Introduction

"If I have seen further it is by standing on the shoulders of Giants."
—Isaac Newton, The Correspondence of Isaac Newton

Altmetrics

The goal of any research assessment is to evaluate the value or quality of the research in comparison to other research. As quality is highly subjective and difficult to measure, citations are used as a proxy. Citations are an important part of scholarly communication and a significant component of research evaluation, with the assumption being that highly cited work has influenced the work of many other researchers and hence it is more valuable (e.g., Moed, Burger, Frankfort, & Van Raan, 1985, Moed, De Bruin, & Van Leeuwen, 1995). Citations are thought to indicate scientific impact, but recently funders and other stakeholders are demanding evidence not only of scientific impact, but also of other types of impact, such as societal impact. More recently, we have seen new online data sources being researched for this purpose, and disruptive ideas with the power to change research assessment, and perhaps even science as a whole, have been born. *Altmetrics* is the new research area that investigates the potential of these new data sources as indicators of the impact that research has made on various audiences. This book will present some of these new data sources, findings from earlier altmetrics research, and the disruptive ideas that may radically change scholarly communication.

The advent of social media has already changed many aspects of scholarly communication; researchers can present their ideas in blogs, discuss their research with colleagues on Facebook, and share their articles on Twitter and Mendeley. Because research is increasingly being brought out from the closed scientific ecosystems to the open web, even people other than just researchers can participate in discussing research and disseminating new discoveries to a wider audience. New forms of scholarly communication require new methods for measurement of impact. Although altmetrics still lacks a widely accepted definition, the idea behind altmetrics and their potential is that the traces of scholarly communication and the attention research has received in social media could be tracked in order to discover something about the impact of that research, and thus the potential value of it.

Because of the diversity of possible data sources, data types in them, and in the audiences creating altmetrics as a byproduct from discussing and sharing research products, altmetrics are envisioned to have the potential to give a more nuanced view of the impact research has made and to reflect the attention from a wider audience. Altmetrics could be able to reveal some previously hidden aspects of the research process; to provide timelier data about the impact of research; to reflect the impact

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of a wider range of scientific products; to indicate impact from different audiences; and to provide a more nuanced view of what impact is and how it should and could be measured (Piwowar, 2013a). In addition to the possibilities connected to research evaluation and science studies, altmetrics could have some practical applications in information filtering (Priem & Hemminger, 2010). Research into these possibilities has, however, just begun.

The steps towards altmetrics

The birth of altmetrics can be traced back to a few developmental steps and a few events that have changed scholarly communication and the way we look at research evaluation. Chronologically, the first step happened when researchers started to use the web in general, and later on social media in particular, for scholarly communication. This development is still going on, as studies of the social media uptake among researchers vary, but tend to show an increasing trend. The second step happened when the Public Library of Science (PLoS) developed a system to present article-level metrics or ALMs (see section 10.3 in Chapter 10), showing not just the impact of articles, but also how articles had been viewed, discussed, and shared. The way how PLoS presents its ALMs has developed into a sophisticated system, presenting many different levels of engagement with the articles and, with that, different levels of impact. In 2010 Jason Priem, Dario Taraborelli, Paul Groth, and Cameron Neylon published the Altmetrics Manifesto (http://altmetrics.org/manifesto/), which begins by stating that "*No one can read everything. We rely on filters to make sense of the scholarly literature, but the narrow, traditional filters are being swamped. However, the growth of new, online scholarly tools allows us to make new filters; these altmetrics reflect the broad, rapid impact of scholarship in this burgeoning ecosystem. We call for more tools and research based on altmetrics*." The Manifesto emphasizes the potential of altmetrics in filtering more valuable research, and by doing so, assesses the impact of research. The Manifesto continues: "*Altmetrics expand our view of what impact looks like, but also of what's making the impact*."

The Manifesto pushed researchers, publishers, librarians, funders, and other stakeholders to think more broadly about impact and question research evaluation based on citations. It also gave a common name under which everyone could come together under and a common ground on which to work. Three days after the publication of the Manifesto, the name was presented to a wider audience quite fittingly in a tweet by Jason Priem (Figure I.1). The fourth significant step in the early development of altmetrics happened in 2012 when a group of researchers, editors, and publishers from the American Society for Cell Biology (ASCB) came together and published a declaration that is today known as the Declaration on Research Assessment (DORA). The declaration states, among other things, that the Journal Impact Factor should not be used for quality assessment of articles, researchers, or as an indicator used in hiring or funding decisions. The DORA states that research should be judged on its own merits alone, summarizing and popularizing a decade's long debate about research assessment. By popularizing the issues, DORA opened the door for article-level metrics, and, with that, altmetrics.

