAGACAGGGG
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aaaaa`b_aa`aa`YaX]aZ`aZM^Z]YRa]YSG[[ZREQLHESDHNDDHNMEEDDMPENITKFLFEEDDDHEJQMEDDD
@HWI-EAS121:4:100:1783:1611#0/1
GGGTGGGCATTTCCACTCGCAGTATGGGTTGCCGCACGACAGGCAGCGGTCAGCCTGCGCTTTGGCCTGGCCTTCGGAAA
+HWI-EAS121:4:100:1783:1611#0/1
a```^\__`_```^a``a`^a_^__]a_]\]`a_______`_^^`]X]_]XTV_\]]NX_XVX]]_TTTTG[VTHPN]VFDZ
@HWI-EAS121:4:100:1783:322#0/1
CGTTTATGTTTTTGAATATGTCTTATCTTAACGGTTATATTTTAGATGTTGGTCTTATTCTAACGGTCATATATTTTCTA
+HWI-EAS121:4:100:1783:322#0/1
abaa`^aaaaabbbaabaabbbbbb`bbbb_bbbbbbbb`bbbaV^_a``a``]``aT]a__V\]]_]^a`]a_abbaV__
@HWI-EAS121:4:100:1783:1394#0/1
GGGTCTTTATTGGTCTGGTGATCCCCCATATTCTCCGGTTGTGTGGTTTAACCGATCATCGCGCATTACTTCCCGGCTGC
+HWI-EAS121:4:100:1783:1394#0/1
```[aa\b^^[]aabbb][`a_abbb`a``bbbbbabaabaaaab_VZa_^___bab_X`[a\HV_[_]_[^_X\T_VQQ
@HWI-EAS121:4:100:1783:207#0/1
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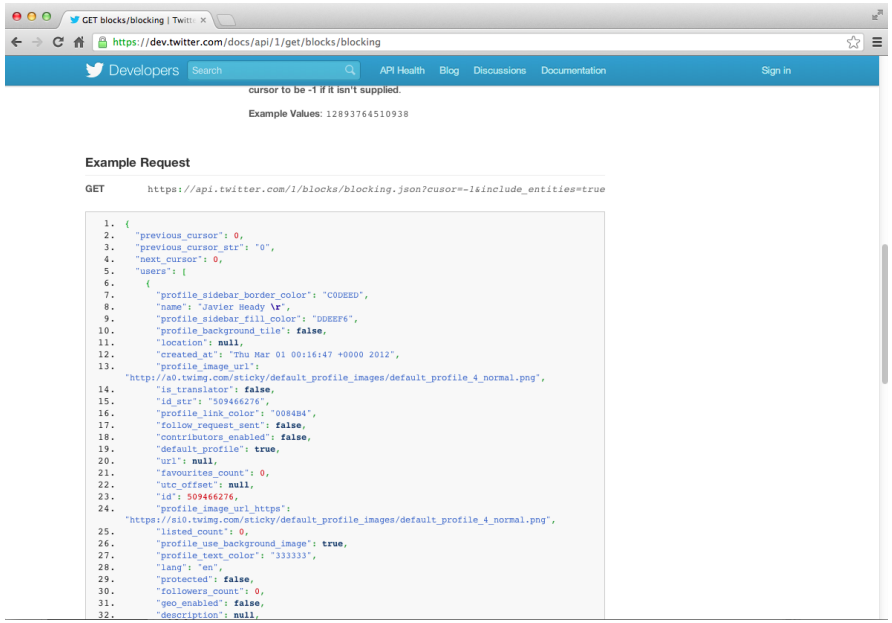
+HWI-EAS121:4:100:1783:207#0/1
abba`Xa\^\\`aa]ba__bba[a_O_a`aa`aa`a]^V]X_a^YS\R_\H_[]\ZTDUZZUSOPX]]POP\GS\WSHHD
@HWI-EAS121:4:100:1783:455#0/1
GGGTAATTCAGGGACAATGTAATGGCTGCACAAAAAAATACATCTTTCATGTTCCATTGCACCATTGACAAATACATATT
