Clustering for Opportunistic Communication

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Collaborators

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Broad Context

- Building software that can proactively help you achieve your goals by understanding enough about what you're doing
- Focus: facilitating resource awareness
  - Watson (documents)
  - I2I (potential collaborators)

Watson

- Watson allows you to easily maintain an awareness of relevant online documents in the context of your work
- See paper, IUI 2000

kane.doc - Microsoft Word

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In both Citizen Kane and The Magnificent Ambersons Orson Welle
to do what is impossible for many theater directors who move into film-ma
managed simultaneously to incorporate the literary nature of the theater an
visual effects available to him in the medium of film. The storytelling craf
theater is evident in both these films. What is interesting to the theater stu
might be termed an exploitation of theatrical form. His knowledge of Shak
and the Ancient Greeks seems to have greatly informed his craft, sometime
effect, and sometimes serving as a detriment.

Turning first to Citizen Kane, one first notices that Welles has play
epic form. He tells the story of a man born to greatness, his great deeds, ar
due to what might be the *hamartia* - tragic flaw. Although tragic flaw mig
as a reductive or simplistic term, in this case, like Shakespeare before him,
taken what he needed from the Greeks and moved it into his own particula

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Search in context:

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kane.doc - Microsoft Word

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Info Lab Assistant

Intelligent Information Laboratory
at Northwestern University

Word Document: C:\Documents and Settings\jlbudzik\My Documents\kane.doc

Summary | Library | Pictures | News | Web

Library (3)

A trip to the movies: 100 years of film as art. (includes related article on films released during the 1960s)(Cover Story)
The Humanist (Hinrichs, Bruce) 01-11-1996; 7(7)

Pictures (5)

Image from Ditto.com
www.homevideos.com/...12.htm (Ditto)

News (19)

CNN - 'The Film 100' a history lesson for film buffs - August 5, 19
ATLANTA (CNN) -- Let's get this out in the open: Most people won't agree with the following list. Not at first, anyway. It's designed to spark debate and interest -- and ...
www.cnn.com/ (CNN)

Search in context:

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Watson --> I2I

- Watson is all about tracking and using context to drive proactive media retrieval
- I2I is aimed at fostering informal collaboration and communication through awareness of *shared contexts*

The Basic Idea

- I2I connects users based on the work they are performing
- For example, I2I users writing papers on a similar topic can
  - become aware of each other's activities through the system and
  - use this awareness as a starting point for collaboration
- We want to make traditionally solitary activities more collaborative by embedding context-sensitive activity awareness facilities into everyday applications

Many of our conversations are not planned in advance

- Awareness of others who are situated in a similar context facilitates informal collaboration and communication
  - E.g., BOF sessions, lunch at conferences
- CMCs typically leave context-awareness out
  - You have to know “where to go” and decide to go “there” to find people to to talk with
  - Fixed, place-based metaphors
- And so the cost of finding help/collaborators often outweighs the perceived benefit

Opportunistic Communication

- We call communication that arises out of an awareness of shared context *opportunistic*
  - Awareness of common active goals (or immediate interests) is required for people to help each other
  - We want to promote this kind of awareness by tracking the work people do and noticing opportunities for collaboration

Clustering Work Contexts

- Similarity-based clustering offers a mechanism for discovering common work contexts
  - Work contexts can be represented as feature vectors
  - Neighborhoods of similar work contexts --> communities of common interest
- What is the content of the feature vector?
  - Goals/Plans
  - Process representations
  - Textual representations

Documents are a Window into a User's Goals and Interests

- People manipulating similar documents
  - On the Web
  - In a word processor
  - In any document manipulation application, in general
- The idea is that people manipulating similar documents often have common goals
  - Obviously this is not perfect: telephone book vs. focused report
  - But the system is opt-in

Richard M. Nixon - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www.whitehouse.gov/WH/glimpse/presidents/html/rn37.html

Information Panel

Refresh | About I2I

Other I2I Users All | Buddies

Total Online: 12
In This Page: 1
Number of Visitors: 7

Chat Activities

Number of chat rooms: 2
Show all chat rooms
Join live chat about this page!