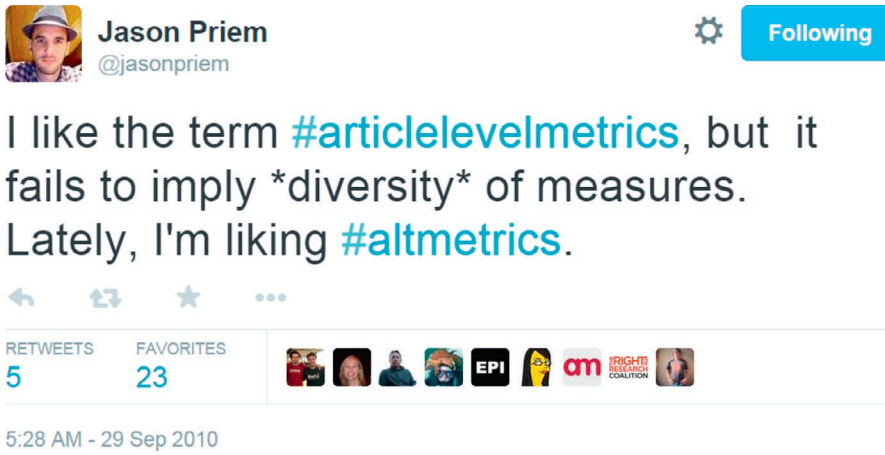

Figure I.1 First mention of altmetrics, fittingly in a tweet.

Social media is changing the way researchers search and disseminate information, leaving measurable traces of their activities behind (see Chapter 8 in Part 2), and new methods are being developed to track these traces. PLoS showed another way of measuring impact and visibility of articles, perhaps that of a wider audience (Lin & Fenner, 2013a, 2013b). The Altmetrics Manifesto gave the movement a name under which to operate. And in DORA the researchers' growing discontent with the use of Journal Impact Factors to assess the quality or impact of individual articles and researchers was manifested and popularized. Followed by some promising research results of the potential of altmetrics in research evaluation, the time was right for altmetrics to gain momentum. Important for the development of altmetrics, although not that easy to pinpoint an exact moment in time for it, has also been the trend among funders to increasingly demand evidence of societal impact of research; the funders want to know exactly how the research they have funded has made an impact on society or how it has possibly changed policy. This has nevertheless been very difficult to measure, but now, with a great deal of the altmetrics being created by the public discussing and sharing research online, there could be new avenues to investigate the societal impact of research.

Although we do not yet fully understand either the meaning or the validity of altmetrics there are already some indications that these "alternative" metrics are changing the practices of how research is evaluated, as brought up by Piwowar (2013a) in a commentary in *Nature*. According to Piwowar (2013a) the US National Science Foundation (NSF) has introduced a new policy, as the principal investigators of research applications are now asked to list their research products rather than publications. Piwowar (2013a) states that today there are more diverse research products than ever before, and that these can be discussed and shared on various social media sites, such as Twitter, YouTube, ResearchGate, Mendeley, Facebook, and many more, indicating the impact of the research products. Similarly the recent Research Excellence Framework (REF) in 2014 in the UK asked for submissions to include "*case studies describing specific examples of impacts achieved during the assessment period*" (REF, 2011).

These case studies could, for instance, include a detailed description of the cultural or societal impact that a specific research product had made or how a dataset compiled or a program developed by a researcher had made an economic impact. Research products are not limited to scientific publications anymore, as other research products such as datasets, algorithms, code, and programs can also have impact and receive attention. Similarly, the traces of scholarly communication and interest or use of different research products are no longer limited to citations alone, as various research products can be shared, commented, and referenced on the web and in social media. These traces of scholarly communication and mentions of various research products in social media could potentially reveal some information about research impact and perhaps provide, if not alternative, complementary indicators to traditional citation-based indicators of research impact.

What's in a name?

