Blogs, Friendship, and Geography

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Work performed at IBM, Verity, Yahoo!, Carleton

Etymology

From the OED new ed. (draft entry, Mar 2003) …

blog *intr.* To write or maintain a weblog. Also: to read or browse through weblogs, esp. habitually.

web·log *n.* **2.** A frequently updated web site consisting of personal observations, excerpts from other sources, etc., typically run by a single person, and usually with hyperlinks to other sites; an online journal or diary.

blog·space *n.* The collection of weblogs; = blogosphere, blogsphere, blogistan, …

Blogs 101

- Characteristics
  - Pages with reverse chronological sequences of dated entries
  - Usually contain a persistent sidebar containing profile (and other blogs read by the author – "blogroll")
  - Usually maintained and published by one of the common variants of public-domain blog software
- From Slashdot, 1999
  "… a new, personal, and determinedly non-hostile evolution of the electric community. They are also the freshest example of how people use the Net to make their own, radically different new media"

Look and feel

- Quirky
- Highly personal
- Consumed by a small number of regular repeat visitors
- Often updated multiple times each day
- Highly interwoven into a network of small but active micro-communities
- Eg: LiveJournal, Blogger, …

The blog era

- Blogs began in 1996, but exploded in popularity in 1999
  - Proliferation of authoring tools
- Newsweek 2002 estimates ~500K
- Annual Blogathon for charity
  - Bloggers update their Blogs every 30m for 24h
  - Sponsors pay …
- Impact of blogs
  - "Miserable failure", "French military victories"

Livejournal blogspace

- Livejournal.com: popular blog site
  - 1.3M bloggers (Feb 2004)
  - 3.9M bloggers (Oct 2005)
- Each blogger has a profile
  - Name, age, …
  - Geographic information (city, state, zip, …)
  - Friends and friend of
  - Interests/communities
- Geographic information:
  - ~35% list a home town in the United States
  - Home towns mapped to lat/long
  - Granularity of locations: roughly cities
- Friendship information
  - Extracted self-reported "friends" of each blogger: 4M friendships
  - 80% of friendships are reciprocal
  - ¾ of network form giant strongly-connected component
  - Clustering coefficient: 0.2
  - Lognormal degree distribution

Eg, LiveJournal user “bill”

User: bill (3215)

Name: bill

Website: Girvan Attractions on the Net

Location: Girvan, United Kingdom

Birthdate: 1954-04-12

E-mail: b.caddis@btinternet.com

Friends: **3:** ajose, webfran, zaxwrit

Friend of: **36:** aqdale, ajose, b4_darkness, boris_the_blade, dkm977, epitaph87, farthead, flatland83, gabbymoe, ghettofabublous, glenda, glitzysqurl, gooooooooooogle, gothgrouch, gruntbill, hammerman, insanephycopath, jakup, jazzzman, laxprincess, louwleadvocals, mandaj8705, marksantos, mini_skeeby, protogonoi, reallyrandom06, sammeh, shortstac, sweetsugar829, sys_developer, thebluesbros, uglyo, uno_bitch, webfran, wikitmel, xo_krista_ox