+HWI-EAS121:4:100:1783:455#0/1
abb_babbabaabbbbbbbbbbbbbbbba\`b`\abbbabbbbabbbbbbaabbbbb`bb`ab_O_bab_Q_bbabaa_a
```

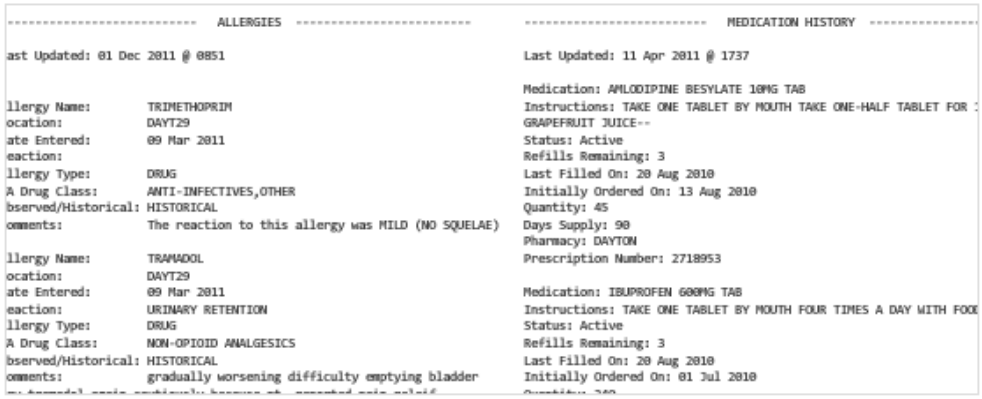
http://brianknaus.com/software/srtoolbox/s_4_1_sequence80.txt
```

What do raw data look like?



https://dev.twitter.com/docs/api/1/get/blocks/blocking

What do raw data look like?



```
------------------------  ALLERGIES  ------------------------

ast Updated: 01 Dec 2011 @ 0851


llergy Name:        TRIMETHOPRIM
ocation:            DAYT29
ate Entered:        09 Mar 2011
eaction:
llergy Type:        DRUG
A Drug Class:       ANTI-INFECTIVES,OTHER
bserved/Historical: HISTORICAL
omments:            The reaction to this allergy was MILD (NO SQUELAE)

llergy Name:        TRAMADOL
ocation:            DAYT29
ate Entered:        09 Mar 2011
eaction:            URINARY RETENTION
llergy Type:        DRUG
A Drug Class:       NON-OPIOID ANALGESICS
bserved/Historical: HISTORICAL
omments:            gradually worsening difficulty emptying bladder
```

```
------------------------  MEDICATION HISTORY  ----------------

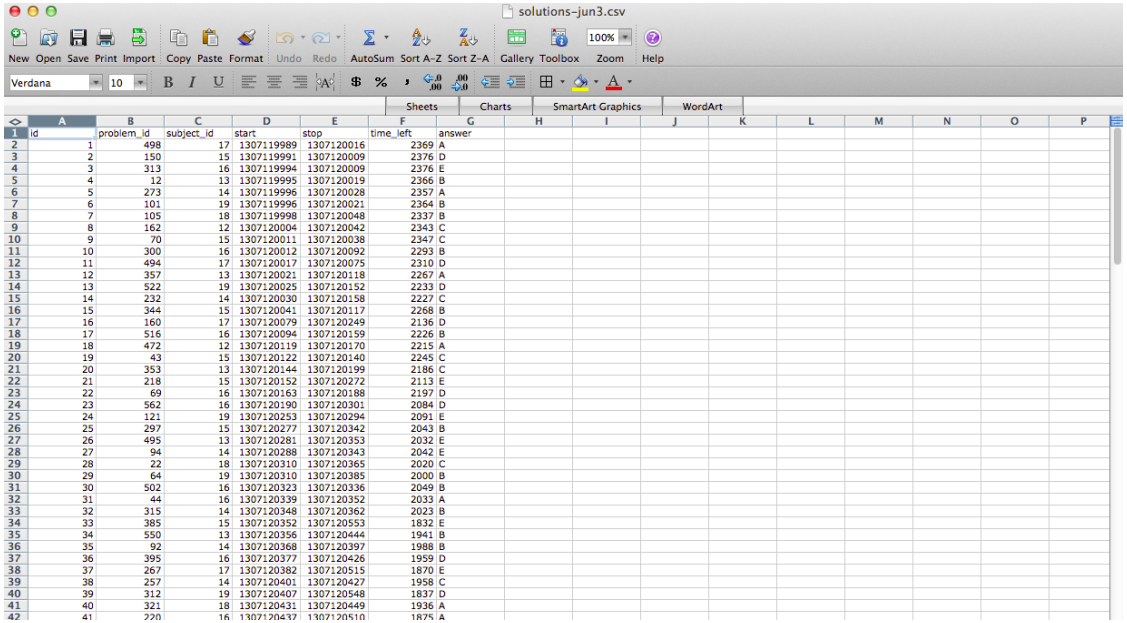
Last Updated: 11 Apr 2011 @ 1737


Medication: AMLODIPINE BESYLATE 10MG TAB
