Credit Allocation Problems

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Credit Allocation

Credit allocation is to solve the problem that how to allocate credits to the coauthors of a joint work. It's a.k.a credit assignment.

- Collaboration among researchers is a vital component in academia.
- No general guideline to place authors: contribution, seniority or alphabetical ordering.
- Number of coauthors is increasing.

There are several common factors that affect the allocation, including the order of the coauthors, the number of coauthors [?] and the reputation in the community [?, ?].

Existing Methods

Shen and Barabási [?] developed a collective credit allocation procedure. It estimates the credits to the coauthors based on the votes from the whole community rather than the coauthors themselves.

Xu et. al. [?] investigated 15 authors credit-assignment schemas. These schemas rely on the order of the coauthors and the total number of coauthors in the publications. These approaches present obvious similarity and strong correlation.

Based on [?], Bao and Zhai [?] proposed to incorporate a reinforcement mechanism and a power-law temporal relaxation function.

Shen's Method

- Target Paper: p_0
- Authors: $\mathcal{A} = \{a_1, a_2, \ldots, a_m\}$
- Papers Citing: $\mathcal{D} = \{d_1, d_2, \ldots, d_\ell\}$
- Papers Co-cited: $\mathcal{P} = \{p_0, p_1, p_2, \ldots, p_n\}$

The credit shares of a coauthor is determined by whether she continues working with other coauthors on the topic of p_0. Here, the set $\mathcal{D}$ plays as a committee from the same community, and the citations are their votes. A bipartite network can be constructed.

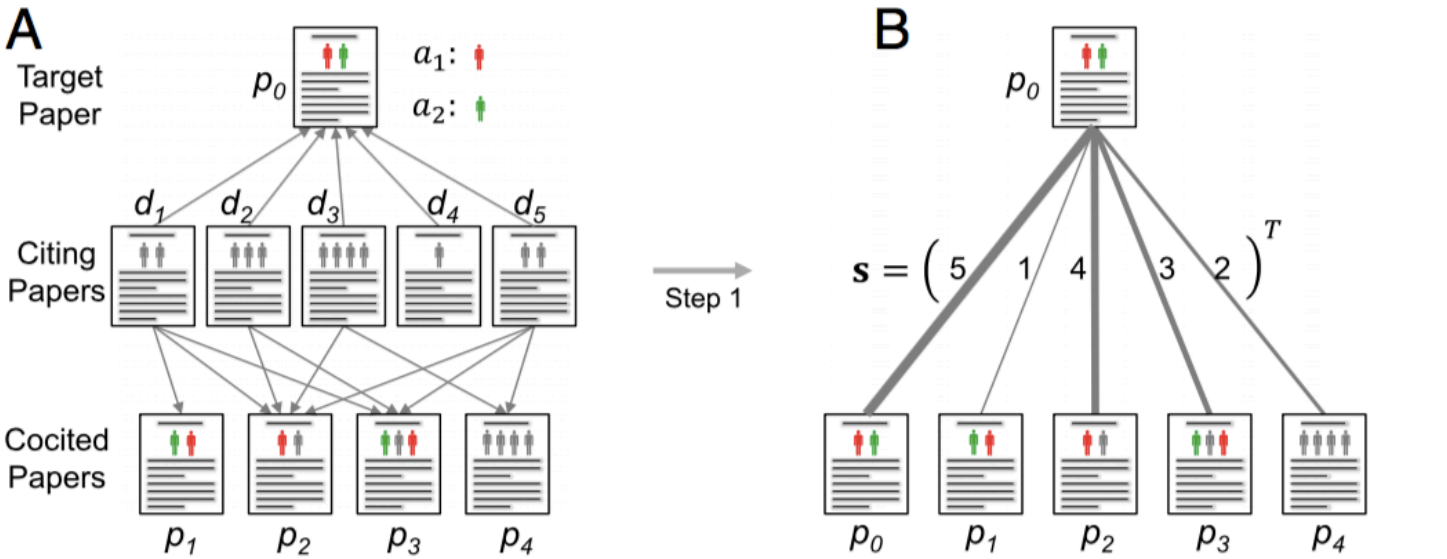
Shen's Method

The credit share of a_i in p_0 is computed with the formula:

$$c_i = \sum_{j=1}^{n} A_{ij} s_j,$$

where A_{ij} is the credit a_i earns from the cocited paper p_j, and each coauthor gets the same amount of shares from p_j. The relevance level (or cocitation strength) s_j of p_j to p_0 is defined as the number of documents in $\mathcal{D}$ referring both p_0 and p_j.

