Article

Portraying Information Systems as a Member of Various Asterisms in the Galaxy of Science

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Abstract

The discipline of Information Systems is often viewed as a social science. Information Systems research and teaching pertain to the management and sociological issues of the computing field. It also includes programming and systems analysis, design and development. It is, therefore, challenging to plot Information Systems on a continuum of disciplinary clusters. Depending on the viewpoint held on the scientific world, the groups of disciplines take on different forms. Although metaphors are often used in Information Systems to portray complex ideas in understandable ways, only a few papers could be found that explain the interdisciplinary nature of the discipline metaphorically. To fill this gap, this article uses the astronomical concepts of galaxy, constellation and asterism to explain the place of Information Systems within the scientific domain. An asterism is a grouping of stars which may be part of various constellations. Six different Information Systems asterisms are proposed. The conceptual reflection in the article offers a fresh perspective on the interdisciplinary nature of Information Systems to the philosophy of science. The article illustrates the proposed metaphors with some existing examples to validate the concept. Suggestions for future research are also provided.

Keywords: Information Systems; interdisciplinarity; galaxy; constellation; asterism; metaphor

Introduction

The discipline of Information Systems (IS) can be defined as the computing field that studies the design, creation, implementation, and management of software applications in, as well as its effect on businesses, organisations and communities. IS is often viewed as a social science because its native and leading reference disciplines fall mainly in this mentioned group of disciplines (Moody, Iacob, and Amrit 2010). It does not focus primarily on the mathematical theory that underlies computer science or on physical

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computer hardware, which is the area of engineering and information and communication technology. IS takes a softer approach by looking at systems that include human aspects. One should also acknowledge that the discipline, as a social science (Glass, Ramesh, and Vessey 2004; Moody et al. 2010), does not merely reflect on relevant phenomena, but that its scientific endeavours also affect social and physical worlds (Sarker et al. 2019). Due to its ubiquitous use in society and almost every other academic field, it is also regarded as inter- or transdisciplinary by its very nature (J. H. Kroeze, Travica, and Van Zyl 2019). In this article, science refers to the abstract concept that encompasses all knowledge fields, while the terms discipline, field and "sciences" (in the plural) are used as synonyms referring to individual, unique scholarly areas.

IS research and teaching pertain to the management and sociological issues of the computing field. It also includes programming, as well as systems analysis, design and development. It is, therefore, challenging to plot IS on a continuum of disciplinary clusters. Sarker et al. (2019) propose a social-technical continuum ranging from more socio-centric to more techno-centric. All IS research topics could be plotted somewhere on this scale. The continuum allows five different types of IS mixes comprising different proportions of social and technical aspects. While all these blends still qualify as IS research in a flexible view of the field, a topic eventually becomes part of another discipline when it moves completely to either the social or the technical side of the continuum. The malleability of this approach suggests that it is impossible to regard IS either as a social science, or as an applied science in the technical field. In fact, it is a complex undertaking to find a neat and tidy division of all knowledge fields, an endeavour that is often simplified as a bipartite division between the natural and human sciences. However, it depends on one's presuppositions to pinpoint the differences between these categories. Depending on the viewpoint held on the scientific world, the groups and connections seem to take on different forms. In fact, "the 'humanities', as well as the 'natural sciences', have never represented a coherent ensemble of disciplines" (Sala 2013, 84).

The manifestation of the sciences could be compared metaphorically to the concepts of constellations and asterisms in astronomy. Looking at the night sky, one sees a myriad of stars without any apparent clustering. Depending on where one is looking from and what one is focusing on, various constellations can be discerned by super-imposing conceptual patterns on groups of stars (cf. "Constellation" 2021). The Great Bear (Ursa Major), Sagittarius and the Southern Cross (Crux) are three well-known constellations (cf. Murdin 2001b). This astronomic concept has been used metaphorically in medicine to refer to "constellations" of symptoms in recognising an illness and diagnosing patients (Lexico.com [Oxford University Press] 2019). Ohlhorst and Schön (2015) use the concept of constellation metaphorically to refer to constellation analysis (Konstellationsanalyse) as a transdisciplinary technology research tool. In the philosophy of IS, McBride (2018b, 219, 224) uses the term to refer to the "constellation of research approaches" and the "constellation of humanities." If there is a constellation of humanities, there could also be constellations of natural and social sciences.

Although the concept of an asterism is less well-known, it provides an intriguing way to describe the interdisciplinary networks of the sciences metaphorically. An asterism is:

> A readily recognizable group or arrangement of (usually bright) stars, which are not necessarily members of a single constellation. Well-known examples are the Plough (part of the constellation Ursa Major), and the False Cross, the Summer Triangle and the Square of Pegasus, all of which comprise stars from more than one constellation. (Murdin 2001a)

Like asterisms that can comprise stars from more than one constellation, some interdisciplinary fields can consist of disciplines in various scientific groups. Due to the current ubiquity of computing in all areas of science, IS can, therefore, be regarded as a member of various "scientific asterisms" in the intersection of knowledge fields. Depending on one's viewpoint, the discipline can be grouped and linked to other disciplines within various "scientific constellations."

In the rest of this article, the metaphor of asterisms is unpacked with specific reference to IS. Since a metaphor compares one aspect of a phenomenon with an everyday concept to elucidate the relevant feature, one should be careful not to overload the meaning of the proposed metaphor (Friedman 1998; Prahbat 2011a). An allegory is an "extended metaphor" (Little, Fowler, and Coulson 1956, 45) which could have more points of commonality, although even they have limitations (Newman 2007). Therefore, not all physical characteristics of stars will be applicable in the discussion below, but only those aspects that are brought to the fore. According to Hassan, Lowry, and Matthiassen (2022), metaphors are useful in all phases of IS theory building to explain difficult abstract ideas in terms of tangible objects. Although we cannot touch the stars, they are empirically observable. Many metaphors have been used in the IS discipline (Geirbo 2017; Jackson 2021), but only a few have been used to describe its interdisciplinary character. The idea of knowledge networks was suggested by Baskerville and Myers (2002). Travica (2003) used the concept of the bridging of disciplines and the cross-pollination between them. The metaphor of an elephant being studied by a group of blind researchers has been used by Hirschheim and Klein (2012) and J. H. Kroeze et al. (2019).