Instructions: TAKE ONE TABLET BY MOUTH TAKE ONE-HALF TABLET FOR
GRAPEFRUIT JUICE--
Status: Active
Refills Remaining: 3
Last Filled On: 20 Aug 2010
Initially Ordered On: 13 Aug 2010
Quantity: 45
Days Supply: 90
Pharmacy: DAYTON
Prescription Number: 2718953

Medication: IBUPROFEN 600MG TAB
Instructions: TAKE ONE TABLET BY MOUTH FOUR TIMES A DAY WITH FOOD
Status: Active
Refills Remaining: 3
Last Filled On: 20 Aug 2010
Initially Ordered On: 01 Jul 2010
```

http://blue-button.github.com/challenge/

What do processed data look like?



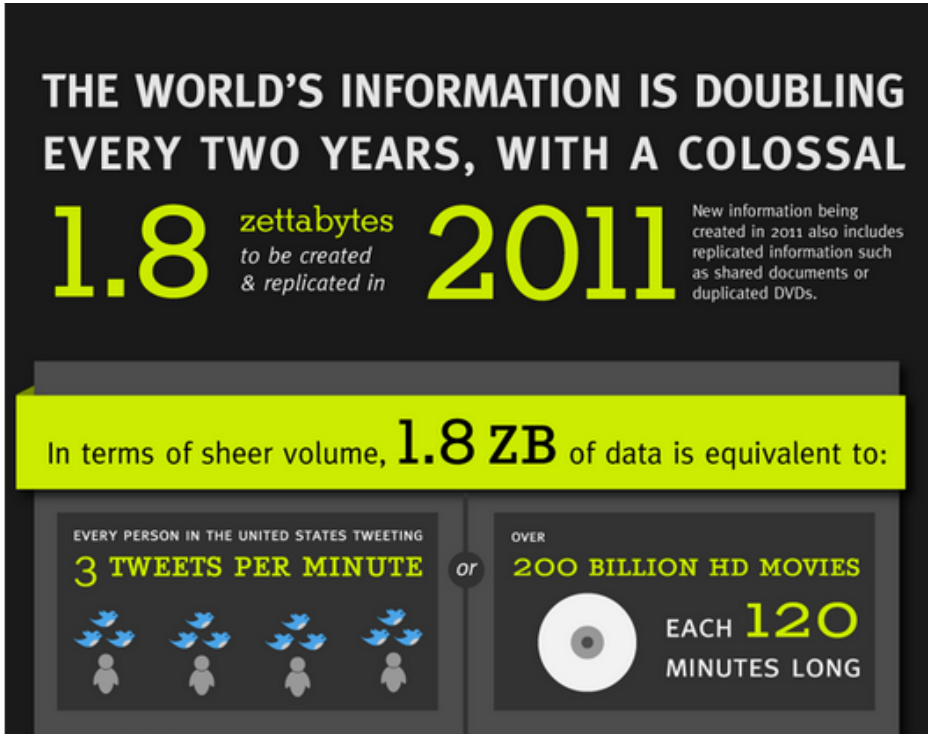
	id	problem_id	subject_id	start	stop	time_left	answer
2	1	498	17	1307119989	1307120016	2369	A
3	2	150	15	1307119991	1307120009	2376	D
4	3	313	16	1307119994	1307120009	2376	E
5	4	12	13	1307119995	1307120019	2366	B
6	5	273	14	1307119996	1307120028	2357	A
7	6	101	19	1307119996	1307120021	2364	B
8	7	105	18	1307119998	1307120048	2337	B
9	8	162	12	1307120004	1307120042	2343	C
10	9	70	15	1307120011	1307120038	2347	C
11	10	300	16	1307120012	1307120092	2293	B
12	11	494	17	1307120017	1307120075	2310	D
13	12	357	13	1307120021	1307120118	2267	A
14	13	522	19	1307120025	1307120152	2233	D