Shen's Method



C

Papers	Author lists
p_0	
p_1	
p_2	
p_3	
p_4	

Step 2 $\mathbf{A}=$

	p_0	p_1	p_2	p_3	p_4	
	0.50	0.50	0.50	0.33	0.00	
	0.50	0.50	0.00	0.33	0.00	

Credit Allocation Matrix

D

Step 3

E

$\mathbf{c} = \mathbf{As} = \begin{pmatrix} 6.0 \\ 4.0 \end{pmatrix} \propto \begin{pmatrix} 0.6 \\ 0.4 \end{pmatrix}$

Credit Share

Priors

There are various author-list based prior rules to construct the credit allocation matrix A:

Disciplines	Priors				
	Count	Fractional	Harmonic	Axiomatic	Zhang
Physics	76%	76%	52%	44%	68%
Chemistry	71%	83%	67%	67%	88%
Medicine	86%	86%	43%	36%	100%
Overall	76%	81%	56%	51%	82%

Priors

- Count prior: Each author of paper p_j gets one credit.

$$A_{ij} = I\{a_i \in p_j\}$$

- Fractional Prior: All authors of paper p_j equally share one credit

$$A_{ij} = I\{a_i \in p_j\}/n_j$$

  where n_j is the number of coauthors in p_j
- Harmonic Prior: All authors of paper p_j share one credit, where the share of the ith author is proportional to the reciprocal of its rank in the author list.

$$A_{ij} = \frac{1}{i} / \sum_{k=1}^{n_j} \frac{1}{k}.$$

Priors

- Axiomatic Prior: All authors of paper p_j share one credit without exogenous information

$$A_{ij} = \frac{\sum_{k=1}^{n_j} \frac{1}{k}}{n_j}.$$

- Zhang's Prior: The total credit of all authors is 3. The first author and corresponding author each get one credit. The remaining authors placed at rank $i (1 \leq i \leq n_j - 2)$ gets credit

$$A_{ij} = \frac{2(n_j - i)}{(n_j + 1)(n_j - 2)}$$

Modified

Total credits C for all papers, including both the cocited and citing papers.
The qualities of the citing papers are also important, because their importance can affect the cocitation strength vector s. Let $w_1, w_2, \ldots, w_\ell$ be the importance score of the citing papers. We modify Shen's method with the information:

$$s_i' = \sum_{j=1}^{\ell} w_j I\{p_i \text{ is cited by } d_j\}.$$

The importance of a paper is proportional to its total credits earned from all its authors:

$$\begin{cases} C &= \sum_i w_i, \\ w_i &= \sum_j c_{ij}. \end{cases}$$

Datasets

- American Physical Society (APS)
  - Period: $1893-2009$
  - Papers and citations from all the 11 journals of APS
  - $463,348$ papers, $4,710,547$ citations, and $248,738$ authors
- Web of Science (WOS)
  - Period: $1955-2012$
  - Multidisciplinary
  - $37,553,657$ papers, $672,321,250$ citations, and $8,724,394$ authors

Evaluation

To evaluate the performance, the Nobel-prize winning papers in Physics (1995 - 2013), Chemistry (1998 - 2013), Medicine (2006 - 2013) and Economics (1998 - 2013) are collected to build the citation network. The credit allocation algorithm produces a credit share for each coauthor appeared in the awarding Nobel Prize papers.

The experimental results indicated that Sen's method performs very well, and successfully assigns the Nobel-prize winners the highest credit share in the awarding papers.

Further Studies

- Integrating both the order of coauthors and the contextual info to design better credit allocation matrix $A = (A_{ij})_{i=m}^{n+1}$
- Differentiate the values of the citing papers $\mathcal{D}$ because of the reputation differences, produce more reliable relevance estimation of s (link-analysis based analyze over all papers)
- Authors' institutions and contextual text of the citation(definition, ideas)