This article first looks at science as a whole (i.e., the "galaxy of science"), then discusses traditional bi-partite and tri-partite divisions, followed by a suggestion of six main constellations (or major scientific groups). It then focuses on IS and its place in this galaxy and its constellations. Some pointers are given towards the differentiation of various IS asterisms, as well as a few examples of existing research that illustrate their validity. The article aims to contribute an alternative view of the IS discipline's place in the scientific world. The author hopes that this reflection on the discipline's role from the perspective of the philosophy of science will enable IS scholars and students to visualise IS's interdisciplinary connections; thus gaining a better understanding of the discipline and its purpose. Although such a "cognitive" contribution increases our knowledge intrinsically (Bunge 2009, 29), the proposed metaphor may prompt IS scholars “to innovate and expand [the IS field] beyond existing intellectual structures” (Hassan 2017, 15). However, it should be noted that Moody et al. (2010) argue that IS has already become an independent discipline with a unique identity and a good balance of native and imported theories. As a member of various asterisms, IS may enrich other disciplines and be enriched by them—compare J. H. Kroeze et al. (2019) regarding the transdisciplinary nature of IS. However, it should never lose its unique identity, i.e., the social-technical axis as the unique and unifying theme across the spectrum of IS sub-fields (Sarker et al. 2019). While many disciplines today constitute a unique intersection of traditional disciplines, one could, likewise, identify other asterisms. In the wider computing field, for example, artificial intelligence is a member of several interdisciplinary fields (think of data science, robotics and smart cities). Many disciplines in other constellations, such as law, form asterisms as well (think of legal philosophy, business law, and IT law).

Science as One Galaxy

It has become conventional to use the term “science” in a very narrow sense as if referring to the natural sciences only, excluding other fields such as the arts and the humanities. This custom often goes together with holding natural science in higher esteem as the only pure form of science. This convention is oblivious to the origins and history of the natural sciences that actually developed as a separate group (“constellation”) out of the humanities (more specifically, out of philosophy) over the last 600 hundred years since the Renaissance and Enlightenment. One should remember that the division of academic disciplines in various streams is a relatively recent endeavour—up to the Renaissance, “little cleavage was felt between the sciences and the arts” (Kuhn 1970, 161).

The perception that the natural sciences and the human sciences are two different cultures is based on a dualistic Cartesian epistemology that separates the subject and object of scientific research (Botha 1997). According to Botha (1997), the differentiation between the natural and social sciences (including the humanities) is an artificial dichotomy. She argues for the unification of all the sciences since they are all built on sets of presuppositions (Kuhn 1970). The most salient characteristic of science is the fact that it makes progress (Kuhn 1970), and this could be indicated as accurate of the whole spectrum of knowledge fields.

Kuhn (1970, 1, 4) used the concept of a “constellation” as a metaphor for the collection of characteristics that typify a reputable academic tradition. He refers to science as “the constellation of facts, theories, and methods” (Kuhn 1970, 1) and to different sets of scientific presuppositions as “particular constellation[s]” (Kuhn 1970, 4). He also uses the term to refer to an epistemology or “paradigm” (“the entire *constellation* of beliefs, values, techniques, and so on [emphasis added]”) used by a group of scientists who share a common research culture, vocabulary, and agenda (Kuhn 1970, 175). Although

Kuhn primarily talks about the natural sciences, his ideas are applicable to other scientific areas (Percival 1976).

This article, therefore, rejects a narrow view of science as only pertaining to the natural sciences (see, e.g., one of the definitions of "science" in Lexico.com [2019]): "[t]he intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment"). Prahbat (2011b, 3) regards the humanities as science too, i.e., as "*a branch of science* that deals with the heritage and the question of what makes us human [emphasis added]." While the narrow definition of science refers only to the natural sciences and regards other fields of knowledge either as quasi-science, pseudo-science or metaphysics, the broader definition includes all disciplines of methodological knowledge (Huang and Chang 2008).

Although the galaxy of scientific disciplines forms a unit in principle, as argued above, various constellations can emerge before the trained eye. The differentiation between the groups of sciences is made with reference to either historical explanations, convention, subject matter, or methodology (I. J. Kroeze 2017).

The division and categorisation of scientific disciplines remain, therefore, a subjective process that has resulted in divergent results and taxonomies. An overview of taxonomies of the branches of science quickly reveals that there is no unanimity on how disciplines should be categorised. Mawande (2018), for example, lists 17 "broad" scientific fields, each encompassing several "main" scientific fields. Information systems and technologies are a subcategory of information and computer science. The arts, humanities, and social sciences are three different groups. The National Academies of Sciences, Engineering, and Medicine in the USA lump together the arts and humanities vs the social and behavioural sciences, while physics and mathematical sciences (including computer science and IS) form another of their five main fields in addition to life sciences, and engineering (The National Academies of Sciences Engineering and Medicine 2006). The Social Sciences Citation Index and the Arts and Humanities Citation Index also split the human sciences into two groups (cf. Nederhof 2006). The endless variations of scientific taxonomies support Piaget's idea that the scientific system is not linear but more similar to a spiral due to the endless inter-connections between the different fields (Piaget 1972). This multi-dimensionality is not only the case for the natural sciences but also, and maybe even more so, for the social sciences and humanities, and all knowledge fields as a whole.

Although it may be difficult to differentiate between the natural sciences, engineering, social sciences, humanities and other groups on a theoretical level, one cannot deny that there are definite boundaries on a practical level. Indeed, for scholars working in interdisciplinary fields, the variety of values, principles, and approaches is a definite reality with which they are often confronted. It will, therefore, be helpful to explore the propensities of the various knowledge fields while keeping in mind that there are no watertight compartments (Piaget 1972). The next section explores the characteristics of the two traditional main "constellations."

Two Constellations: Natural and Human Sciences

Two main streams of knowledge fields are usually differentiated, the natural sciences, and the social sciences and humanities (SSH), also called human sciences (Felt 2014). Dilthey calls the SSH the "Geisteswissenschaften", i.e., cultural sciences, spiritual sciences or "sciences of the mind" (Dilthey 1988, 78). Kuhn (1970) explains the difference by referring to theoretical issues vs practical issues. SSH problems are often those that need urgent solutions that address important difficulties in society, while natural science is somewhat isolated from society and focuses on theoretical problems that can be solved within a dominant paradigm.

Dilthey is regarded as one of the leading advocates of non-positivistic approaches in science in the broad sense of the word (Sala 2013). He coined the well-known dichotomy of explanation vs understanding (Erklären vs Verstehen). Natural phenomena can be explained in terms of cause and effect, while cultural phenomena should be understood by a hermeneutic process that is embedded in a deep historical context and insight. Although Dilthey differentiated between the natural sciences and the SSH based on topic (external or natural phenomena vs internal human issues and relations), as well as methodology (abstraction and explanation vs analytical understanding of the complex whole), he did not exclude abstraction and causal explanations from the SSH altogether (with specific reference to psychology and history) (Makkreel 2016). Rather than setting up a watertight divide between the human and natural sciences as idiographic vs nomothetic sciences, one should rather place them on a continuum or, even better, a two-dimensional graph or a three-dimensional sphere since there are many concepts that they share to a larger or lesser extent. Dilthey believed that the natural sciences also use idiographic approaches, while the cultural sciences often have nomothetic aims as well (Makkreel 2016).