15	14	232	14	1307120030	1307120158	2227	C
16	15	344	15	1307120041	1307120117	2268	B
17	16	160	17	1307120079	1307120249	2136	D
18	17	516	16	1307120094	1307120159	2226	B
19	18	472	12	1307120119	1307120170	2215	A
20	19	43	15	1307120122	1307120140	2245	C
21	20	353	13	1307120144	1307120199	2186	C
22	21	218	15	1307120152	1307120272	2113	E
23	22	69	16	1307120163	1307120188	2197	D
24	23	562	16	1307120190	1307120301	2084	D
25	24	121	19	1307120253	1307120294	2091	E
26	25	297	15	1307120277	1307120342	2043	B
27	26	495	13	1307120281	1307120353	2032	E
28	27	94	14	1307120288	1307120343	2042	E
29	28	22	18	1307120310	1307120365	2020	C
30	29	64	19	1307120310	1307120385	2000	B
31	30	502	16	1307120323	1307120336	2049	B
32	31	44	16	1307120339	1307120352	2033	A
33	32	315	14	1307120348	1307120362	2023	B
34	33	385	15	1307120352	1307120553	1832	E
35	34	550	13	1307120356	1307120444	1941	B
36	35	92	14	1307120368	1307120397	1988	B
37	36	395	16	1307120377	1307120426	1959	D
38	37	267	17	1307120382	1307120515	1870	E
39	38	257	14	1307120401	1307120427	1958	C
40	39	312	19	1307120407	1307120548	1837	D
41	40	321	18	1307120431	1307120449	1936	A
42	41	220	16	1307120437	1307120510	1875	A