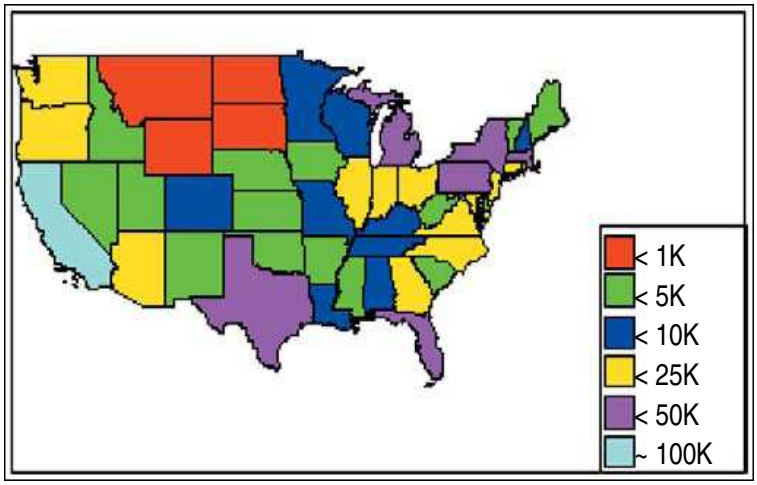
Member of: **1:** paidmembers

Account type: Early Adopter

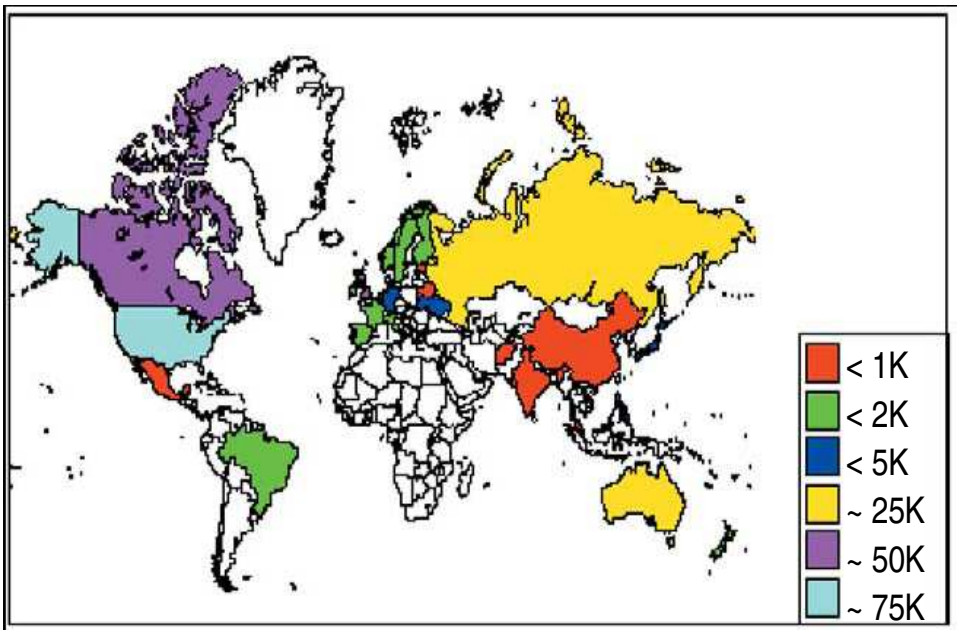
(more details...)

Yahoo! Research

LJ bloggers in US



LJ bloggers world-wide

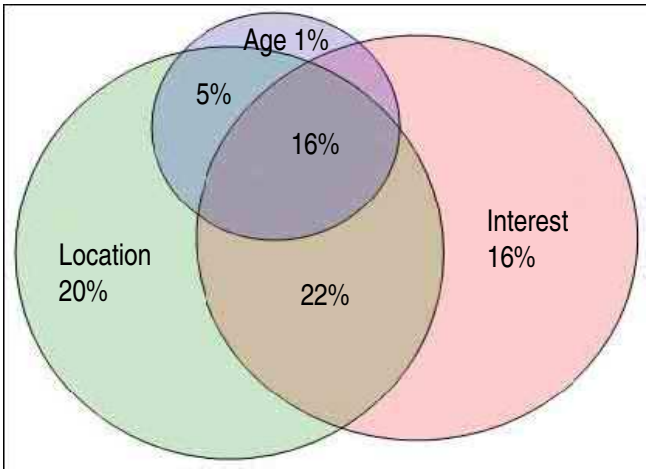


Who are they?