Snow (1961) coined the phrase "two cultures" as referring to the natural sciences and the human sciences. The metaphor of a divide between the human sciences and the natural sciences seems to have touched a raw nerve, and the gulf has ever since become more insurmountable. The two streams have become so specialised and even obscure that natural scientists and humanists do not understand each other anymore, and neither do they have a way to communicate their academic ideas clearly with the rest of the world (Judd 2002).

The concept of "human sciences" has so far been used as an umbrella term for this group of fields (SSH). If one reserved the term "science" for the natural sciences only, the term "human sciences" would become problematic and could only include those disciplines or approaches that rely on empiricism and "rational theorising" ("The Human Sciences Theoryofknowledge.Net" n.d.). In fact, the drive to follow the natural science paradigm has infiltrated into the arts and humanities, for example, approaches in linguistics to abstract and formalise language rules. Staal (2001) differentiates between the humanities (letters, arts, liberal arts), which focus on individuality and diversity, and the "human sciences," which, according to him, follow a pure, exact, formal and abstract scientistic approach, such as Noam Chomsky's mathematical approach to the study of language.

According to Staal (2001, 15), the humanities focus on humans' "artistic creations and spiritual gleanings" and are not concerned with knowledge or science. This idea rests on the notion that the term "science" only refers to natural science, which Staal ironically admits to being paradoxical. Staal says that:

> [T]here is no such thing as a single or unique scientific method. Scientific knowledge, like all reliable knowledge, springs from intuitions steeped in facts, sharpened by logic, and continuously tested by both. Such knowledge is never final, not because anything else is, but because it is likely to be replaced, sooner or later, by something more probable and more nearly true. (Staal 2001, 15)

This article, therefore, rather accepts other authors' definition of human sciences as an encompassing term for the humanities, arts and social sciences (Ingthorsson 2013; Klein 2004; Makkreel 2016). "All contemporary classifiers divide the human sciences into the humanities and social sciences" (Savelieva 2015, 3).

A different view on the bipartite differentiation of knowledge fields is to group the social sciences with the natural sciences vs the arts and humanities. According to Sitze, Sarat and Wolfson (2015), the term "exact sciences" can be used as an umbrella term for the natural and social sciences vs the humanities, which can be characterised as those disciplines—or rather a set of inquiries—that are committed to self-questioning and self-critique. The different ways in which the sciences can be categorised in a bi-partite fashion indicate the complexity of trying to find a clear and simple division. The fact that the social sciences can either be grouped with the natural sciences or with the humanities suggests that there may be a third constellation that sits somewhere in between the two groups. The next section will address this possibility in more detail.

Three Constellations: Natural Sciences, Humanities, and Social Sciences

Above, it transpired that the social sciences are sometimes grouped with either the natural sciences or the humanities. This group of disciplines thus started to emerge as a third constellation in the galaxy of sciences. Felt (2014) acknowledges that the SSH clustering is a very broad classification and that there are important divides between the heterogeneous disciplines in this collection. The social sciences seem to oscillate between two extreme poles of science by studying similar topics as the humanities and by using methods that are typical of both the natural sciences and the arts:

> While the disciplines and approaches of the humanities and the social sciences each seek [sic] to understand and appreciate the human condition, they rely on contrasting ways

> of knowing and methodologies to do so. What distinguishes the humanities from the social sciences, for example, is not so much a subject matter and topic … but it is rather the mode of approach to any given question and the resulting analysis or interpretation. ("The Humanities and the Social Sciences: Contrasting Approaches; Developed for ISEM 101 Integrative Seminars" 2013)

However, it should be noted that other scholars understand the difference in other ways. The natural and social sciences have similarities in terms of shared ontological, epistemological and methodological points of departure, while they differ regarding origins, study fields and limitations (Boutellier et al. 2011).

While the social sciences share positivist-empiricist approaches with the natural sciences to determine causality, the humanities use interpretative methodologies to "understand meaning and purpose, and generate wisdom" (Frey 2012a, 2012b; "The Humanities and the Social Sciences: Contrasting Approaches; Developed for ISEM 101 Integrative Seminars" 2013). Since IS is often regarded as a social science (Moody et al. 2010), it is not surprising that empirical approaches used to test theory-based hypotheses have remained influential and dominant (cf. Hassan 2017; Hassan, Mathiassen, and Lowry 2019; Siponen and Klaavuniemi 2020).

Varghese (2011) groups the arts and humanities together (e.g., philosophy, language, literature, fine arts, music, painting), and the natural (or "pure") and technical sciences as a second main group. The social sciences (e.g., anthropology, psychology, sociology) is a third group that started in the 18th century and emerged in the 19th century. According to Varghese (2011), the French Revolution contributed to this process with its focus on human rights and the perfectibility of knowledge. Kant added another dimension, namely the use of reason and individual thinking. Liberal thinking gave a further stimulus to this process by trying to find a midway between the old church and king dominated paradigm and the new radicalist movement that attempted to destroy historical forms of social control. The liberalists believed that a democratic, rational approach toward social issues could bridge this divide. While Comte saw sociology as a natural science (social physics), psychologists and anthropologists soon realised that their fields should take into account the non-rational side of humans as well.

> So in the social sciences two sections emerged: one that followed the nomothetic epistemology of Newtonian sciences like sociology, economics and political science; and the other one that employed an idiographic epistemology of humanities represented by disciplines like psychology and anthropology. (Varghese 2011, 96)

In the second half of the 20th century, a plethora of new social science disciplines emerged, including African studies, postcolonial studies, and studies regarding other historically marginalised groups.

It has now become clear that there are more than two constellations in the galaxy of science. It may, in fact, be helpful to differentiate between more than three main scientific constellations. The next section will propose six main scientific groups or constellations. It will also argue for various scientific asterisms with IS as one of their "stars" (members).

Six Scientific Constellations

I. J. Kroeze (2013, 2017) believes that the difference between the three main groups of sciences, discussed above, fundamentally boils down to the difference between empiricism (rules with predictive power being generalised from observation through the senses; induction) and rationalism (logic; deduction), and how these philosophies underlie the various methodologies. "[R]ationalists argue that knowledge is prior (a priori) to observation and empiricists argue that knowledge flows from observations and is therefore the result (a posteriori)" (I. J. Kroeze 2017, 2). She believes that all sciences have elements of both, but that there is a continuum of disciplines from those that are more empiricist to others that are more rationalist, while the social sciences are ambivalent with an equal balance of methodologies (I. J. Kroeze 2013). Surprisingly, this principle implies that mathematics and computer science are closer to the humanities than the natural sciences because they are, in essence, rationalist (I. J. Kroeze 2013).