Calling cards Add | Show All

Number of calling cards: 2
Show calling cards

Related Pages Being Read

Number of related pages: 2
Show related pages

Richar

Thirty-Seventh

[Patric

Fun Fact: Though President Richard Nixon disliked m
House swimming pool filled in, to give reporters more
events. But one president's decisions about the White
next. After Richard Nixon resigned on August 9, 1974
president, his friends had another pool dug on the Whit

Fast Fact: The Watergate scandal forced Richard M.

Richard M. Nixon - Microsoft Internet Explorer

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Information Panel

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Readers Online

- mary
- julie3

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Readers Online

- mary
- julie3

Current Page: Richard M. Nixon: His Despicable Yet Admirable Self

Contact julie3

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Related Pages

- Richard M. Nixon: His Despicable Yet Admirable Self
- Constitutional Issues: Watergate and the Constitution
- There's Life after Failure
- Turmoil
- Washington D.C.
- Washington D.C.
- GLOSSARY: RICHARD M. NIXON
- U.S. Presidential Impeachment
- Re: how was ROSEMARY WOODS significant in the Watergate scandal?
- The History Place - Sounds of History
- Turmoil

Related Images/Video

- Richard Nixon And Jack Benny Play Musical Duet - 1959
- Richard Nixon Campaigns At Madison Square Garden

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Information Panel

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Live Chat Rooms New

- watergate
  - Number of users: 3
  - Started at: 2-12-2000, 0:46
- impeachment
- elvis
- Washington Post

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Address http://www.whitehouse.gov/WH/glimpse/presidents/html/rn37.html Go

Information Panel

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Washing

I2I Chat Room - I2I Chat

File Edit Format Help

Person Message

julie3 what do you think was on the missing nine minutes?

People Rooms

julie3

mary

At Richard M. Nixon » 4 Status » Connected

Message » I don't know ...

Send Whisper Clear

Ready 7:13 PM

His election in 1968 had climaxed a career unusual on two counts: his early success and

Done Internet

Richard M. Nixon - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www.whitehouse.gov/WH/glimpse/presidents/html/rn37.html

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Calling Cards New

- Nixon vs. Clinton
- US/China relations during the Nixon era

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Information Panel

Refresh | About I2I

Calling Cards New

- Nixon vs. Clinton
- US/China relations during the Nixon era

Left by: kris
At: Richard M. Nixon: His Despicable Yet Admirable Self
Date: 2-10-2000, 21:11
Contact kris

I'm looking to talk with someone who knows more about how the Nixon administration helped relations between the US and China, and how it effects China-US relations today.

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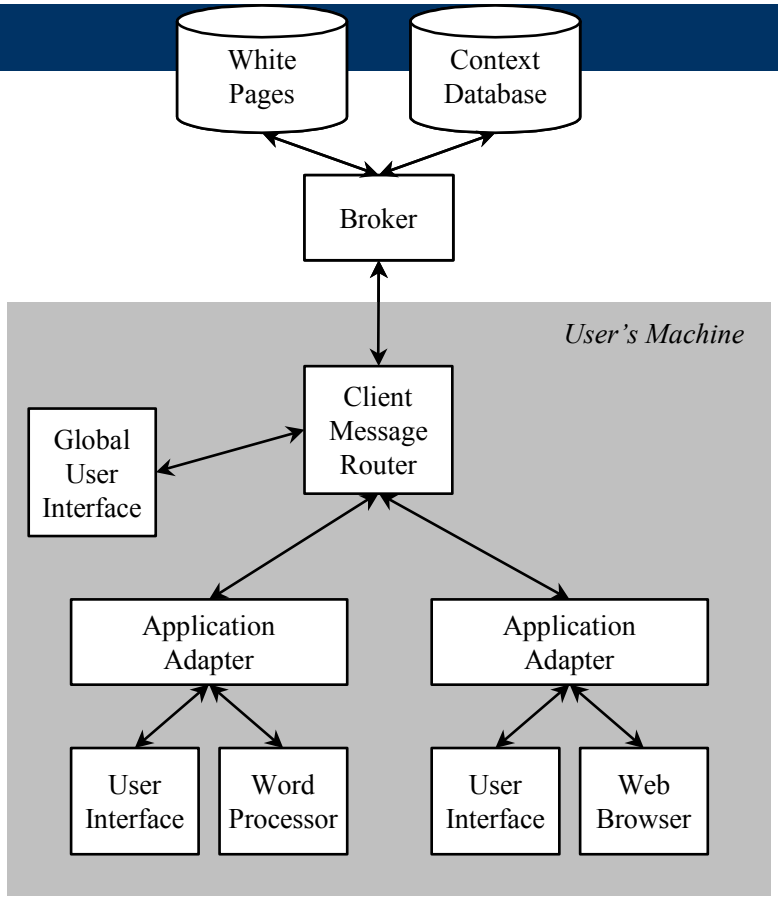
Contexts of use

