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First and Others credit-assignment schema for evaluating the academic contribution of coauthors

Key words: Bibliometrics; Credit of coauthorship; *H*-index; Informetrics; Scholar information

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Introduction

- Credit-assignment schemas are widely applied by providing fixed or flexible credit distribution formulas to evaluate the contributions of coauthors of a scientific publication. In this paper, we propose an approach named First and Others (F&O) counting.
- (1) flexible assignment of credits by modifying the formula (with the change of α) and applying preference to the individual author by adjusting the weights (with the change of β), and (2) calculation of the credits by separating the formula for the first author from others. With formula separation, the credit of the second author shows an inflection point according to the change of α.
- Through a comparative analysis using a set of empirical data from the fields of chemistry, medicine, psychology, and the Harvard survey data, the performance of the F&O approach is compared with those of other methods to demonstrate its benefits by the criteria of lack of fit and coefficient of determination.

The Definitions of F&O and parameters

Definition 1 First and Others counting, F&O(i, N), is defined to estimate the contributions of the ith (i=1, 2, …, N) coauthor of a publication:

$$\mathrm{F\&O}(i,N) = \begin{cases} 1-\sum_{j=2}^{N}\mathrm{F\&O}(j,N), & i=1, \\ \dfrac{\beta}{i+(N-\alpha)}, & i=2,3,\ldots,N,\ \alpha \le N, \end{cases} \tag{10}$$

where 0≤F&O(i, N)≤1 (i=1, 2, ..., N) and α and β are the selected values.

Normative credit contributions by F&O

Table 2 Credits by F&O for up to six authors (α=1.5, β=1)

Number of authors (N)	F&O(i, N)					
	i=1	i=2	i=3	i=4	i=5	i=6
1	1.000					
2	0.600	0.400				
3	0.492	0.286	0.222			
4	0.442	0.222	0.182	0.154		
5	0.413	0.182	0.154	0.133	0.118	
6	0.394	0.154	0.133	0.118	0.105	0.095

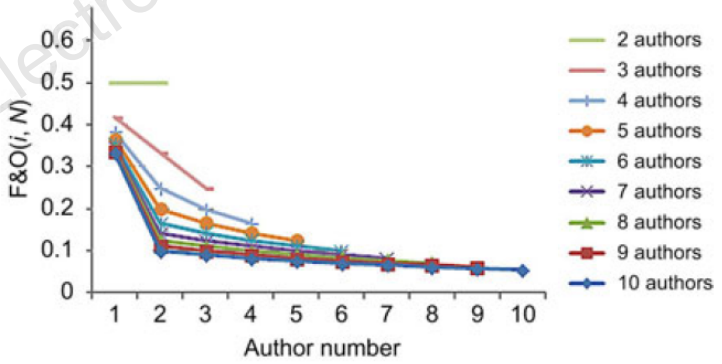

Fig. 1 Distribution of credits for authors by F&O (α=2 and β=1) (References to color refer to the online version of this figure)

Theorem 2 If no coauthors claim preference contribution, the credit of the second author by F&O counting acts as an inflection point in the credit distribution according to the change of α. Specifically, when α=2, there is F&O(2, N)=1/N for this point.