> Mathematics … is rationalist in character … and the natural sciences … depend for their success on empirical data … "[L]ogicism" … [is] the view that mathematics is really a part of logic. (Kant and Frege in Garvey and Stangroom 2012, 270, 355)

Indeed, even within the traditional natural sciences, two main streams can be differentiated based on the dominating epistemological traditions, namely empiricism and pure deduction. For example, mathematics and logic are purely deductive sciences, while physics and chemistry are experimental disciplines in which empirical work is needed to verify or falsify facts and theories (Piaget 1972). According to Boutellier et al. (2011), the natural and social sciences are both "real" [read empiricist] sciences, while disciplines like mathematics and theoretical computer science are "formal sciences." This divide reflects the empiricism-rationalism split in the philosophy of science (cf. Garvey and Stangroom 2012). Applied sciences like medicine and engineering can be regarded as a subgroup of the "real" (exact) sciences. According to Bunge (2009), applied science has a utilitarian aim while the aim of basic science is purely to increase knowledge, yet the two types employ the same method.

There are subcategories within the humanities category too. The terms humanities and arts are both often used to describe an encompassing field. See, for example, Zuccala and Van Leeuwen's (2011) study on citation cultures of book reviews where the following disciplines are included as humanities: history and philosophy of science, philosophy, religion, language and linguistics, literature, literary theory and criticism, history, classics, archaeology, architecture, music, art, theatre, dance, and poetry. Dilthey believed that the human sciences should include contributions from the arts and aesthetics to reach a deep and rich understanding of its study phenomena, acknowledging that people filter information via “apperception” in the process of sense-making (i.e., to make new knowledge your own by integrating it with existing knowledge and understanding) (Makkreel 2016). “The humanities [in its wider sense including the arts] involve inquiry into consciousness, values, ideas, and ideals as they seek to describe how experiences shape our understanding of the world” (Myers n.d.). One could, therefore, differentiate between the humanities and the arts as follows: the humanities focus on theoretical aspects of these fields, while the fine arts, such as poetry, literature, music, art, dance, and drama, are “applied humanities” focusing on the creation of literary, visual and audible artifacts.

Using both topic (or subject matter) and methodology as differentiating measures, based on the discussion above (cf. the references above to Dilthey, as well as Kant and Frege in Garvey and Stangroom 2012), one can map six groups of disciplines onto a two-dimensional table representing the scientific “galaxy” yielding the main proposed constellations: natural sciences, formal sciences, applied sciences, social sciences, humanities, and fine arts (see table 1). The fact that the social sciences and the humanities appear in two levels on the vertical axis is due to the blending of the two constellations in terms of their methodologies. Both constellations developed gradually to presently implement both quantitative-empirical-inductive and qualitative-conceptual-deductive approaches, thus dissolving the historical differentiations to some degree.

Table 1: Six main constellations of scientific disciplines differentiated based on topic (subject matter) and methodology

		Topic (subject matter)	
		Natural/concrete phenomena	*Humanistic phenomena*
	Practical actuation of theory	Applied natural sciences	Fine arts (applied humanities)
Methodology	*Inductive*	Empirical natural sciences	Empirical social sciences (and even some empirical humanities branches)
	Deductive	Formal sciences (rationalist)	Conceptual humanities and social sciences

The six proposed scientific constellations are presented graphically in figure 1. The two main divisions are based on subject matter, while the subdivision into six constellations is done on a continuum of methodology. On this continuum, the social sciences (including IS) are positioned more or less in the centre between the empiricist-conceptual extremes, acknowledging that this constellation has two evenly strong branches: quantitative-empirical-inductive vs qualitative-conceptual-deductive.

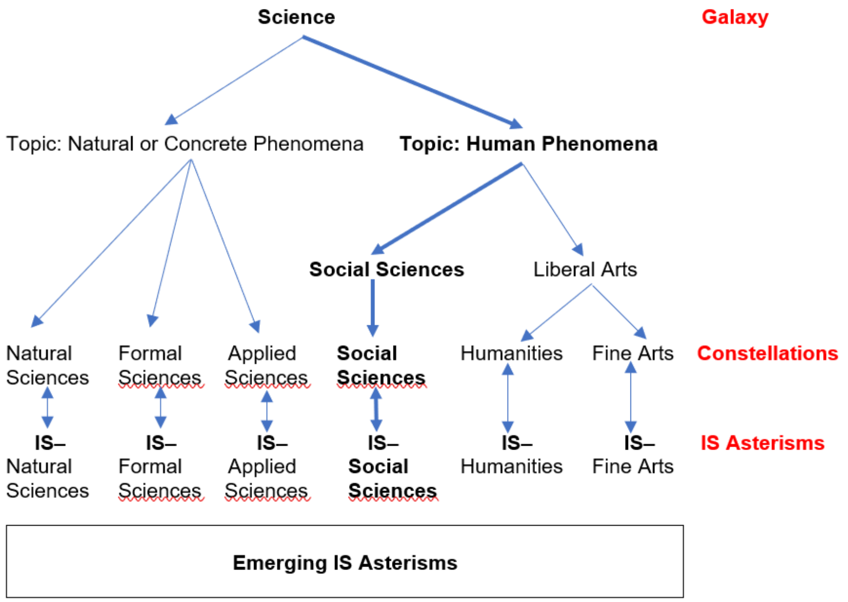

Figure 1: A high-level overview of IS asterisms in and across all six constellations in the galaxy of science (adapted from J. H. Kroeze 2019b, 3, used with permission)

Emerging IS Asterisms: Proposing and Analysing Asterisms

If one now focuses on the place of IS within the science galaxy, one may distinguish various IS asterisms that are discernible across the six constellations (see figure 1). Barkhi and Sheetz (2001, 14–15) foresaw the theoretical diversity in IS: "the breadth of IS phenomena implies that a large set of theories will continue to be necessary for members of the IS discipline." While IS is regarded mainly as a social science (indicated by the bold arrows in figure 1), it also appears in asterisms with disciplines in the other constellations.

Some examples from IS literature support the six asterisms containing IS as one of the key members:

- **IS-Natural Sciences.** According to Neumeier et al. (2017), studies on the business value of Information Technology (IT) need inputs from both the natural science paradigm (NSP) and the design science paradigm (DSP). While a DSP approach aims to create practical value by designing information systems that solve business problems, NSP approaches are, inter alia, used to define and justify theories, to propose and test hypotheses, and to explain and predict the efficiency of IT processes. Gregory (1996) argues for the use of the principle of falsifiability in IS to make the discipline more rigorous and scientific. Since a large portion (about one third) of IS research makes use of surveys and laboratory experiments (McBride

2018a), this asterism is rather obvious and does not have to be discussed in more depth.