- Community building across cultural/physical boundaries
  - In education
- Reduce replication, aid in expertise location, facilitate synchronization
  - In business, especially for large organizations

I2I Architecture



Brokering Opportunities for Collaboration

- A central broker computes a similarity matrix for user contexts
- By grouping conceptually similar contexts together, I2I makes it more likely that people will see each other

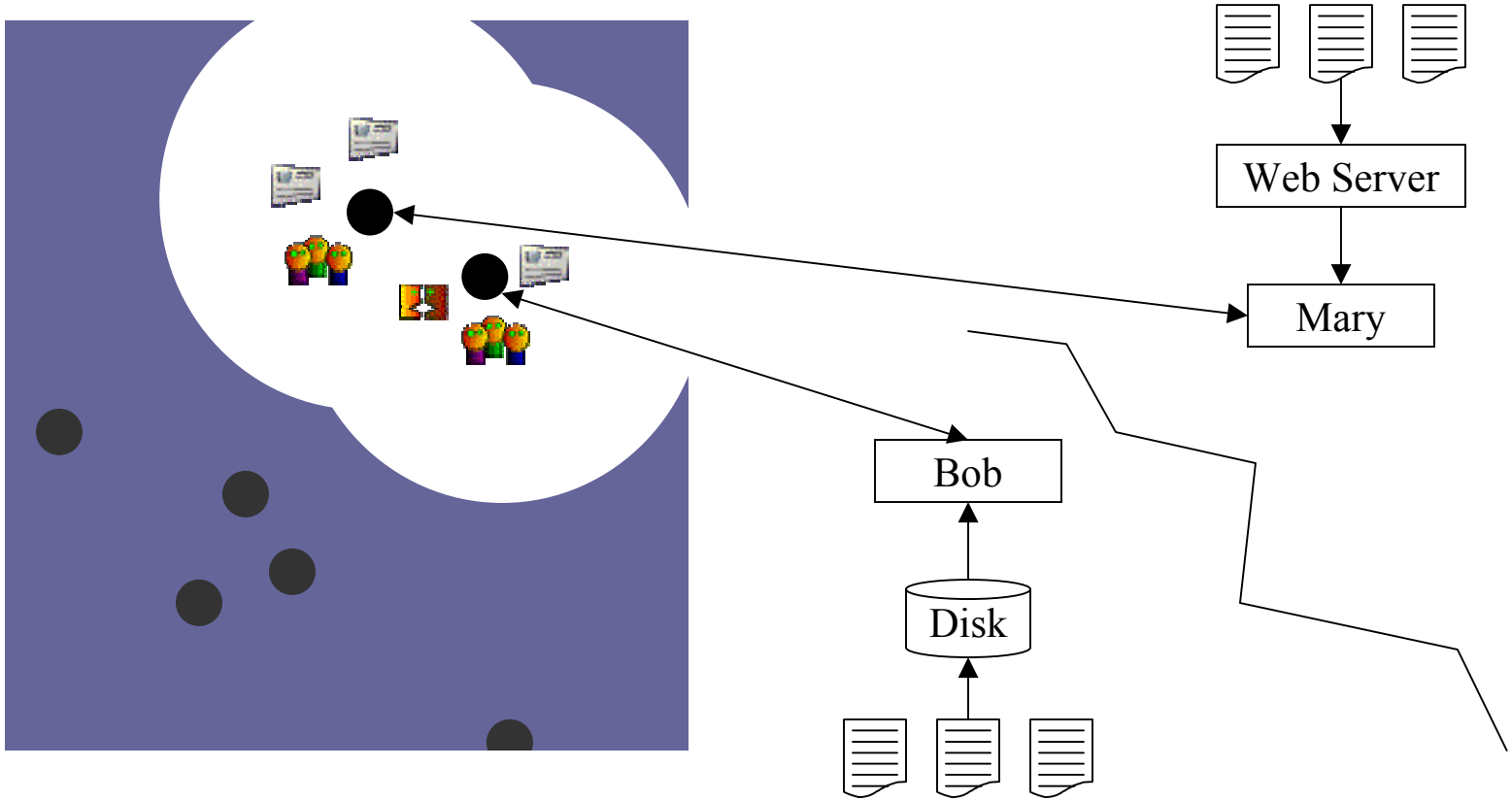
Context (Document) Similarity

- Vector-space model (Porter stemmer)
- TFIDF term weights
- Cosine measure (all due to Salton, et al.)
- Fixed similarity threshold
- Basically, if two documents have enough content-bearing words in common, they are deemed ‘similar enough’

