International Journal of Accounting Information Systems xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

International Journal of Accounting Information Systems

journal homepage: www.elsevier.com/locate/accinf

"The reports of my death are greatly exaggerated"—Artificial intelligence research in accounting

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ARTICLE INFO

Article history:
Received 6 June 2015
Received in revised form 14 September 2015
Accepted 14 July 2016
Available online xxxx

Keywords:
Artificial intelligence
Expert systems
Knowledge based systems
Machine learning
Audit
Accounting

ABSTRACT

Gray et al. (2014) examined the productivity of expert systems/artificial intelligence research in accounting and came to the conclusion that both research on and practice use of expert systems/artificial intelligence had waned since the late 1990s. In our study, we reconsider these findings based on a broader view that is 'artificial intelligence' centric versus 'expert systems' centric. The results show that while there was a bit of a lull in the late 1990s, artificial intelligence research in accounting has continued to steadily increase over the past 30 years. Further consideration of artificial intelligence techniques as embedded modules in integrated audit support systems also suggest that use by practice continues to be robust. Based on these findings, we make a call for much more research on the usability, and use, of artificial intelligence techniques in accounting domains. Contrary to earlier perceptions, the research domain remains vibrant and holds great potential for AIS researchers to take a leadership role in advancing the field.

1. Introduction

Gray et al. (2014) analyze expert systems/artificial intelligence research in accounting through the lens of the life cycle of technology and paints a fairly bleak picture of the state of AIS research during a time of explosion in artificial intelligence applications outside of accounting (Brynjolfsson and McAfee, 2014). The findings of Gray et al. (2014) suggest that AIS research on expert systems/artificial intelligence has waned over the last decade plus, and suggest this may have been fueled by the abandonment of expert systems by the major accounting firms. However, this perceived abandonment of expert systems/artificial intelligence by the accounting firms appears in stark contrast with recent studies reporting extensive use of artificial intelligence in integrated audit support systems (Dowling and Leech, 2007, 2014), the targeting of management accounting practice by business intelligence vendors (Elbashir et al., 2011), and the calls for greater understanding of machine learning principles by accounting graduates (PwC, 2015, AACSB International Committee on Accreditation Policy, 2014).

The purpose of this study is to revisit the foundations underlying Gray et al. (2014) with an emphasis on the artificial intelligence side of the expert systems/artificial intelligence nexus in an effort to reconcile these differences in the literature and to better understand the role accounting academics should play in the future of artificial intelligence in accounting. The rationale behind this focus on artificial intelligence is that expert systems are a subclass of artificial intelligence applications, and the use of the more general classification of artificial intelligence seems the more relevant concern.[1] It is potentially less concerning if expert systems have simply waned and are

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[1] For simplicity purposes, the Webopedia definition for expert system provides a fairly succinct explanation: "A computer application that performs a task that would otherwise be performed by a human expert… Some expert systems are designed to take the place of human experts, while others are designed to aid them. Expert systems are part of a general category of computer applications known as *artificial intelligence* (emphasis added)."

http://dx.doi.org/10.1016/j.accinf.2016.07.005
1467-0895/

being supplemented by other forms of intelligent systems that are possibly more advanced and are actually moving the research and practice disciplines forward, as opposed to the declining nature of being late in the life cycle or the so-called maturing and degrading phase of the Gartner Hype Cycle (Fenn and Linden, 2005; O'Leary, 2008; Gray et al., 2014).

To achieve this objective, this study first addresses the literature analysis as presented in Gray et al. (2014). Their study focused on the use of two search terms: *expert systems* and *artificial intelligence*. However, as noted in Gregor and Benbasat's (1999, 498) seminal paper on explanation facilities,

> "[K]nowledge-based (expert) systems (KBS) and intelligent systems in general, are important components of an organization's information systems portfolio… what we will label generically "intelligent systems" to indicate a broader focus than that of traditional KBS. The distinguishing feature of intelligent systems is that they commonly contain a knowledge component—a computerized version of human tacit and explicit knowledge. Such systems are based on the basic elements of artificial intelligence: knowledge representation, inference and control."