- **IS-Formal Sciences.** Relational database theory is one of the most influential, imported theories in IS (Moody et al. 2010). Various authors discuss the use of mathematics and formal logic underlying different types of database management systems. Choe and Lee (2015) propose the use of process algebra and δ-calculus to improve the security of distributed business applications. Golubtsov (2017) discusses the "algebra of big data" to facilitate the parallelisation of algorithms that search and process massive amounts of data. Vardi (2004, 13) applies the use of graph theory, automata theory, and logic as algorithmic techniques to conduct database verification; this is important to ensure the accuracy of the technology that underlies "computer aided design, decision support systems, e-commerce, expert systems, geographical information systems, multimedia, and the like." Also compare Veldwijk et al. (1991) regarding mathematics, relational calculus and formal logic underlying data models; Barkhi and Sheetz (2001) regarding graph theory and mathematical set theory as only two of many theories used in IS; and Fischetti and Pisinger (2019) regarding the use of mathematical optimisation to improve information-systems algorithms to enhance the efficiency of wind farm design. These examples convincingly support the statement by Dennis, Valacich, and Brown (2018) that "[s]ome IS research is mathematics." Zemanek (1966) refers to the fact that there are discrepancies even between mathematicians of different schools. Hawking (2009) discusses how a new mathematical system had to be developed for the theory of quantum mechanics. The realisation that not even an "exact" science such as mathematics is unchangeable leaves room for contributions from other mathematical schools to amend the logic of computing. These examples, therefore, cause this asterism to emerge clearly across two constellations (social sciences and formal sciences).

- **IS-Applied Sciences.** This asterism has developed to the degree that interdisciplinary fields like software engineering (cf. Hadar, Sherman, and Hazzan 2019), health informatics (cf. Luz et al. 2019), geographic information systems (cf. Manzano, Ramaprasad, and Syn 2018), and bioinformatics (cf. Ficociello and Balka 2012) have become independent disciplines. In this regard, we should acknowledge the work often done by researchers and practitioners in other fields such as biology (e.g., Margaret Dayhoff, a physical chemist and founder of bioinformatics [cf. Gauthier et al. 2019]), medicine (e.g., Robert S. Ledley and Lee Browning Lusted, the fathers of health informatics [cf. Masic 2014]), and geography (e.g., Roger Tomlinson, a geographer who pioneered geoinformatics [Esri, n.d.]), who contributed to the IS field out of need, without necessarily being qualified IS scholars themselves. Concepts borrowed from the health sciences have been used metaphorically in IS. One such example is the metaphor of homeostasis to describe a stable state of interaction between man and machine (Harwood and Eaves 2017). Glass et al. (2004) discuss the similarities and differences between computer science, IS and software engineering, showing how they are unique and complementing each other, yet sharing some research approaches and methods.

- **IS-Social Sciences.** Typical of the social sciences that use both natural science and humanities approaches, Thatcher, Pu, and Pienta (2018, 11) believe that "the IS discipline has room for myriad research approaches, which includes modelling IS as social humanity." According to Dennis et al. (2018, 212), IS is a "polyglot" of social science, mathematics and design science. Alter (2018) gives an example of social aspects of IT use that can be quantified, for example the number of logons to determine a system's efficiency, but he also leaves room for interpretivist approaches.

- **IS-Humanities.** Boland, Newman, and Pentland's (2010) work on hermeneutics in IS is an admirable example of this asterism. They explain six exegetical techniques and demonstrate how they can be applied in an IS systems analysis and development project to solve fundamental problems of interpretation throughout the software lifecycle. Jackson (2021) uses discourse dynamics to enrich the IS theory about the use of organisational metaphors. Waguespack, Babb, and Yates (2018) apply linguistics and semiotics concepts (using metaphors) to bridge business stakeholders' technical rationality and designers' aesthetic concerns. While mathematical principles underlie relational database technology (see above), "intuitive heuristics such as analogical reasoning" may be a better fit when teaching students how to query an Extensible Markup Language (XML) document to retrieve information (Mitri 2012, 393). It should also be noted here that formal logic is based on philosophical logic (A. S. Lee and Hubona 2009). These examples imply that the theory of IS as a social science has been enriched with theoretical constructs from the humanities (cf. J. H. Kroeze 2019b). McBride (2018a, 170) even argues that IS is not a natural science, but "rather a humanity that resonates with human creativity, with the human state, and with human relationships and contexts."

- **IS-Fine Arts.** Oates's (2006) work on computer art as an information system and the bi-directional enrichment between the two disciplines is a prime example of this asterism. Aguerrevere, Thoring, and Mueller (2019) developed a canvas-based tool (the Idea Arc) to clarify immature business ideas and to refine the specifications for prototypes. [It seems from the context that the Idea Arc is a digital information system, although it is not stated clearly.] The Idea Arc is a bridge drawn on the canvas showing the transformation from the state of the user before and after the implementation of the proposed application. According to Gregory and Henfridsson (2021), metaphors can be used to bridge relevance and rigor during IS theorisation. They regard theorising as an art and a science, thus intermingling creativity and logic. Metaphors stimulate the imaginative thinking that is needed to conceptualise a new theory. Storytelling is also a form of art that can be used to communicate theoretical ideas in a comprehensible way.

The examples above were selected because they illustrate and support the proposed asterisms metaphor sufficiently. This article is, of course, by no means a comprehensive rendering of all relevant works. However, the author trusts that the argument of the article may convince other scholars to research each asterism in more depth. The six asterisms indicate the potential for the IS discipline to flourish in a plurality of inter- and transdisciplinary fields (J. H. Kroeze et al. 2019). In many, if not all, scientific fields, computing and IS today play a significant role. Interdisciplinarity arose in the 20th century, studying fields in the interface of the humanities and traditional social sciences on the one hand, while a similar shift took place in the natural sciences studying complexity to include "non-systemic, non-rational and non-predictive dimensions of reality" (Varghese 2011, 96). Recently, there are both a super-specialisation in all disciplines and a robust multidisciplinary drive across all disciplines, with ubiquitous computing and, by implication, information systems playing a major facilitating role (Varghese 2011, 96). The interdisciplinary nature of computing and IS underlies the topic of computer-human interaction in all its facets. Contemporary techno-science (including big data, artificial intelligence, cybernetics, and computer science) has prompted deep philosophical reflection about the essence and meaning of being human. This has created new opportunities for the humanities to become entwined with the natural and social sciences in an attempt to find answers to these new problems and to extend its own array of hermeneutic technologies (Sitze et al. 2015, 196, 197).