The term "altmetrics" comes from "alternative metrics," often thought of as an alternative to traditional, citation-based metrics. It should be noted that the term altmetrics refers to both the actual metrics that are being analyzed and to the research area that is concerned with analyzing these new web-based metrics (Priem, 2014). The choice of words is a bit unfortunate as many researchers have already argued that altmetrics cannot be considered as alternatives to citation-based indicators; in fact, there seems to be a consensus in the research community about this (e.g., Haustein, Bowman, Holmberg, Larivière, & Peters, 2014; Haustein, Costas, & Larivière, 2015). It is indeed of utmost importance to recognize that currently altmetrics do not stand for alternative metrics in this sense, as much more work needs to be done to fully understand the meaning of these new metrics and to validate them as reliable and relevant indicators of research impact. Therefore, altmetrics may not be the best of terms, but "complimetrics" (Adie, 2014a) or "influmetrics" (Rousseau & Ye, 2013) have not gained any support. Another option could be to call these new metrics "social media metrics," but as altmetrics can include data sources from the web in general (and not just from social media) "social media metrics" is too narrow. Some of the aggregators of altmetrics are already collecting mentions of research products from, for instance, newspapers and policy documents. On the other hand, "social media metrics" is widely used in business intelligence and social media marketing, and therefore fails to acknowledge the specificity of the use and sources of the new metrics as indicators of research impact and their potential applications in research assessment. Webometrics would be the obvious and probably a better choice, as it covers all the online data sources and it represents an already established research area that have already for over a decade investigated the potential of various online data sources to be used for research evaluation. Webometrics did, however, fail to attract wider interest to the online metrics, something that altmetrics succeeded in doing.

As altmetrics has now become the widely recognized term and it has managed to attract a vibrant community of researchers and practitioners to work together under the same title, we should perhaps alter and define what we mean by "alternative" instead of trying to come up with yet another term. The "alternative" in altmetrics could and probably should refer to something else. Adie (2014a) explains that the "alternative"

in altmetrics is the view on research metrics in general. Adie and Roe (2013) write that "*altmetrics presents an alternative to the current practice of relying only on citation counts and journal impact factors for the quantitative analysis of impact by introducing new complementary approaches and sources of data*." This emphasizes that altmetrics do not stand for alternative metrics, but rather an alternative view on research indicators and approaches to research evaluation in general. The greatest potential of altmetrics may indeed be in complementing citation-based indicators and in providing information about otherwise hidden aspects and underlying impact of scientific work. Altmetrics could "*reflect more broad views of research impact*" (Liu & Adie, 2013), including (1) a multidimensional view on scholarly communication in the networked digital world, and (2) a more nuanced view on the impact research has made beyond the scientific community. While some altmetrics are created from scholarly communication and are therefore connected to research work, an increasing body of evidence suggests that at least some altmetrics that are created by the general public may indicate some other types of impact, such as societal impact (e.g., Bornmann, 2012, 2014a). It is nevertheless important to keep in mind that altmetrics come in many forms and that some of them have shown some potential to be used as scientific impact measures, while others have not. Even though all of these different data sources are frequently referred to as altmetrics, they are very different from each other and may measure different things.

Levels of impact

Over the last couple of years, a multitude of articles and editorials presenting altmetrics to audiences from different academic disciplines have been published (e.g., Galligan & Dyas-Correia, 2013; Galloway, Pease, & Rauh, 2013; Osterieder, 2013; Barbaro, Gentill, & Rebuffi, 2014; Brigham, 2014; Crotty, 2014; Dinsmore, Allen, & Dolby, 2014). A common feature of most of these has been that they see much potential and promise in altmetrics. Some express concerns and recommend a cautious uptake, while others predict the end of scientific publishing (and with that the end of citation-based research evaluation) as it is today. Although altmetrics alone will probably not be able to deliver a disruptive change in scientific publishing or in science as a whole, altmetrics have already ignited a change in how we look at impact and research assessment.

While citations can only reflect scientific use and, with that, scientific impact, as the various altmetrics are created by a much wider audience and probably for a wider range of different purposes and motivations, altmetrics has the potential to give a more nuanced view of research impact. With altmetrics we are measuring a greater diversity of impact from a greater diversity of users. The different social media sites where research is discussed and shared reflect different types and levels of engagement with research products and, with that, different levels of impact that the research products have had. A tweet, for instance, cannot in its limited form reflect a very high level of impact, while a blog entry or Mendeley readership lists probably can. This, of course, is a simplification of the situation, but on average this appears to be the case. This possibility of measuring different levels of impact could be one of the keys to understanding the meaning of different altmetrics.