Age	%	Representative interests
1 to 3	0.5	treats, catnips, daddy, mommy, purring, mice, playing, napping, scratching, milk
13 to 15	3.5	webdesigning, Jeremy Sumpter, Chris Wilson, Emma Watson, T. V., Tom Felton, FUSE, Adam Carson, Guyz, Pac Sun, mall, going online
16 to 18	25.2	198{6,7,8}, class of 200{4,5}, dream street, drama club, band trips, 16, Brave New Girl, drum major, talkin on the phone, highschool, JROTC
19 to 21	32.8	198{3,5}, class of 2003, dorm life, frat parties, college life, my tattoo, pre-med
22 to 24	18.7	198{1,2}, Dumbledore's army, Midori sours, Long island iced tea, Liquid Television, bar hopping, disco house, Sam Adams, fraternity, He-Man, She-Ra
25 to 27	8.4	1979, Catherine Wheel, dive bars, grad school, preacher, Garth Ennis, good beer, public radio
28 to 30	4.4	Hal Hartley, geocaching, Camarilla, Amtgard, Tivo, Concrete Blonde, motherhood, SQL, TRON
31 to 33	2.4	my kids, parenting, my daughter, my wife, Bloom County, Doctor Who, geocaching, the prisoner, good eats, herbalism
34 to 36	1.5	Cross Stitch, Thelema, Tivo, parenting, cubs, role-playing games, bicycling, shamanism, Burning Man
37 to 45	1.6	SCA, Babylon 5, pagan, gardening, Star Trek, Hogwarts, Macintosh, Kate Bush, Zen, tarot
46 to 57	0.5	science fiction, wine, walking, travel, cooking, politics, history, poetry, jazz, writing, reading, hiking
> 57	0.2	death, cheese, photography, cats, poetry

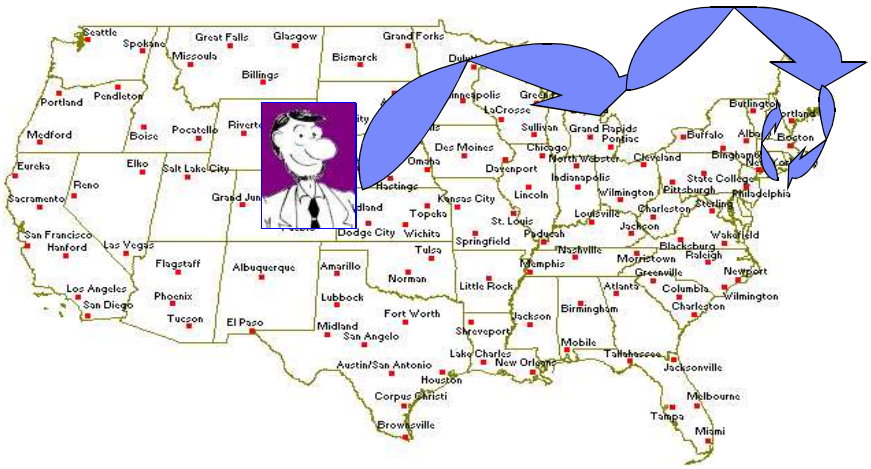
Friendship graph

- Directed
- 80% mutual
- Average degree ~ 14
- Power law degrees
- Clustering coeff. ~ 0.2
- Most friendships explained by age, location, interest



Message forwarding

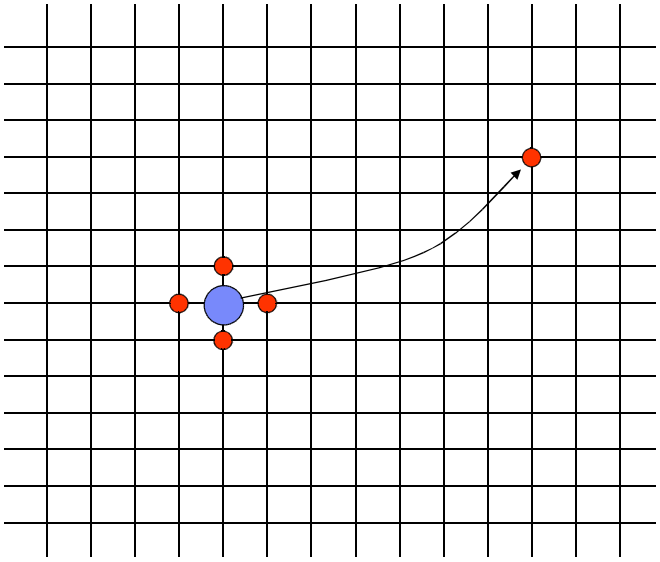
- Stanley Milgram: short paths in social networks, small worlds, and “Six degrees of separation”, 1967.



What's surprising about Milgram?