A Reflection on the Future of the Proposed IS Asterisms

Possible implications of the identification and grounding of the six asterisms for IS research are discussed in this section. In the bulleted sections below, I refer to proposals made by other authors in this regard (research or practice). I also propose future work pertaining to database management studies or applications, which are at the heart of the IS scope (compare the discussion on the IS-Formal Sciences asterism above).

- **IS-Natural Sciences.** In follow-up work, IS philosophers could explore to what extent IS has indeed become more "scientific" over the past 25 years since Gregory's (1996) paper was published. According to Hassan (2017) and Hassan et al. (2019) this indeed seems to be the case (hypothesis testing has become the norm, and justification has been used to make IS more rigorous). In an IS study dealing with database technology, one can follow the natural science paradigm by conducting empirical experiments to test hypotheses about the efficiency of various types of database management systems. One can compare the speed of database transactions in the global North and global South, and other quantifiable or measurable issues that may affect the usability and interaction design of these systems (for related work, cf. Rivera-Illingworth, Heeks, and Renken 2020).

- **IS-Formal Sciences.** According to Siponen and Klaavuniemi (2020), statistical research can be used in IS to determine probabilities that support or contradict inductively reached hypotheses. One could further ask if any other mathematical systems could be used as alternatives to amend the theory and design of relational database architectures or even to form the foundations of new types of databases, especially to address the unique needs of diverse cultures and populations (for related work, cf. Chahine 2013; J. H. Kroeze 2019a).

- **IS-Applied Sciences.** While IS has been focusing on organisational and social aspects of computing, the growing emphasis on design science (and design science research) approaches "may be an attempt to redress the balance to technological aspects, though this may lead to identity problems of its own in differentiation from computer science and software engineering" (Moody et al. 2010, 11). Hassan (2017) lists two design theories as examples of the most cited philosophical papers in IS. Applying this asterism to our database example, IS researchers could explore the human aspects of software engineering (such as user experience of software artifacts) to determine the most suitable database management systems for applications in diverse areas or professions (for related work, cf. K. K.-Y. Lee, Tang, and Choi 2013).

- **IS-Social Sciences.** IS may have leaned too heavily on the natural sciences for its theoretical concepts and methodologies (McBride 2018a). "While only native theories help define our disciplinary identity, imported theories help root IS research in more mature disciplines" (many of which are borrowed from the social sciences) (Moody et al. 2010, 8). IS could make use of metaphors to stimulate new concepts that fit the field's socio-material reality better (Hassan et al. 2022). Reversely, IS concepts can also be used in other social sciences: McElroy, Lyytinen, and Boland (2015), for example, use the human-computer interaction concept of affordances in climate change research. Referring back to our database example, IS researchers could study the effect of operational database management systems on organisational and societal cultures using both quantitative and qualitative approaches (for related work, cf. Hyun, Kamioka, and Hosoya 2020).

- **IS-Humanities.** The theory of IS as a social science should be enriched with theoretical constructs from the humanities (cf. J. H. Kroeze 2019b). McBride (2018a, 2018b) refers to hermeneutics and narratives as an essential facet of IS research but adds other humanities disciplines such as history, philosophy and politics into the mix. The following research questions can be asked: To what extent have IS researchers taken note of recent paradigm shifts in hermeneutics (cf. Van der Merwe 2015), or are we exclusively using principles formulated more than two decades ago (cf. Parmiggiani, Østerlie, and Almklov 2022)? If so, how can recent developments in the study fields of hermeneutics and exegesis be used to enrich systems analysis and design approaches? Returning to our database example, we could investigate how recent exegetical methods could assist analysts and programmers in transforming business rules into database management system structures that facilitate relevant and feasible SQL queries (for related work, cf. Joubert, De Villiers, and Kroeze 2018).

- **IS-Fine Arts.** Enriching IS by complementing the discipline with methodological constructs from the fine arts may especially be used in disciplines like human-computer interaction to maximise the usability and user experience of software (cf. J. H. Kroeze 2019b). McBride (2018a) refers to dance studies as an interdisciplinary sister discipline—nestled in the creative arts—that wrestles with the same identity issues as IS. He believes the development of software is a creative art that integrates and entangles diverse technical and social aspects. Like a cut diamond, the resulting artifact reveals a multitude of facets depending on the angle from which it is viewed (McBride 2018b). Aguerrevere et al.'s (2019) Idea Arc, discussed above, could be applied in interaction design to elucidate innovative but fuzzy software ideas.

The author trusts that the pointers given above convincingly show how the proposed asterisms metaphor can stimulate novel but viable avenues for IS research and practice.

Conclusion

This article aimed to clarify the structure of the sciences as a galaxy with six constellations, and IS's place in this galaxy as a member of various asterisms emerging in and across them. While IS basically belongs to the constellation of the social sciences, it also has strong relationships with disciplines in the natural sciences, applied sciences, exact sciences, (other) social sciences, the humanities, and the arts. Once one realises that science is an ever-changing and self-correcting process, one can see the opportunities to enrich existing paradigms from new and alternative perspectives. Zemanek (1966) refers to the fact that there are discrepancies even between mathematicians of different schools. Hawking (2009) discusses how a new mathematical system had to be developed for the theory of quantum mechanics. The observation that not even an "exact" science such as mathematics is unchangeable, leaves room for contributions from other mathematical schools to amend the logic of computing. In turn, the humanities, arts, and social sciences can complement the theory of computing by focusing on the understanding, design, and impact of information systems. Since many disciplines today constitute a unique intersection of traditional disciplines, one could similarly identify other asterisms of which artificial intelligence or human-computer interaction, for example, is a central member. The scholarly floor is open for further debate on the feasibility of the proposed asterism metaphor and for suggestions to augment the proof on concept.

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1 https://aisel.aisnet.org/amcis2020/philosophical_is/philosophical_is/3.

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References

Aguerrevere, A. L., K. Thoring, and R. M. Mueller. 2019. "The Idea Arc: Designing a Visual Canvas for Fuzzy Ideas." In *Proceedings of the 52nd Annual Hawaii International Conference on System Sciences*, 551–560. https://doi.org/10.24251/hicss.2019.068.

Alter, S. 2018. "Applying Seven Images of Science in Exploring whether Information Systems is a Science." *Communications of the Association for Information Systems*, 43. https://doi.org/10.17705/1CAIS.04310.

Barkhi, R., and S. D. Sheetz. 2001. "The State of Theoretical Diversity." *Communications of the Association for Information Systems* 7 (6): 1–19. https://doi.org/10.17705/1cais.00706.

Baskerville, R. L., and M. D. Myers. 2002. "Information Systems as a Reference Discipline." *MIS Quarterly: Management Information Systems* 26 (1): 1–14. https://doi.org/10.2307/4132338.

