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Exercises to

Swarm Intelligence

Summer 2022

Sheet 6

These problems are for the meetings on June 21st/24th and on June 28th/July 1st. Please start implementing your solutions at home before visiting the meetings. The room will always be *0.157-115 – CIP Pool EEI*, the times will be the regular exercise times.

Problem 16:

(a) Implement Kleinberg's HITS algorithm presented in the lecture and apply it to the graph $S_\sigma = (V_{S_\sigma}, E_{S_\sigma})$, which is given as XML-file *graph.xml*[1] available on the StudOn page for the course in the directory "Exercises/Sheet 06."

This can be interpreted as the query with $\sigma =$ *Algorithmus*.

What hub weight and authority weight do you get for each chapter?

Note:

- HITS-Algorithm:
  1: Initialize hub weights $y^{\langle p \rangle}$ and authorities $x^{\langle p \rangle}$ of all chapters p to 1
  2: **while** maximum number of iterations not reached **do**
  3: **for all** chapters p **do**
  4: $x^{\langle p \rangle} = \sum_{q:(q,p)\in E_{S_\sigma}} y^{\langle q \rangle}$
  5: **end for**
  6: **for all** chapters p **do**
  7: $y^{\langle p \rangle} = \sum_{q:(p,q)\in E_{S_\sigma}} x^{\langle q \rangle}$
  8: **end for**
  9: Normalize such that $\sum_{p\in V_{S_\sigma}} (x^{\langle p \rangle})^2 = 1$ and $\sum_{p\in V_{S_\sigma}} (y^{\langle p \rangle})^2 = 1$
  10: **end while**
- Simple XML parsers that you can use to read in the input graph are given on the StudOn page in the directory "Exercises/Sheet 06":
  * *DumbXMLParser.java*, *DumbXMLParser2.m*, *DumbXMLParser3.cpp*

(b) Compare the ranking determined by the HITS algorithm with the output of the PageRank algorithm you implemented for Sheet 5.[2].

[1] The book graph ("which chapter refers to which?") of the *Taschenbuch der Algorithmen (engl.: Algorithms Unplugged)*, Springer, 2008. (`doi:10.1007/978-3-540-76394-9`)

[2] The PageRank results are available on the StudOn page for the course in the directory "Exercises/Sheet 06"

What similarities and differences do you notice? Can you explain them? Which output would you prefer when searching for $\sigma = \textit{Algorithmus}$?

(c) Analyze the speed of convergence experimentally. After how many iterations do you have a result that matches the result after 1000 iterations to within 5 digits?

(d) How does the initialization of the hub weights and authority weights affect your result?

(e) What happens if you do not normalize the weights (i.e., if you remove line 9 from the algorithm)?

(f) Using the HITS algorithm, determine which chapters contain relevant information related to the chapter *Traveling Salesman Problem* ("similarity query").

Problem 17:
While we are at it, which one is the "central chapter" of the *Taschenbuch der Algorithmen*? Calculate the three indicators of centrality you learned about in Problem 15 on Sheet 5.

- Note that the book graph is directed. Do you adjust the measures to the directed case, or do you take the direction from the edges? Discuss both approaches.
- The Floyd-Warshall algorithm for calculating the lengths of all the shortest paths in a graph can be extended to compute their number as well.

  The non-extended algorithm can be found on:

  `https://en.wikipedia.org/wiki/Floyd-Warshall_algorithm`