Page Rank

Last time …

- Complexity theory for MapReduce
- PageRank

Today …

- PageRank
  - Topic specific
  - Combatting spam
- Assignment 2
  - Matrix multiplication
  - Page Rank

Efficient Computation of PageRank

- Transition Matrix M is very sparse
- Store locations of non-zero entries
- In general for sparse matrices
  - (i, j, M_{ij}) → 4+4+8 bytes
- Further compression possible for transition matrix
  - Store degree of column plus indices
  - Number of links on a page plus the indices of those pages

Topic Sensitive PageRank

- Weight certain pages more because of their topic
- Allows personalization of results to users
  - Ideally a separate page rank vector for each user
  - Not scalable
- Create one vector for each of a small set of topics
  - Basis vectors
  - Determine weights for each individual user
    - size → number of basis vectors

Biased Random Walks

- Identify certain pages that represent a given topic
- (re) introduce random surfers to only topic specific pages
- Let S be the set of integers consisting of the indices of topic-specific pages, and $\boldsymbol{e}_S$ be a vector that is 1 in S and 0 elsewhere
- Topic sensitive PageRank

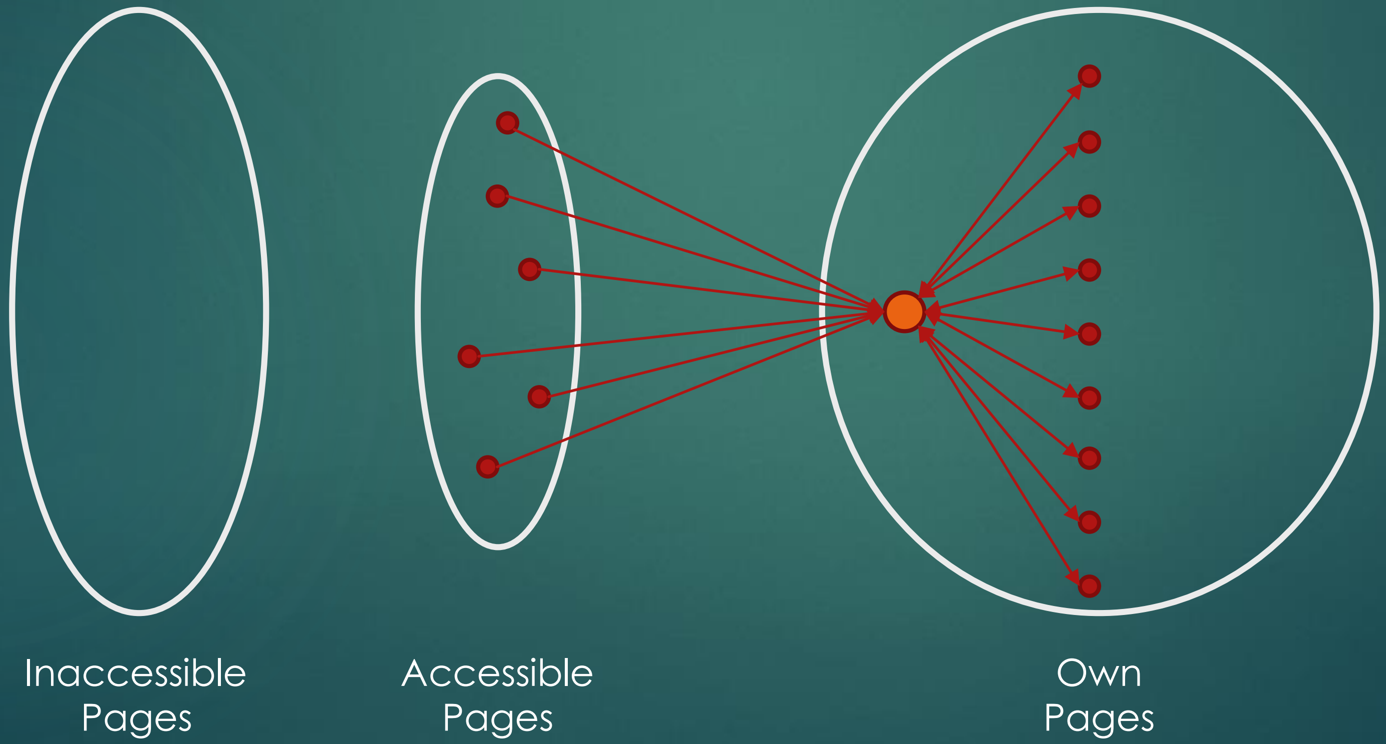
$$v' = \beta M v + \frac{(1-\beta)e_S}{|S|}$$

Using topic-sensitive PageRank

- Decide on the topics for which we shall create specialized PageRank vectors
  - Manually
  - From Data
- Pick the set S for each of these topics, and use that set to compute the topic-sensitive PageRank vector for that topic
- Determine which topics are of most interest to a particular user/query
- Use the PageRank vectors for those topics in ordering the results

Link Spam

- Techniques for artificially increasing the PageRank of a page
- Spam Farm



Analysis of a Spam farm

- β → taxation parameter
- n → total number of webpages
- Target t with m supporting pages
- Let x be the amount of PageRank contributed by accessible pages
- Let us compute y, the PageRank of t

Analysis of a Spam farm

- PageRank of each supporting page

$$\frac{\beta y}{m}+\frac{1-\beta}{n}$$

- PageRank of target

$$y=x+\beta m\left(\frac{\beta y}{m}+\frac{1-\beta}{n}\right)+\frac{1-\beta}{n}$$

Analysis of a Spam farm

- PageRank of each supporting page

$$\frac{\beta y}{m} + \frac{1-\beta}{n}$$

- PageRank of target

$$y = x + \beta^2 y + \beta(1-\beta)\frac{m}{n}$$

Analysis of a Spam farm

- PageRank of each supporting page

$$\frac{\beta y}{m} + \frac{1-\beta}{n}$$

- PageRank of target

$$y = \frac{x}{1-\beta^2} + \frac{\beta}{1+\beta}\frac{m}{n}$$

- If $\beta = 0.85$

Analysis of a Spam farm

- PageRank of each supporting page

$$\frac{\beta y}{m} + \frac{1-\beta}{n}$$

- PageRank of target

$$y = 3.6\,x + 0.46\,\frac{m}{n}$$

Combating Link Spam

- *TrustRank*: variation of topic-sensitive PageRank
- *Spam mass*: calculation that identifies spam farms

Trust Rank

- topic-sensitive PageRank, where the *topic* is a set of pages believed to be trustworthy
- Manually select trustworthy pages
- Avoid trustworthy sites where anyone can create links
  - Many websites prevent users from entering URLs in comments
- Domains where membership is controlled
  - .edu .gov etc …

Spam Mass

- Measure the fraction of the pagerank that comes from spam
- Compute the ordinary pagerank (r) and trustrank (t) of a page
  - Spam mass $= \frac{r-t}{r}$
- Negative or small positive spam mass → not spam
- Closer to 1 → spam