Boland, R. J., M. Newman, and B. T. Pentland. 2010. "Hermeneutical Exegesis in Information Systems Design and Use." *Information and Organization* 20 (1): 1–20. https://doi.org/10.1016/j.infoandorg.2009.09.001.

Botha, M. E. 1997. "Humanizing the Natural Sciences: A Methodological Imperative for a Society in Transition." In *Knowledge and Method and the Public Good*, 295–312, edited by J. Mouton and J. Muller. Pretoria: Human Sciences Research Council. www.allofliferedeemed.co.uk/Botha/MEBHumanizing.pdf.

Boutellier, R., O. Gassmann, S. Raeder, D. Dönmez, and Y. Domigall. 2011. "What Is the Difference between Social and Natural Sciences?" (Working paper). http://www.collier.sts.vt.edu/sciwrite/pdfs/boutellier_2011.pdf.

Bunge, M. 2009. *Philosophy of Science: Volume 1, from Problem to Theory*, revised edition. New Brunswick, NJ: Transaction Publishers.

Chahine, I. 2013. "Mathematics Teachers' Explorations of Indigenous Mathematical Knowledge Systems through Immersion in African Cultures." In *Memorias I CEMACYC,* 1–10, edited by Y. Morales and A. Ramirez. Santo Domingo: CEMACYC.

Choe, Y., and M. Lee. 2015. "δ-calculus: Process Algebra to Model Secure Movements of Distributed Mobile Processes in Real-time Business Applications." In *Proceedings of the 23rd European Conference on Information Systems*, 1–14. https://aisel.aisnet.org/ecis2015_cr/29/.

Constellation. 2021. In *Encyclopaedia Britannica*. https://www.britannica.com/science/constellation.

Dennis, A. R., J. S. Valacich, and S. A. Brown. 2018. "A Comment on 'Is Information Systems a science?'" *Communications of the Association for Information Systems* 43: 211–216. https://doi.org/10.17705/1CAIS.04314.

Dilthey, W. 1988. *Introduction to the Human Sciences: An Attempt to Lay a Foundation for the Study of Society and History,* translated with an introductory essay by Ramon J. Betanzos. Detroit, MI: Wayne State University Press.

Esri. (n.d.). "The History of GIS." https://www.esri.com/en-us/what-is-gis/history-of-gis.

Felt, U. 2014. "Within, across and beyond: Reconsidering the Role of Social Sciences and Humanities in Europe." *Science as Culture* 23 (3): 384–396. https://doi.org/10.1080/09505431.2014.926146.

Ficociello, M. A., and E. Balka. 2012. "Operationalizing Personalized Medicine: Data Translation Practices in Bioinformatics Laboratories." In *Proceedings of the 18th Americas Conference on Information Systems*. https://aisel.aisnet.org/amcis2012/proceedings/PerspectivesIS/17%0A.

Fischetti, M., and D. Pisinger. 2019. "Mathematical Optimization and Algorithms for Offshore Wind Farm Design: An Overview." *Business and Information Systems Engineering* 61 (4): 469–485. https://doi.org/10.1007/s12599-018-0538-0.

Frey, R. 2012a. "Sacred Journey: Humanities, Social Sciences and Indigeneity/Spiritual: An Integrated Methodology." http://www.webpages.uidaho.edu/~rfrey/PDF/166/HumanitiesSocialSciences.pdf.

Frey, R. 2012b. "Turning of the Wheel: The Interplay of the Unique and the Universal; A Humanities Exploration into the University of Idaho Community and beyond 2011–12." https://www.lib.uidaho.edu/digital/turning/index.html.

Friedman, W. 1998. "A Theory of Metaphors in Information Technology." In *Proceedings of the 1998 Americas Conference on Information Systems*, 826–828. https://aisel.aisnet.org/amcis1998/278.

Garvey, J., and J. Stangroom. 2012. *The Story of Philosophy: A History of Western Thought*. London: Quercus Publishing. https://books.google.co.za/books?id=F6GhAWxkiSsC.

Gauthier, J., A. T. Vincent, S. J. Charette, and N. Derome. 2019. "A Brief History of Bioinformatics." *Briefings in Bioinformatics* 20 (6): 1981–1996. https://doi.org/10.1093/bib/bby063.

Geirbo, H. C. 2017. "Smart Environments? Reflections on the Role of Metaphors in IS." *Scandinavian Journal of Information Systems* 29 (2): 85–92. https://aisel.aisnet.org/sjis/vol29/iss2/4.

Glass, R. L., V. Ramesh, and I. Vessey. 2004. "An Analysis of Research in Computing Disciplines." *Communications of the ACM* 47 (6): 89–94. https://doi.org/10.1145/990680.990686.

Golubtsov, P. 2017. "Algebra of Information in Big Data Processing." In *Proceedings of the International Conference on Information Systems 2017, Special Interest Group on Big Data*, 1–15.

Gregory, F. H. 1996. "The Need for 'Scientific' Information Systems." In *Proceedings of the 1996 Americas Conference on Information Systems*, 1–5. http://aisel.aisnet.org/amcis1996/287.

Gregory, R. W., and O. Henfridsson. 2021. "Bridging Art and Science: Phenomenon-driven Theorizing." *Journal of the Association for Information Systems* 22 (6): 1509–1523. https://doi.org/10.17705/1jais.00703.

Hadar, I., S. Sherman, and O. Hazzan. 2019. "Learning Human Aspects of Collaborative Software Development." *Journal of Information Systems Education* 19 (3): 311–320. https://aisel.aisnet.org/jise/vol19/iss3/8.

Harwood, S., and S. Eaves. 2017. "Homeostasis: From Metaphor to Mechanism in the Tech-human Relationship." In *Proceedings of the 2017 UK Academy for Information Systems Conference*, 1–17. https://aisel.aisnet.org/ukais2017.

Hassan, N. R. 2017. "Editorial: The History and Philosophy Department." *Communications of the Association for Information Systems* 41 (15): 319–333. https://doi.org/10.17705/1CAIS.04115.

Hassan, N. R., P. B. Lowry, and L. Mathiassen. 2022. "Useful Products in Information Systems Theorizing: A Discursive Formation Perspective." *Journal of the Association for Information Systems Preprints* 23 (2): 418–446. https://doi.org/10.17705/1jais.00730.

Hassan, N. R., L. Mathiassen, and P. B. Lowry. 2019. "The Process of Information Systems Theorizing as a Discursive Practice." *Journal of Information Technology* 34 (3): 198–220. https://doi.org/10.1177/0268396219832004.

Hawking, S. 2009. *A Brief History of Time: From the Big Bang to Black Holes* (updated edition, Kindle). Transworld Digital.