Secondary objects are associated with Contexts

- People
- Chat Rooms
- Calling cards
- In the future, experts, representations of expertise (FAQs), and open questions

I2I Builds a Parallel Conceptual Channel



Keeping track of appropriate contexts for presentation

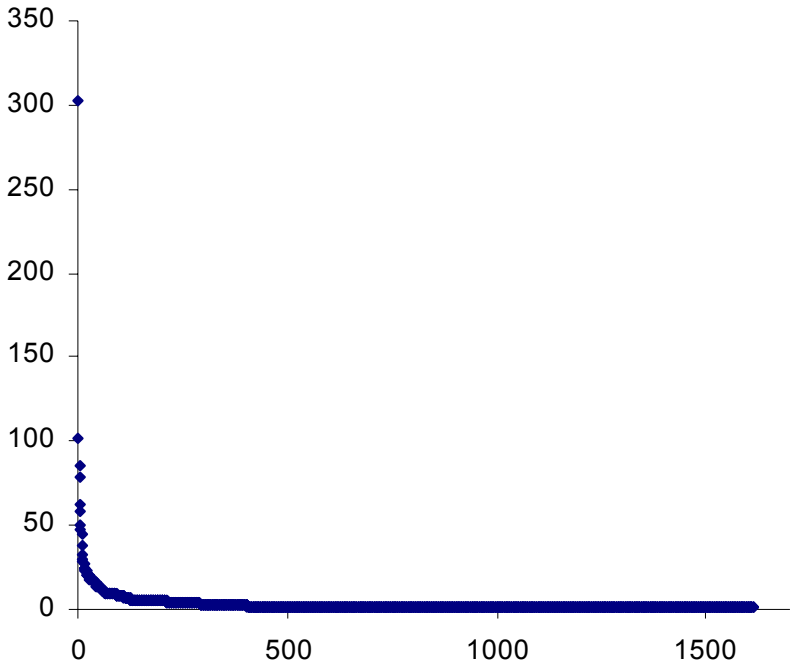
- Indexing calling cards and chat rooms in this way allows the system to maintain consistent relationships between the contributed content and the contexts in which a note was intended to be viewed
- It accounts for the ephemeral nature of information on the Web (sites go down, pages move, and content changes), allowing the system to maintain correspondence between context and contributed content
  - Similar to Bob Wilensky's "robust hyperlinks" work (WWW9)