1. Each variable forms a column
2. Each observation forms a row
3. Each table/file stores data about one kind of observation (e.g. people/hospitals).

http://vita.had.co.nz/papers/tidy-data.pdf

Leek, Taub, and Pineda 2011 PLoS One

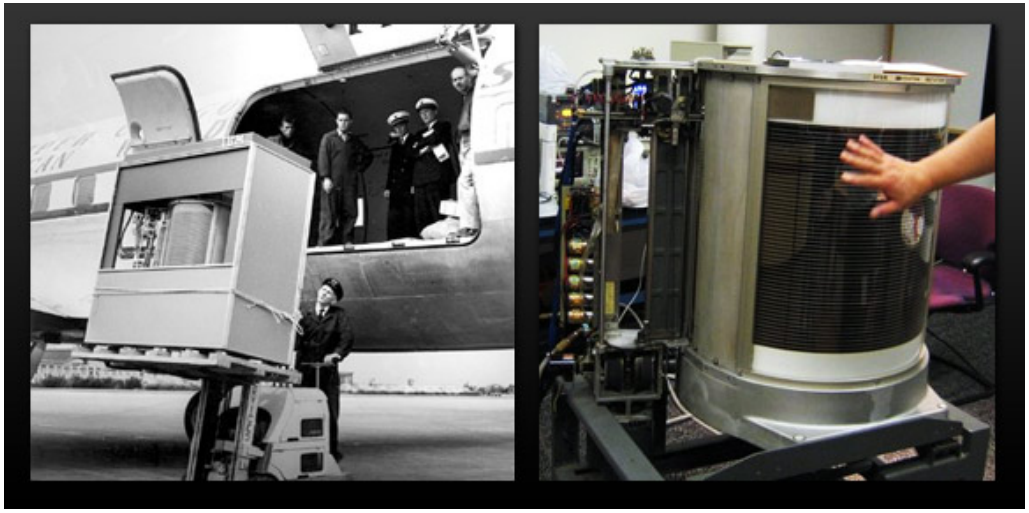
How much is there?



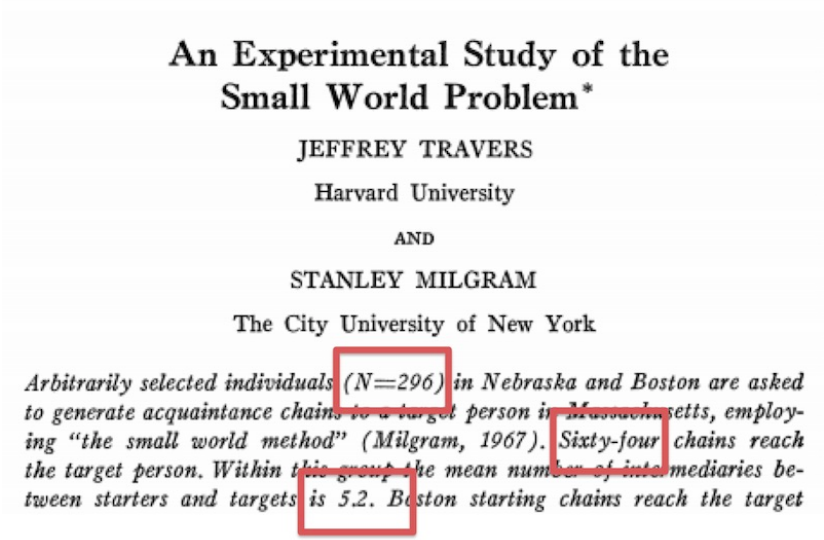
http://mashable.com/2011/06/28/data-infographic/

So what about big data?

Depends on your perspective



Why big data now?