This dance across terminology presented in the opening paragraphs of their paper highlights the complexity of defining the research area in narrow terms. As such, an effort is made in this study to use a broad set of search terms including artificial intelligence, expert systems, knowledge-based systems, intelligent systems, and so forth. The result is a very different conclusion on where AIS lies in the life cycle as the past decade reflects growth rather than decline in related research.

These findings lead to a further examination of the state of artificial intelligence use by accounting professionals in practice. Again, our research shows that the use of artificial intelligence in supporting knowledge-based systems is alive and well among accounting professionals; with a new emphasis on data analytics and the associated use of machine learning techniques, increased use of artificial intelligence in the future seems inevitable.

Based on these combined findings, our focus shifts to a discussion of the extant literature on artificial intelligence in accounting with an eye towards how academics can once again take a leadership role in the application of artificial intelligence techniques to support accounting decision making. This discussion also highlights the necessity for academics to assume the role of a conscience to the profession in highlighting the ethical and epistemological concerns that come with the likely increased use of artificial intelligence techniques.

This research contributes to the literature in several ways. First, the results provide a clearer picture of the role artificial intelligence has played in the extant accounting research and the sustained vibrancy of the research domain. Second, a bridge is established between early standalone expert systems applying artificial intelligence techniques and the more contemporary approach in practice of using integrated systems with expertise embedded into an array of intelligent systems. Third, the groundwork laid with the previous two contributions leads to the presentation of an agenda for research that can place AIS researchers in a leadership position in the advancement of artificial intelligence in accounting practice and establishes the vital role that researchers have in the overall ecosystem of artificial intelligence application in accounting domains.

The remainder of this paper is presented in four sections. The second section presents a reanalysis of the AIS publication history in the area of artificial intelligence. Section three follows with a reanalysis of the use of artificial intelligence in accounting practice. The fourth section focuses on future research directions while the final section provides a brief summary and conclusions.

2. Artificial intelligence life cycle in AIS research

At the heart of the Gray et al. (2014) study is a search for publications since 1980 that are at the intersection of artificial intelligence/expert systems and accounting. This set of identified publications become their basis for assessing (1) whether AIS research in the domain is in decline indicating a maturity and loss of interest, (2) who the major contributors to the research domain are, and (3) what universities have been the greatest producers of dissertations in the domain. The key is that everything in the Gray et al. (2014) study revolves around the initial search for publications.

There is no reason to question the accuracy of the study's data and results based on the authors' defined criteria. Gray et al. (2014, 433–434) conducted an extensive search for articles from the major databases including EbscoHost, Science Direct, Wiley, and Scopus. The initial searches were based on three pairs of key words: "expert systems & accounting", "expert systems & auditing", and "expert systems & tax". After finding in their initial search that some authors preferred to use the term artificial intelligence, they replaced "expert systems" with "artificial intelligence" and reconducted the search to capture both dimensions. The result was the identification of 315 unique articles for the time period 1980–2011.

The first question raised in our study is whether "expert systems" is the fundamental concept of interest or whether the broader domain of "intelligent systems" should be considered. As noted earlier, Gregor and Benbasat (1999) highlight the closeness and almost interchangeable use of *expert systems* and *knowledge-based systems* that are indicative of a broader set of applications referred to simply as *intelligent systems*. Indeed, one of the ironies from the Gray et al. (2014) study is that they note the de facto journal for the Artificial Intelligence/Expert Systems Section of the AAA in its early years was the journal edited by Dan O'Leary entitled *International Journal of Intelligent Systems in Accounting, Finance & Management*. Yet, *intelligent system* was not a term used in their search criteria.

Please cite this article as: Sutton, S.G., et al., *"The reports of my death are greatly exaggerated"*—Artificial intelligence research in accounting, Int J Account Inf Syst (2016), http://dx.doi.org/10.1016/j.accinf.2016.07.005