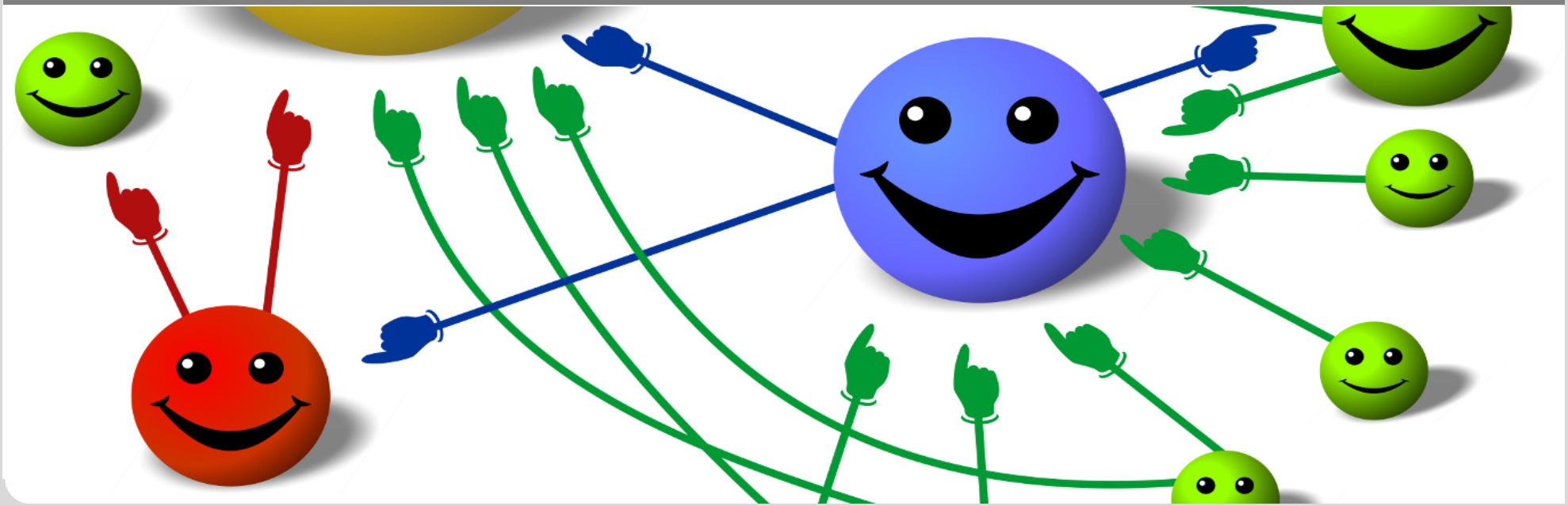
Karlsruhe Institute of Technology

How Google searches work

History, Algorithm

Martin Thoma, Benjamin Lipp | 7th of February, 2013

SPRACHENZENTRUM



Contents

The early days

In the beginning, there were only web catalogues (maintained by hand)

The early days

Web crawler

Basics

- Humans know what is good for them
- Humans create Websites
- Humans will only link to Websites they like

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- Simply count number of links to a Website
- ✗ 10,000 links from only one page
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- ✗ Quality of the page matters
- ✗ Total number of links on the source page matters

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A brilliant idea

Sergey Brin

Larry Page

Ideas of PageRank

- Decisions of humans are complicated
- A lot of webpages get visited

$\Rightarrow$ modellize clicks on links as random behaviour

- Links are important
- Links of page A get less important, if A has many links
- Links of page A get more important, if many link to A

$\Rightarrow$ if B has a link from A, the rank of B increases by $\frac{Rank(A)}{Links(A)}$

if A links to B **then**

$$Rank(B) \mathrel{+}= \frac{Rank(A)}{Links(A)}$$

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Ants

- Websites = nodes = anthill
- Links = edges = paths
- You place ants on each node
- They walk over the paths
  (at random, they are ants!)
- After some time, some anthills will have more ants than others
- Those hills are more attractive than others
- # ants is probability that a random user would end on a website

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Mathematics

Let x be a web page. Then

- $L(x)$ is the set of Websites that link to x
- $C(y)$ is the out-degree of page y
- α is probability of random jump
- N is the total number of websites

$$PR(x) := \alpha \left(\frac{1}{N}\right) + (1-\alpha) \sum_{y \in L(x)} \frac{PR(y)}{C_y}$$

Pseudocode

function PageRank(Graph web, double $q = 0.15$, int $iterations$)
    for all $page \in G$ **do**
        $page.pageRank = \frac{1}{|G|}$ ▷ intial probability
    end for
    while $iterations > 0$ **do**
        for all $page \in G$ **do** ▷ calculate pageRank of $page$
            $page.pageRank = q$
            for all $y \in L(page)$ **do**
                $page.pageRank \mathrel{+}= \frac{y.pageRank}{C(y)}$
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What you've learned

- Web catalogues
- Webcrawler
- Graph (nodes, eges)
- Random walk (ants)
- PageRank
- Read Pseudocode

Image sources

- PageRank by Felipe Micaroni Lalli
- Sergey Brin by enlewof
- Larry Page by aweigend

Thank you for your attention!