- Surprising fact number one (observed by Milgram): network contains short paths
- Surprising fact number two (observed much later by Kleinberg): a purely local algorithm allows discovery of these short paths

Models to explain greedy routing



- Each grid point is a person
- Each person "knows" the four neighbors
- Each person also knows one other person

[Kleinberg 2000]

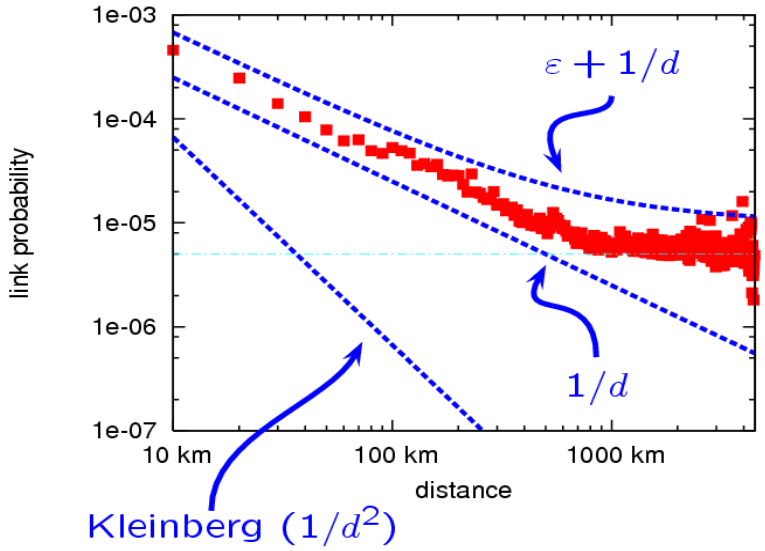
How should the "long-range" neighbor be chosen

- For a candidate neighbor x at distance d away,
  Pr[*x* is the long-range neighbor] ~ $1/d^k$
- If k=2:
  - Network contains short paths for every pair (polylog(n))
  - Short paths can be discovered by local greedy routing
- If k != 2:
  - Networks does not contain short paths (poly(n))
- Exponential gap between k=2 and k!=2

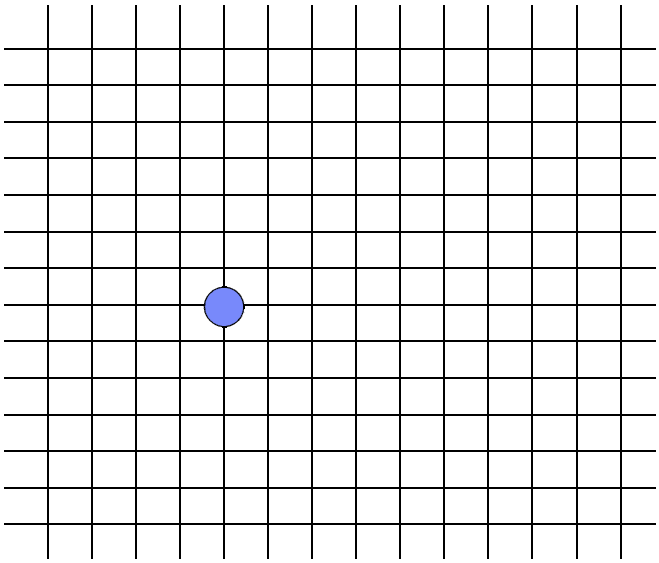
Simulating geographic greedy routing on LiveJournal data

- Can simulate geographic greedy routing on the LiveJournal network
- Results show short paths between most pairs – similar to Milgram's experiment
- So relationship between friendship and distance should follow $1/d^2$

Results

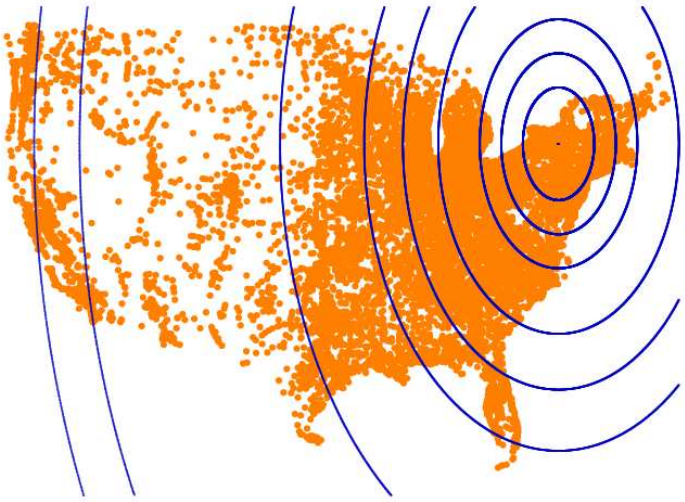


What's happening?