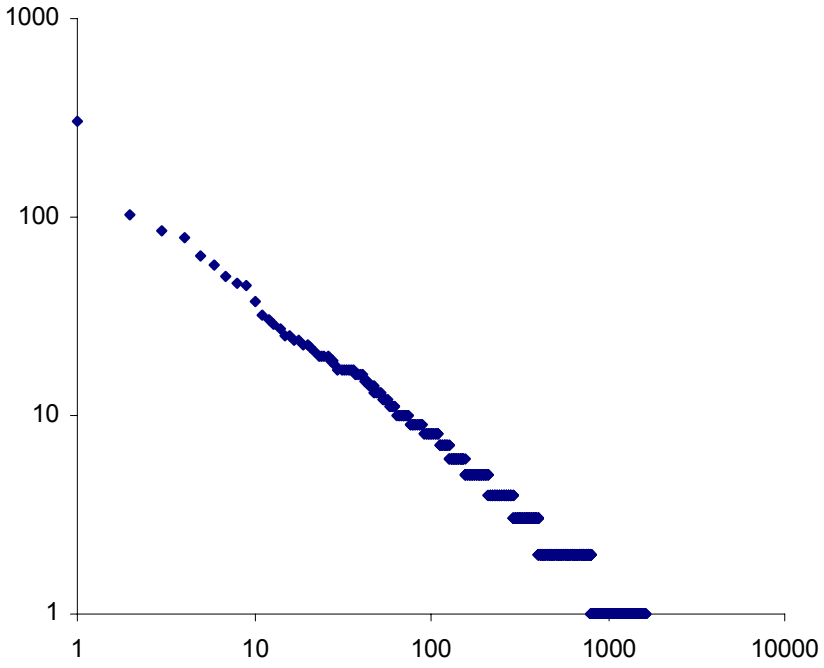
Prior Work

- Introduce visitors on the *same Web* page.
- Sociable Web (Donath, WWW2) and others
- Gooey, Odigo and others
- Why might document clustering be better?
  - Clustering makes connections more likely
  - How many people do we need to start to see results? (Grudin's "critical mass" problem)
    - Is there a similarity threshold that optimizes the tradeoff between finding someone and finding someone *relevant*?

The Data

- Two days of browsing logs from 11 people in and outside of the department
  - Internet Explorer plug-in recorded content (not just URL) to a data file when a page was fully loaded
- 1612 unique URLs accessed 5039 times over 2 days