Much of the current research is testing whether altmetrics from different sources correlate with citation counts to the same articles. A strong correlation would then

suggest that the two are measuring similar aspects. While this is a useful line of research if the goal is to discover timelier indicators of impact or to predict future citations, it is of little use if we want to investigate what kind of impact research has made beyond scientific impact. If our goal is to find alternatives to citation-based evaluations, perhaps alternative indicators that would provide timelier and more democratic data, then research should focus on finding evidence that a specific social media site (or some other data source) is being used by researchers, and that the indicators built on the data from a specific social media site are valid, stable, and reliable for research evaluation. If, on the other hand, our goal is to investigate other forms of impact (e.g., economic, cultural, societal, environmental) then a low correlation with citation counts could be an indication of a promising research direction.

The questions unanswered

We have just begun investigating altmetrics and research about the meaning and validity of different altmetrics is still in its infancy. Much of the current research has focused on Twitter and Mendeley, two sites that appear to have the most extensive coverage of scientific publications (e.g., Thelwall, Haustein, Lariviére, & Sugimoto, 2013; Haustein, Larivière, Thelwall, Amoyt, & Peters, 2014; Alhoori & Furuta, 2014), but there are plenty of other venues yet to be explored. One of the challenges for altmetrics is to figure out which social media sites can provide reliable and relevant indicators. Other practical challenges relate to data collection and level of aggregation, while the more abstract challenges relate to the actual meaning and validity of altmetrics. There are still many unanswered questions of which the perhaps most current and important include:

1. Questions related to meaning of altmetrics:
   - How does online attention reflect impact?
   - Can altmetrics reflect the impact of research?
   - Can altmetrics reflect different types and different levels of impact?
   - Who creates the events underlying altmetrics on different social media sites?
   - What motivates the creation of altmetrics?
2. Questions related to validity of altmetrics:
   - How can we normalize altmetrics?
   - How can we standardize altmetrics?
   - Are altmetrics being manipulated by researchers and journals?
   - How can we detect gaming of altmetrics?
   - How do we control for the diversity of altmetrics, especially in such a dynamic environment as social media?

This book is, however, not intended to give all the answers; in fact, it will raise even more questions on the way. The aim of this book is to present some of the pieces of the puzzle that is altmetrics and to show how those pieces connect to each other. There are still many pieces missing and without all the pieces we cannot fully understand the meaning of altmetrics, but we already have enough pieces to see both the advantages and disadvantages with altmetrics.

Outline of this book

The main goal of this book is to introduce altmetrics—what they are and how they can be used—to information professionals at academic libraries and other organizations involved and interested in research evaluation and science policy, as well as to students in these areas. The book starts by presenting some of the key ideas and innovations in earlier research that have been driving the evolution from bibliometrics to webometrics, and with the advent of social media to altmetrics.

The first part of the book will discuss the past of altmetrics, its origins, its scientific roots, and its connection with bibliometrics and webometrics. In many aspects the past of altmetrics is also the past of bibliometrics and webometrics, but it needs to be emphasized that the beginning of altmetrics does not mean the end of bibliometrics or webometrics. The three research areas are developing side by side, learning from each other, complementing each other. The first part of the book will give an overview of scholarly communication and the research methods involved in "counting, measuring, and weighing" it, namely bibliometrics and, more recently after the advent of the web, webometrics to analyze scholarly communication on the web. The shortcomings and pitfalls of bibliometrics in research evaluation will be discussed and the current standards and practices for most reliable bibliometric analyses will be presented. With that, the technical developments and societal changes that paved the way for altmetrics will be presented. The first part of the book will end by focusing on developments in social media, which as an increasingly important place for scholarly communication, has made altmetrics possible.

In the second part, current altmetrics research is presented. This part begins with an overview of scholarly communication on the web, its potential, and current status. This is followed by an overview of some of the sources of these new online metrics. The service providers or aggregators of altmetrics are briefly presented, followed by a discussion of the different stakeholders. There are many stakeholders connected to altmetrics, all of whom can use them somewhat differently and benefit from them in various ways. Some of the earlier research of altmetrics will be presented; research that has pushed the development of altmetrics forward and continues to push it as the web evolves and the way we use the web changes.

The third and final part of the book will begin with a discussion about how altmetrics are created partly by researchers and partly by the public, how altmetrics can be detected and collected, and how they can be used to measure reach and impact. This part of the book will envision possible directions of how to measure impact and how the indication of different levels of impact could be used in altmetrics. A possible concern related to altmetrics that will be discussed in this book is the possible unintentional and intentional gaming of the metrics that may occur and that may have a significant impact on the results from any analysis where these "alternative" metrics are being used. The book will end with a discussion about future trends in altmetrics research and some possible directions where the area may develop.