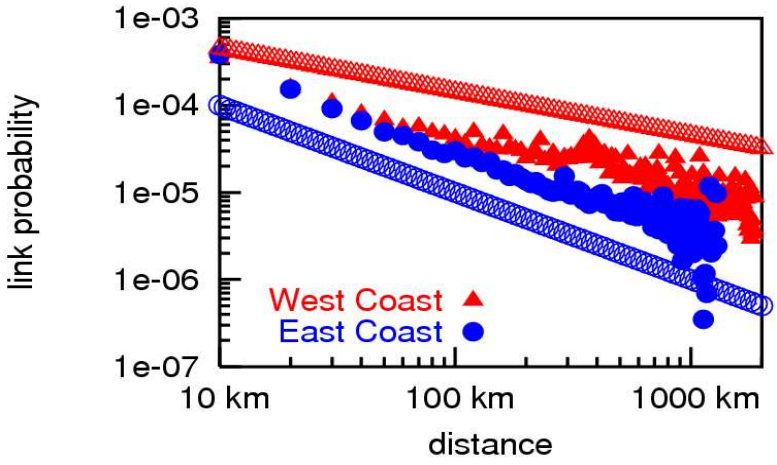
- Assumption: one person per grid point
- Reality: highly varying number of people per grid point

Population density



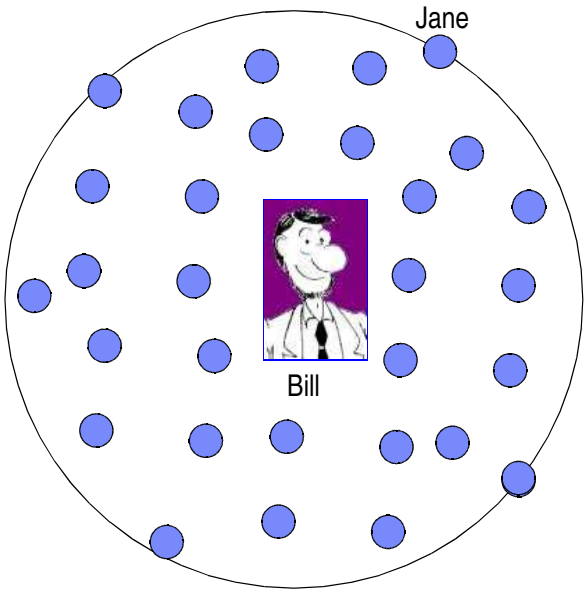
- Dot for every inhabited location
- Each circle represents 50,000 bloggers
- Centered on Ithaca, NY

Does population density (or other factors) impact the relationship between friendship and geography?



Our solution

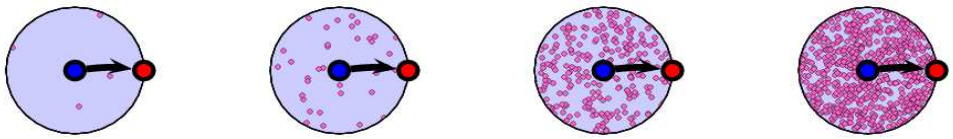
- Why use distance to determine friendship probabilities?
  - –Two people who live a mile apart in Beijing will never meet
  - –Two people who live a mile apart in Iowa will be close acquaintances
- What's the difference?
  - –Within Manhattan, there are thousands of people living within a mile
  - –Within Iowa, there are very few
- Probability of friendship should depend on the size of the candidate population



Pr[friendship] ~ 1 / (# of closer people)

Properties of Rank-based friendship

- Population density determines relationship between distance and friendship



- For uniform density, rank-based friendship is equivalent to Kleinberg – same theorems hold
- For non-uniform density, a similar theorem can be shown…