An Experimental Study of the Small World Problem*

JEFFREY TRAVERS

Harvard University

AND

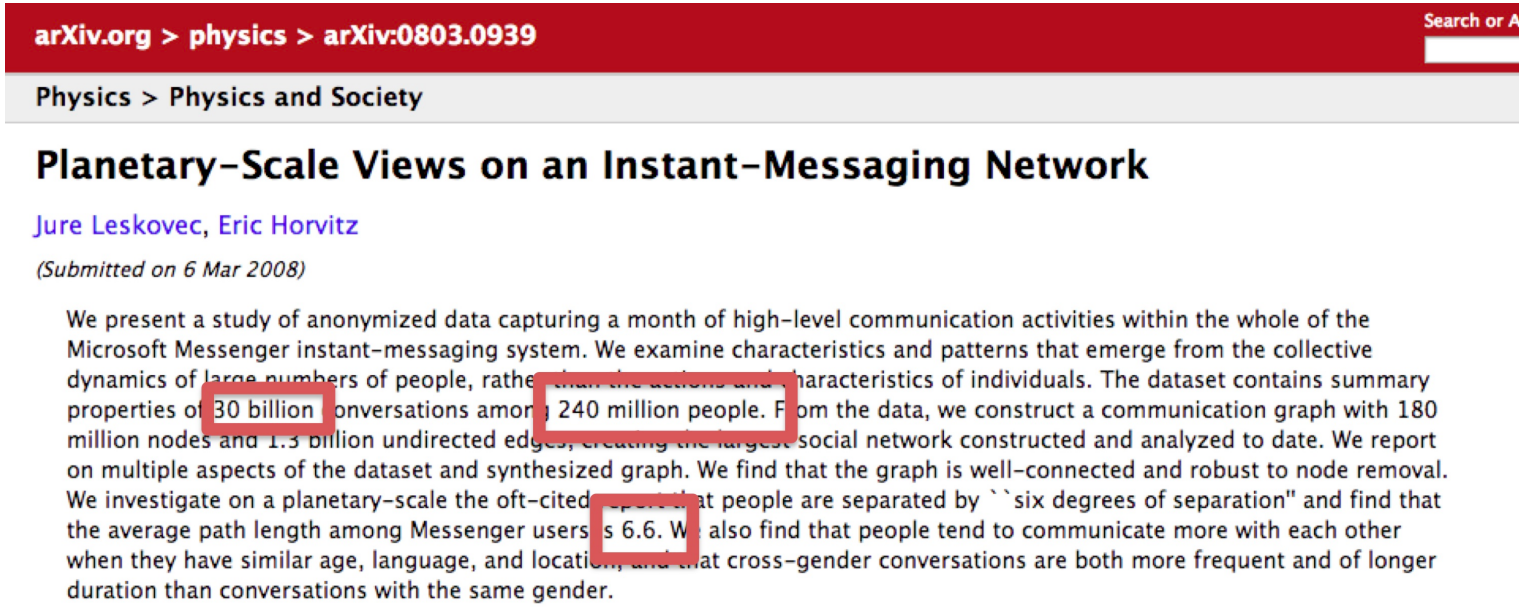
STANLEY MILGRAM

The City University of New York

Arbitrarily selected individuals (N=296) in Nebraska and Boston are asked to generate acquaintance chains to a target person in Massachusetts, employing "the small world method" (Milgram, 1967). Sixty-four chains reach the target person. Within this group the mean number of intermediaries between starters and targets is 5.2. Boston starting chains reach the target

Travers and Milgram (1969) Sociometry

Why big data now?



arXiv.org > physics > arXiv:0803.0939

Search or A

Physics > Physics and Society

Planetary-Scale Views on an Instant-Messaging Network

Jure Leskovec, Eric Horvitz

(Submitted on 6 Mar 2008)

We present a study of anonymized data capturing a month of high-level communication activities within the whole of the Microsoft Messenger instant-messaging system. We examine characteristics and patterns that emerge from the collective dynamics of large numbers of people, rathe haracteristics of individuals. The dataset contains summary properties of 30 billion onversations amon 240 million people. F om the data, we construct a communication graph with 180 million nodes and 1.3 billion undirected edg social network constructed and analyzed to date. We report on multiple aspects of the dataset and synthesized graph. We find that the graph is well-connected and robust to node removal. We investigate on a planetary-scale the oft-cited t people are separated by ``six degrees of separation'' and find that the average path length among Messenger users s 6.6. W also find that people tend to communicate more with each other when they have similar age, language, and locati at cross-gender conversations are both more frequent and of longer duration than conversations with the same gender.

Leskovec and Horvitz WWW '08

Big or small - you need the right data

> “The data may not contain the answer. The combination of some data and an aching desire for an answer does not ensure that a reasonable answer can be extracted from a given body of data...”

Tukey

Big or small - you need the right data

> “...no matter how big the data are.”

Leek