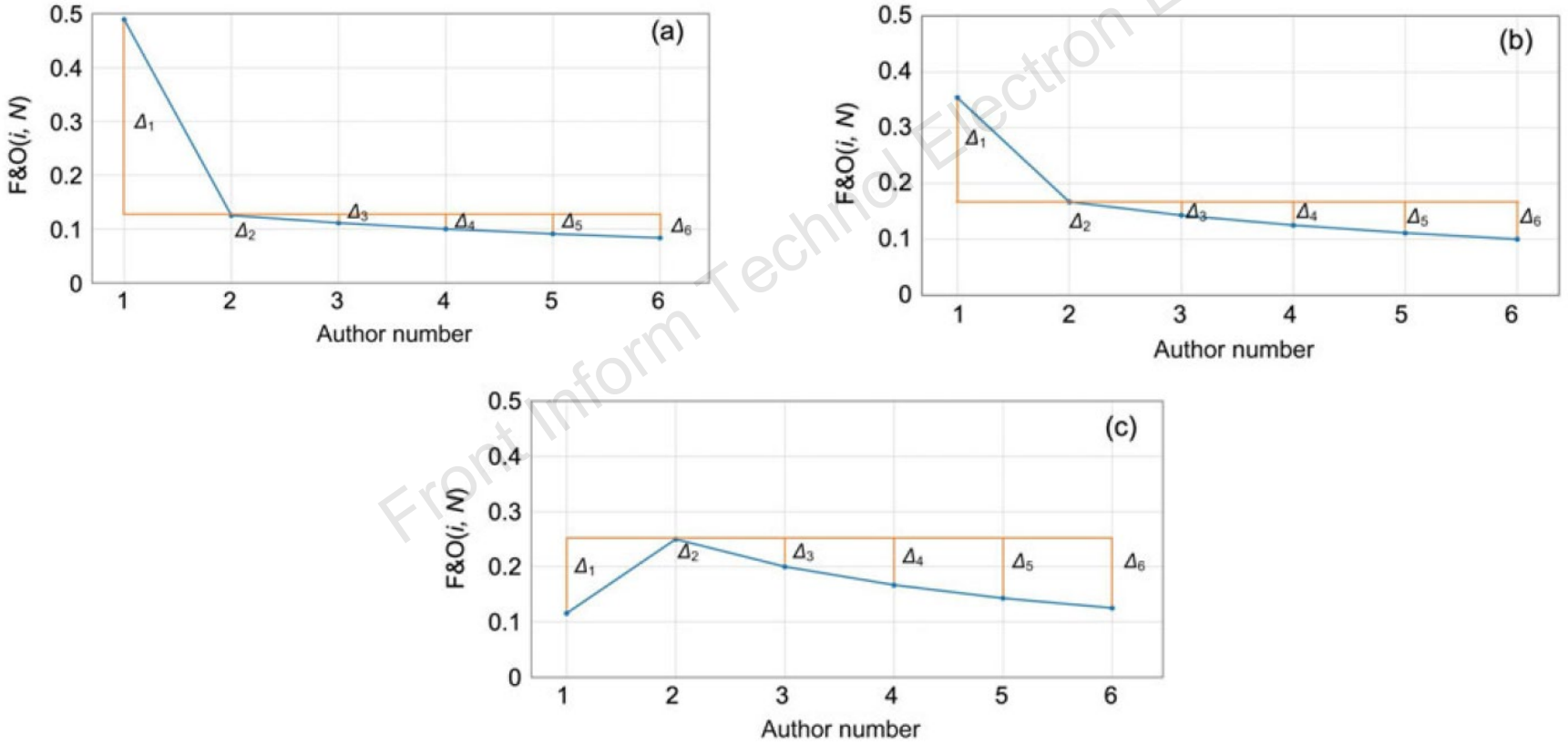

Fig. 2 F&O counting with α=0 (a), α=2 (b), and α=4 (c) (β=1 and N=6)

Generalization of Coles and harmonic countings

Remark 1 If no coauthors claim preference contribution, i.e., $\beta=0$, F&O counting behaves as Coles counting and implements straight counting for the first author.

Remark 2 If no coauthors claim preference contribution, $\alpha=N$ and $\beta=1/(1+1/2+1/3+\cdots+1/N)$, F&O counting yields credit distribution in the same form as harmonic counting: $\text{F\&O}(i, N)=\beta/i$ ($i=2, 3, \ldots, N$) and $F(1, N)=1-\sum_{i=2}^{N}\text{F\&O}(i,N)$.

Lack_of_fit between observation and prediction

Table 6 Lack of fit between observation and prediction

Model	lack_of_fit			
	Self focused	Other focused	Higher view	Lower view
Geometric	0.0532	0.0381	0.0573	0.0682
A index	0.0520	0.0370	0.0566	0.0664
F&O (α=1, β=1)	0.0130	0.0081	0.0121	0.0324
Harmonic	0.0099	0.0047	0.0104	0.0226
Arithmetic	0.0089	0.0073	0.0111	0.0104
F&O (α=2, β=1)	0.0012	0.0041	0.0008	0.0049

Comparison of the coauthor credits between the empirical data and prediction models

Table 7 Comparison of the coauthor credits between the empirical data and prediction models