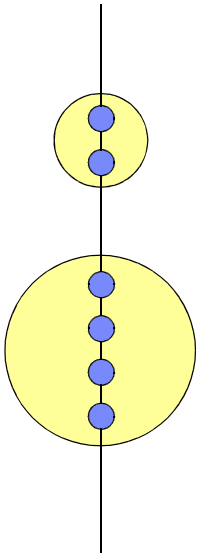
Theorem

- For any *n*-person population network, for arbitrary source *s*, and uniformly-chosen target *t*, the expected length of a geographic greedy routing path from s to the location of t is $O(\log^3 n)$
- Compared to Kleinberg:
  - Lose: expectation rather than with high probability
  - Lose: another log factor
  - Gain: arbitrary population distributions

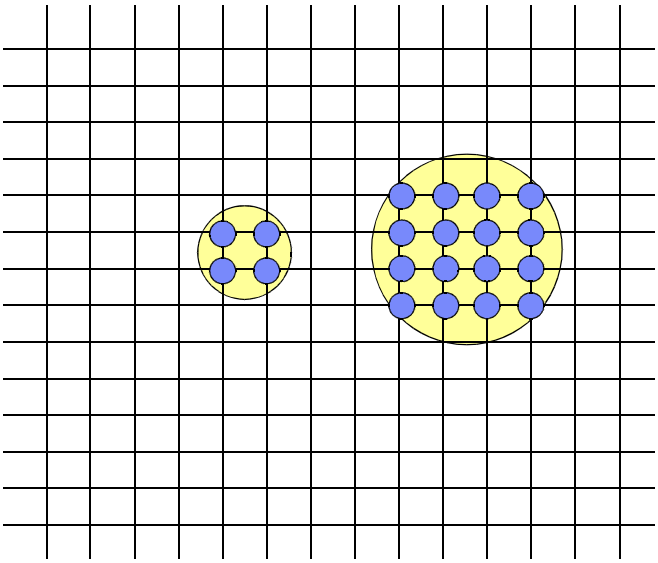
Generalization 1: General metric spaces

- Motivation: "distance" between people may represent complex phenomena: shared interests, similar backgrounds, personality similarity, etc. Would like to allow as general a distance function as possible.
- Model:
  - Local edges: pick a shortest path graph in the metric space, include all "local" neighbors that are on a shortest path
  - Long-range edges: rank-based friendship

Doubling Dimension



4/2 = 2
log(2) = 1



16/4 = 4
log(4) = 2

Generalization 1: General metric spaces

- Input: an n-person social network whose underlying metric space has doubling dimension alpha, aspect ratio AR, and long-range degree d
- Theorem: For arbitrary source person s and uniformly chosen target person t, the expected length of a path from s to the location of t is $O(\log(n) \log^2(AR) 2^{alpha}/d)$.

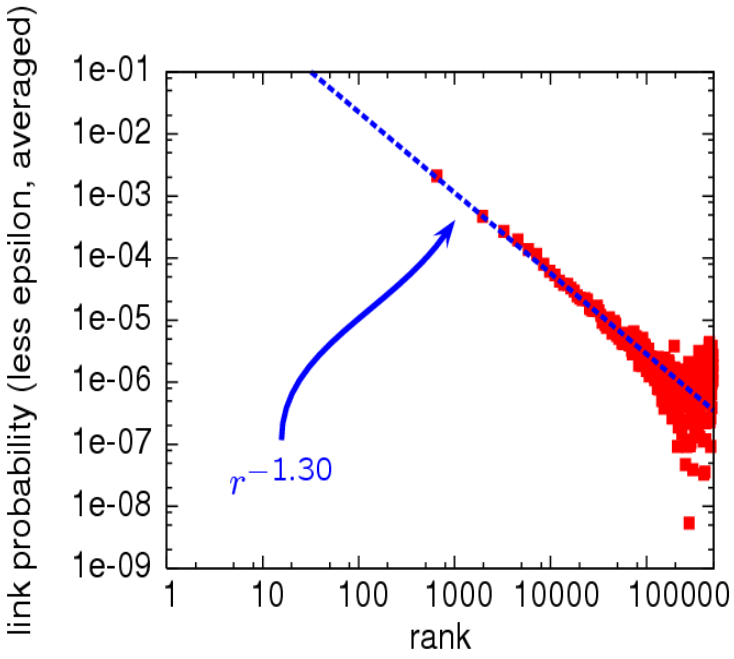
Generalization 2: Recursive networks

- Motivation: send a message to Manhattan, then route within the sub-network to the correct building, then to the correct room
- Model: As in a standard population network, but each point contains either a singleton person or a recursive sub-network
- Input: a recursive population network of depth O(poly(n))
- Theorem: For arbitrary source person s and uniformly chosen destination person t, the expected path length from s to t is O(T x min{log(n), depth}) where T is the expected path length of a non-recursive network