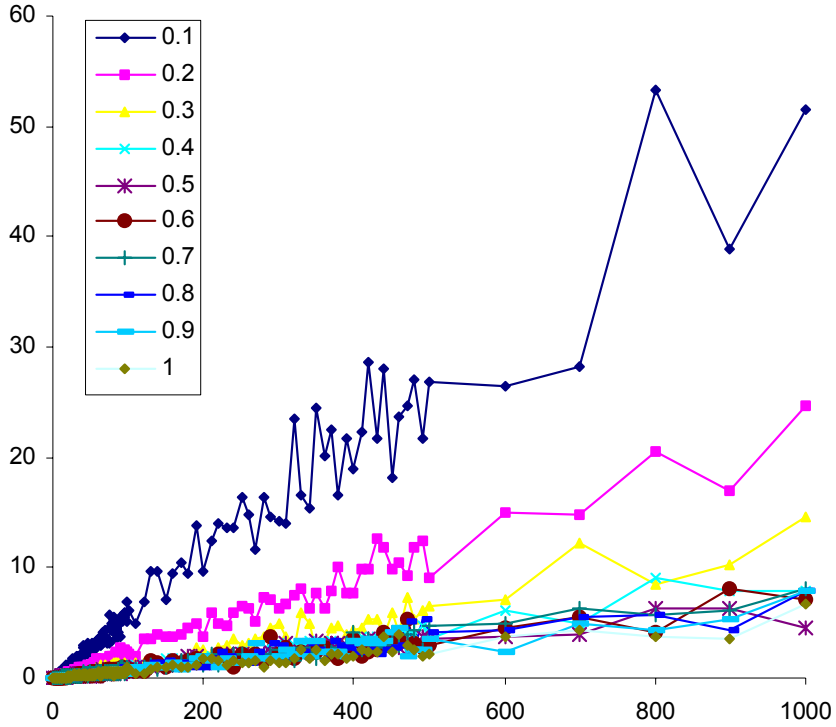
Access Frequencies vs. Frequency Rank

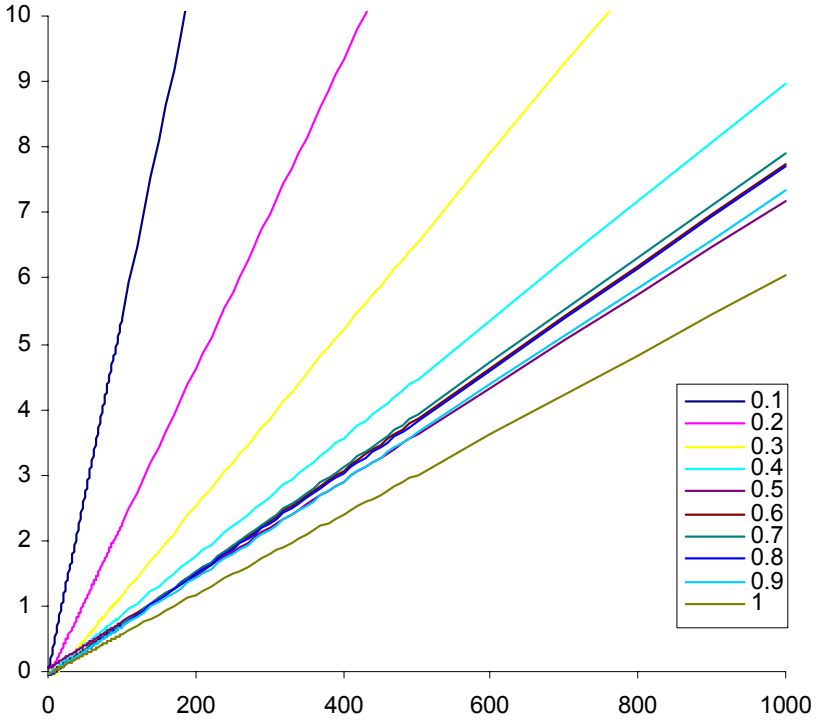
The Data

- Follows Zipf distribution, and mirrors characteristics of a larger data set (575K URLs, 591 users over ~3 months):
  - Cunha, Bestavros, and Corvella (BU CS TR-95-010)
- Large number of pages are accessed infrequently
- This implies there will be critical mass problems for page-based systems
  - All or nothing
  - Clustering based on user contexts may provide a solution

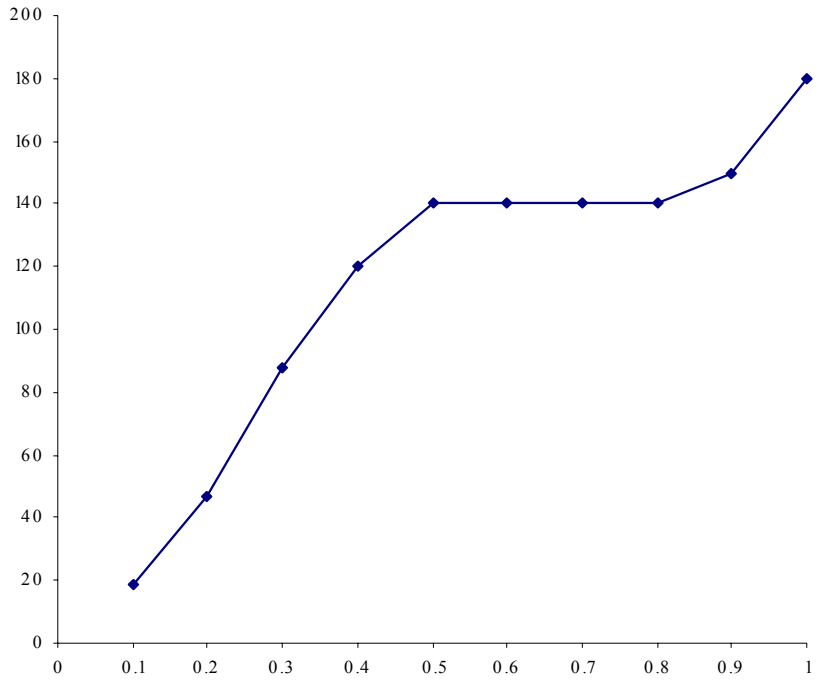
Simulating Large Numbers of Users

- Simulated users created by randomly sampling from the original distribution and averaging over 100 samplings
  - E.g., it was more likely that one of our simulated users would be at the more popular pages
  - We will do studies with larger numbers of users when the system is deployed