Subfield	Author number	Credit								
		Empirical	Liu and Fang (2012)		Lukovits and Vinkler (1995)		Trueba and Guerrero (2004)		F&O	
			q=0.89	q=1.0	H=10	H=21	f=1/3, c_1=0.5	f=1/3, c_1=0.7	α=1.5, β=1	α=1.0, β flexible
Chemistry	1	0.40	0.4089	0.4380	0.4162	0.4488	0.3296	0.3963	0.4134	0.4183
	2	0.25	0.2206	0.2190	0.2081	0.2048	0.3148	0.1982	0.1818	0.2500
	3	0.15	0.1538	0.1460	0.1503	0.1425	0.1333	0.1537	0.1538	0.1429
	4	0.10	0.1191	0.1095	0.1214	0.1113	0.1185	0.1333	0.1333	0.1000
	5	0.10	0.0976	0.0876	0.1040	0.0926	0.1037	0.1185	0.1176	0.0889
lack_of_fit			0.0018	0.0026	0.0032	0.0044	0.0084	0.0062	0.0093	0.0006
Medicine	1	0.34	0.3148	0.3285	0.3122	0.3268	0.3296	0.2972	0.2976	0.3341
	2	0.12	0.1538	0.1460	0.1503	0.1425	0.1333	0.1537	0.1538	0.1429
	3	0.08	0.1191	0.1095	0.1214	0.1113	0.1185	0.1333	0.1333	0.1000
	4	0.07	0.0976	0.0876	0.1040	0.0926	0.1037	0.1185	0.1176	0.0889
	5	0.38	0.3148	0.3285	0.3122	0.3268	0.3148	0.2972	0.2976	0.3341
lack_of_fit			0.0109	0.0061	0.0121	0.0068	0.0097	0.0195	0.0192	0.0045
Psychology	1	0.42	0.4531	0.4800	0.4747	0.5048	0.4000	0.4333	0.4421	0.4195
	2	0.24	0.2445	0.2400	0.2278	0.2212	0.2444	0.2278	0.2222	0.2400
	3	0.19	0.1704	0.1600	0.1646	0.1538	0.1556	0.1556	0.1818	0.1833
	4	0.15	0.1319	0.1200	0.1329	0.1202	0.2000	0.1833	0.1538	0.1571
lack_of_fit			0.0024	0.0069	0.0044	0.0106	0.0071	0.0049	0.0010	0.0002
R^2			0.9457	0.9431	0.9232	0.9197	0.9123	0.9109	0.9011	0.9817

Summary and comparison of Bibliometric counting

Table 9 Summary and comparison of bibliometric counting

Model	Counting	Distribution method	lack_of_fit/R^2	Flexible formula	Flexible weight(s)
N/*N*	Whole	One score for each	No fitting	–	–
1/*N*	Fractional	1/*N* for each	0.1121/0.0363	–	–
S/*N*	Arithmetic	Sequence-determines-credit (SDC)	0.0200/0.8440	Yes (α)	–
	Geometric		0.0136/0.9595	–	–
	A index		0.0087/0.9346	–	–
	L&V		0.0068/0.9197	Yes (T)	–
	Harmonic		0.0061/0.9431	–	–
	NBA		0.0058/0.9102	Yes (d)	–
	F&O		0.0045/0.9817	Yes (α)	Yes (β)
U/*N*	T&G	First-corresponding-author-emphasis (FCAE)	0.0097/–	–	Yes (f, c)
	UF&O		0.0069/–	Yes (α)	Yes (β)

Conclusions

- In studying relevant credit-assignment schemas (e.g., arithmetic, A-index, geometric, harmonic, and others), we cited four models (i.e., N/N, 1/N, S/N, and U/N) for evaluating coauthor contribution. We proposed a First and Others (F&O) schema and introduced the tuning parameter α and weight β to make the evaluation model more attuned to actual contribution levels. By changing α, the ratio of credits between the first author and others can be adjusted in the F&O approach. By the separation of the calculation in F&O, the credit of the second individual shows an inflection point in the distribution.
- This paper applies nine existing theoretical schemas together with F&O to completely analyze the survey data provided by Harvard University and the University of Chicago and a set of empirical data form chemistry, medicine, and psychology. The analyses demonstrated the practicality and utility of the proposed new schema.