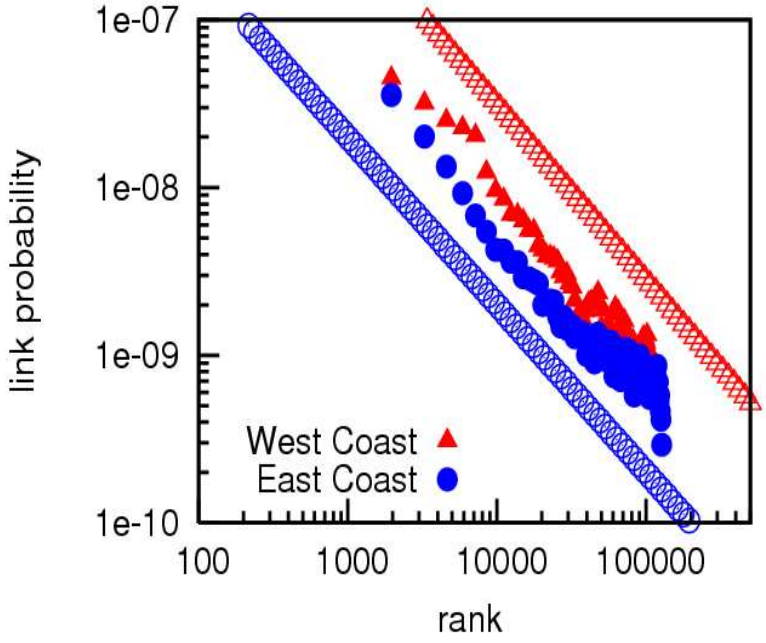
Generalization 3: Trees with no local edges

- Motivation: many models for social networks have been proposed for trees, without strong routing results
- Input: binary tree of depth $\log^k(n)$
- Model:
  - Each person has $\log^{k+1}(n)$ long-range links by rank-based friendship
  - Local links: none
- Theorem: With arbitrary probability, for arbitrary source person s and uniformly chosen destination person t, the expected path length from s to the location of t is $O(\log^k(n))$

Friendship versus rank

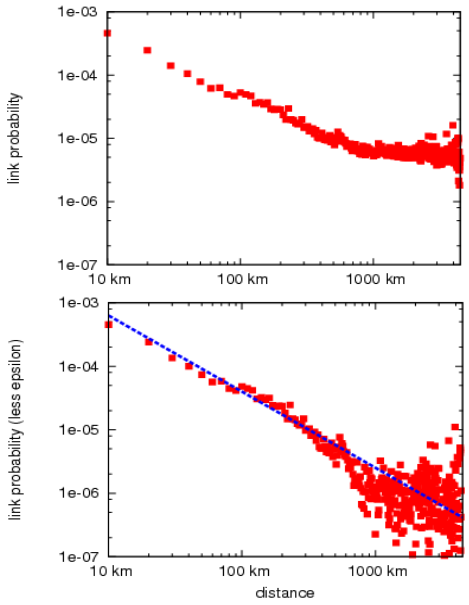


East versus West Coast revisisted



How much does geography explain?

- Graph of distance versus friendship probability
- Good estimator of friendship: function of distance *plus* constant
- Constant term represents geographically-independent reasons for friendship
- Back-solving, we find that 2.5/8 friends are non-geographic
- Could shared interests explain these friendships?



Yahoo! Research

Conclusions

- Friendship and Distance are strongly related
- Modeling friendship as a function of distance is problematic
- Rank is a better measure of friendship than distance
- Some friendships form with no geographic correlation (2.5/8)

More Information

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