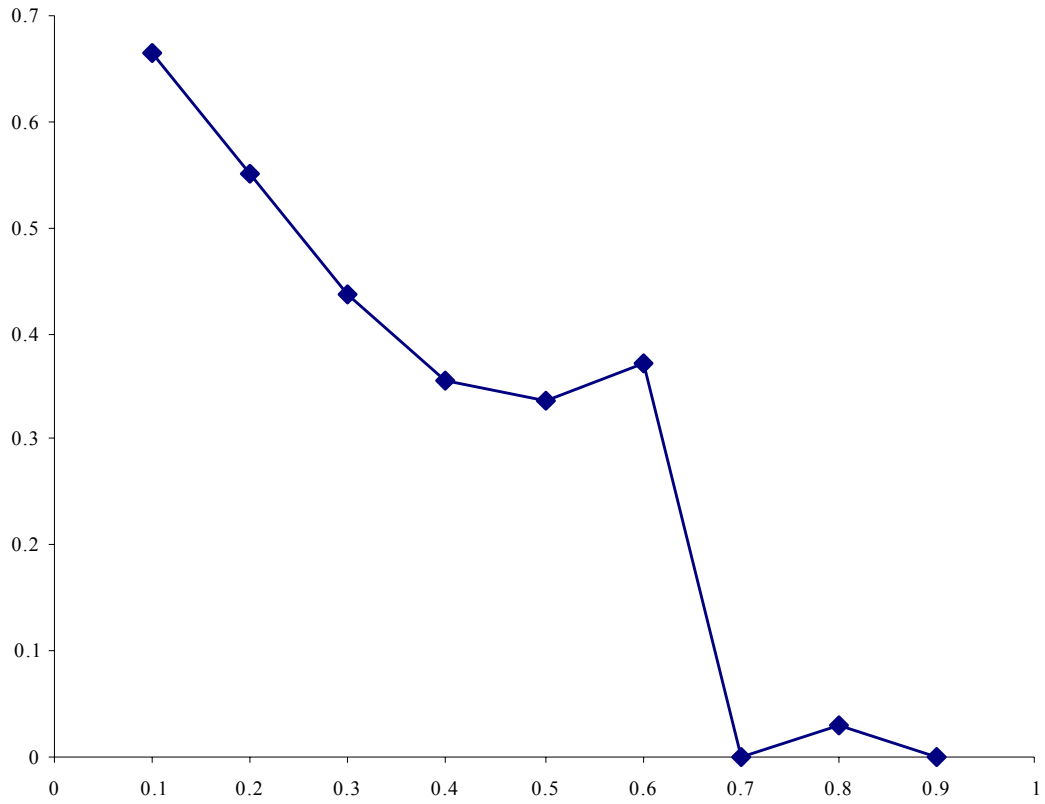
- Number of simulated people vs. average number of people they would see from a particular page



- Number of people that must be using the system to see one other person on average, vs. threshold (interception of the regression line with $y = 1$).
- 29% improvement over URL-based systems

Effectiveness

- Clustering effectiveness all over the literature
- For this task
  - For each threshold (0.1 to 0.9)
    - 10 random ‘source’ documents
      - 10 random ‘similar’ documents
- 900 comparisons by a single volunteer
  - Forthcoming study (HT02) on variance of similarity judgments suggest single-subject design is still representative



Threshold vs. percentage of inappropriate associations made by the system. As expected, as the threshold increases, the number of erroneous associations decreases

Balancing the Tradeoff

- Fixed similarity threshold of about 0.7
  - Adaptive similarity
  - New representations (e.g., global and local history) for adaptive computation
    - Use more detailed representations to discriminate among visitors at more popular sites
  - Clustering improves the chances a given user will see some *relevant* other

Clustering User Contexts as a Basis For Awareness

- Provides a framework in which constraints can easily be manipulated by the system so a manageable number of people can be presented
- Provides a framework for including novel representations of user contexts
  - Document Contents + Historical Profile
  - Other domains (e.g., CAD, music, etc.)

Textual Representations of Context

- Much of work is document-centric
- Unlike URL-based representations, text allows unpublished documents to serve as an entry point to the system
  - People who are writing can see others who are viewing related items on the Web
- Account for the multiplicity of documents on the same topic and access patterns observed on the Web
- Doesn’t help for the most popular pages

Conclusion

- I2I embeds communication facilities in applications so that users that share interests can be aware of each other and communicate freely in an informal environment
- I2I proposes a framework for opportunistic communication that overcomes many of the problems associated with document-based awareness and annotation technologies
- New method of dealing with critical mass problems in collaborative systems

Future Work

- Scalability
  - Efficient *k*-nearest neighbors algorithms exist
- Interfaces that enable the user to have accurate expectations about the automated features of the system
  - Where will my calling card be seen?
  - Interfaces for introduction
  - Exposing more internal state so people can ``debug'' inappropriate associations
- Semantics of good collaborators (due to Larry Birnbaum)
- The Semantic Web – moving up to higher level representations

The Vision – Frictionless Information Systems

- As you work the resources you need are delivered to you automatically
  - People (I2I)
  - Documents (Watson)
- No Queries, Sites, Rooms, or Places
- Instead, personalized, contextually-relevant content
  - A system aware of your goals will dynamically gather resources from relevant sources on your behalf
  - You will be free to pursue your goals instead of getting hung up on instrumental tasks

More Information

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- budzik@cs.northwestern.edu