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# A categorization of arguments for counting methods for publication and citation indicators $\stackrel{\star}{}$

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#### ABSTRACT

Most publication and citation indicators are based on datasets with multi-authored publications and thus a change in counting method will often change the value of an indicator. Therefore it is important to know why a specific counting method has been applied. I have identified arguments for counting methods in a sample of 32 bibliometric studies published in 2016 and compared the result with discussions of arguments for counting methods in three older studies. Based on the underlying logics of the arguments I have arranged the arguments in four groups. Group 1 focuses on arguments related to what an indicator measures, Group 2 on the additivity of a counting method, Group 3 on pragmatic reasons for the choice of counting method, and Group 4 on an indicator's influence on the research community or how it is perceived by researchers. This categorization can be used to describe and discuss how bibliometric studies with publication and citation indicators argue for counting

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#### 1. Introduction

Publication and citation indicators are often used in policy reports about research and many bibliometric research studies focus on the development of new indicators. The choice of counting method is an inevitable and important step in calculating an indicator. A wide range of counting methods can be used to allocate credit for a publication and its citations to the authors, to the authors' institutions, to the journals they have published in, etc. It is well-documented that for multi-authored publications, a change in counting method will often change the value of an indicator and sometimes the conclusion of an analysis (see e.g. Gauffriau, Larsen, Maye, Roulin-Perriard, & von Ins, 2008). Therefore, to fully understand an indicator, it is important to know why a specific counting method has been applied. In this paper, I will show that there are at least four groups of arguments for counting methods.

My objective is twofold:

- 1. to identify arguments for counting methods for publication and citation indicators in a sample of recent bibliometric studies
- 2. to use the identified arguments to develop a categorization of arguments for counting methods for publication and citation indicators.

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I aim to facilitate the discussion concerning the application of counting methods in bibliometric studies and policy reports. The categorization of arguments for counting methods can help researchers describe and discuss their choice of counting method in a specific study. This information can be used by other researchers and policymakers when assessing and using the study. The categorization can also offer an overview of how counting methods are used across bibliometric studies. Ultimately, how we argue for counting methods may reveal tacit knowledge about what publication and citation indicators measure and add to a common understanding of these indicators.

There is a large body of literature discussing counting methods for publication and citation indicators with a focus on theoretical and methodological arguments for each counting method. This is elaborated in Section 2. To the best of my knowledge, however, there has been no systematic exploration of how researchers choose counting methods for their studies, that is, which arguments they use for a counting method. This is what I wish to analyze to establish a new way of discussing counting methods. The aim of my study is not to provide a literature review on counting methods, which would probably mainly encompass theoretical and methodological arguments. Nor is it to identify the most appropriate counting method as this would probably draw upon just one or two types of arguments and a specific purpose of an analysis. As my analysis will show, there are many very different types of arguments for counting methods, and these can be grouped in accordance with their distinct underlying logics.

#### 2. Theory

#### 2.1. Terminology

Throughout the paper, I use the terminology established by Gauffriau, Larsen, Maye, Roulin-Perriard, & von Ins, (2007, pp. 178–180), except that I replace the term normalized with fractionalized. Following this terminology, whole counting means that all authors of a publication get one credit each for the publication. If countries are the basic unit of analysis, all unique countries mentioned in the affiliation of a publication get one credit each. This counting method is called full/total/integer/whole counting, or simply number of publications/citations, or counts in many of studies in my sample. Complete fractionalized counting means that all authors of a publication share one credit for the publication. If countries are the basic unit of analysis, all countries mentioned in the affiliation of a publication share one credit. In the sample of studies, this method is often called fractional counting. Complete fractionalized counting can be divided in two sub-groups: the rank-independent in which all authors of a publication get equal shares of the credit, and the rank-dependent in which each author gets one credit and co-authors get none. There are many other types of complete fractionalized and rank-dependent counting methods, e.g. harmonic counting, arithmetic counting, geometric counting (see a short review in Waltman, 2016, p. 379–380).

#### 2.2. Background

Counting methods were discussed even in the pioneering scientometric works. In the definition of Lotka's law, Lotka wrote about the counting method: "Joint contributions have in all cases been credited to the senior author only" (Lotka, 1926, p. 323) and advanced the idea that some publications "should perhaps be considered separately since they are not the product of one person unassisted" (Lotka, 1926). Price analyzed whole, complete fractionalized, and straight counting in *Big Science, Little Science* (Price, 1963, pp. 127–129), and Cole and Cole discussed whole and straight counting in *Social Stratification in Science* (Cole & Cole, 1973, pp. 32–33).

Today, there is still a debate concerning counting methods. Counting methods are compared, and the best is selected, or new counting methods are developed. In contrast to these approaches, I focus on the arguments for the counting methods. Studies that discuss counting methods argue for counting methods too, of course, but it is the counting methods themselves that are analyzed, not the arguments. Below, I give a few examples of arguments for counting methods from one of the first studies to analyze the effect of different counting methods.

Lindsey analyzed and discussed straight, whole, and complete fractionalized counting and ultimately advocated complete fractionalized counting for publication and citation indicators as a consequence of the growing number of multi-authored publications (Lindsey, 1980). Many arguments can be identified in the analysis and discussion. Lindsey did not agree with all of them. A pragmatic argument for straight counting is that the method "greatly reduces the work required to collect data" (Lindsey, 1980, p. 146). An argument for complete fractionalized counting refers to mathematical properties: "the weights must sum to one, because what is being measured is 'one scientific paper" (Lindsey, 1980, p. 151). The next sentence in Lindsey's study is an argument for whole counting based on intuition: "Although this [fractionalization] is the logical procedure, it violates the intuitive judgment of many scientists" (Lindsey, 1980, p. 151). The examples show that the intention behind the choice of counting method can point in many directions. If this information is not available in a bibliometric study, it can lead to misinterpretation of an indicator.

A few studies have presented a dedicated analysis of and discussion on how bibliometric studies argue for counting methods. Larsen concluded that only five out of 85 studies from the *International Society for Scientometrics and Informetrics*' 2005 and 2007 proceedings argued for the choices of counting methods (Larsen, 2008, p. 237). Gauffriau et al. presented examples of arguments from the literature and discussed them from a mathematical perspective (Gauffriau et al., 2008

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