Hirschheim, R., and H. K. Klein. 2012. "A Glorious and not-so-short History of the Information Systems Field." *Journal of the Association of Information Systems* 13 (4): 188–235. https://doi.org/10.1093/oxfordhb/9780199580583.003.0003.

Huang, M., and Y. Chang. 2008. “Characteristics of Research Output in Social Sciences and Humanities: From a Research Evaluation Perspective.” *Journal of the American Society for Information Science and Technology* 59 (11): 1819–1828. https://doi.org/10.1002/asi.20885.

Hyun, Y., T. Kamioka, and R. Hosoya. 2020. “Improving Agility Using Big Data Analytics: The Role of Democratization Culture.” *Pacific Asia Journal of the Association for Information Systems* 12 (2): 35–63. https://doi.org/10.17705/1pais.12202.

Ingthorsson, R. D. 2013. The Natural vs the Human Sciences: Myth, Methodology and Ontology. *Discusiones Filosóficas* 14 (22): 25–41. https://www.academia.edu/3553833/The_Natural_vs_The_Human_Sciences_Myth_Methodology_and_Ontology.

Jackson, S. 2021. “Exploring the Use and Adoption of Workplace Automation through Metaphors: A Discourse Dynamics Analysis.” *Communications of the Association for Information Systems* 49: 86–109. https://doi.org/10.17705/1CAIS.04904.

Joubert, P., C. de Villiers, and J. H. Kroeze. 2018. “An Integrative Modelling Technique Bridging the Gap between Business and Information Systems Development.” *South African Computer Journal* 30 (1): 40–65. https://doi.org/10.18489/sacj.v30i1.413.

Judd, O. 2002. “The Two Cultures and the Scientific Revolution (1959)” (review). brothersjudd.com website: http://brothersjudd.com/index.cfm/fuseaction/reviews.detail/book_id/991/Two Cultures.htm.

Klein, J. T. 2004. “Prospects for Transdisciplinarity.” *Futures* 36 (4): 515–526. https://doi.org/10.1016/j.futures.2003.10.007.

Kroeze, I. J. 2013. “Legal Research Methodology and the Dream of Interdisciplinarity.” *Potchefstroom Electronic Law Journal* 16 (3): 36–65. https://doi.org/10.4314/pelj.v16i3.3.

Kroeze, I. J. 2017. “Climate Wars and Fat Wars: A New Role for Law.” *The Journal for Transdisciplinary Research in Southern Africa* 13 (1): 1–9. https://doi.org/10.4102/td.v13i1.419.

Kroeze, J. H. 2019a. “A Framework for the Africanisation of the Information Systems Discipline.” *Alternation: Interdisciplinary Journal for the Study of the Arts and Humanities in Southern Africa* 28*:* 38–65. https://doi.org/doi.org/10.29086/2519-5476/2019/sp28.4a2.

Kroeze, J. H. 2019b. “Is the Philosophy of the Information Systems Discipline Informed by the Arts and Humanities?” *Phronimon* 20 (4898): 1–30. https://doi.org/10.25159/2413-3086/4898.

Kroeze, J. H., B. Travica, and I. van Zyl. 2019. “Information Systems in a Transdisciplinary Perspective: Leaping to a Larger Stage.” *Alternation: Interdisciplinary Journal for the Study of the Arts and Humanities in Southern Africa* Sp (24): 9–47. https://doi.org/10.29086/2519-5476/2019/sp24.2a2.

Kuhn, T. S. 1970. “The Structure of Scientific Revolutions.” In *International Encyclopaedia of Unified Science,* 2nd enlarged edition. Chicago, IL: University of Chicago Press.

Lee, A. S., and G. S. Hubona. 2009. “A Scientific Basis for Rigor in Information Systems Research.” *MIS Quarterly: Management Information Systems* 33 (2): 237–262. https://doi.org/10.2307/20650291.

Lee, K. K.-Y., W.-C. Tang, and K.-S. Choi. 2013. “Alternatives to Relational Database: Comparison of NoSQL and XML Approaches for Clinical Data Storage.” *Computer Methods and Programs in Biomedicine* 110 (1): 99–109. https://doi.org/10.1016/j.cmpb.2012.10.018.

Lexico.com (Oxford University Press). 2019. “Constellation/Science.” Oxford University Press website: https://www.lexico.com/en/definition/constellation; https://www.lexico.com/en/definition/science.

Little, W., H. W. Fowler, and J. Coulson. 1956. *The Shorter Oxford English Dictionary on Historical Principles,* 3rd edition. Oxford: Clarendon Press.

Luz, R., A. Dutra, R. Lacerda, C. C. Mussi, and L. C. Chaves. 2019. “Large-scale Health Information Systems: Selection and Analysis of a Bibliographic Portfolio.” In *Proceedings of CONF-IRM 2019*. https://aisel.aisnet.org/confirm2019/33.

Makkreel, R. 2016. “Wilhelm Dilthey.” In *The Stanford Encyclopedia of Philosophy*. https://plato.stanford.edu/archives/fall2016/entries/dilthey/.

Manzano, C. A., A. Ramaprasad, and T. Syn. 2018. “Information Systems to Manage Local Climate Change Effects: A Unified Network.” In *Proceedings of PACIS 2018*. https://aisel.aisnet.org/pacis2018/11.

Masic, I. 2014. Five Periods in Development of Medical Informatics. *Acta Informatica Medica* 22 (1): 44–48. https://doi.org/10.5455/aim.2014.22.44-48.

Mawande. 2018. “StudyResearchFields (1).” Scribd website: https://www.scribd.com/document/371537085/StudyResearchFields-1.

McBride, N. 2018a. “Is Information Systems a Science?” *Communications of the Association for Information Systems* 43 (1): 163–174. https://doi.org/10.17705/1CAIS.04309.

McBride, N. 2018b. “Is Information Systems a Science? Rejoinder to Five Commentaries.” *Communications of the Association for Information Systems* 43 (1): 218–227. https://doi.org/10.17705/1CAIS.04315.

McElroy, C., K. Lyytinen, and R. Boland. 2015. “IT Affordances and Reconciling Alternative Modes of Evidence Giving in Cyberinfrastructure: The Case of Climate Change Research.” In *Proceedings of the Thirty Sixth International Conference on Information Systems*, 1–16. https://aisel.aisnet.org/icis2015/proceedings/Sustainability/6.

Mitri, M. 2012. “Applying Analogical Reasoning Techniques for Teaching XML Document Querying Skills in Database Classes.” *Journal of Information Systems Education* 23 (4): 385–394. https://aisel.aisnet.org/jise/vol23/iss4/5/.

Moody, D. L., M.-E. Iacob, and C. Amrit. 2010. “In Search of Paradigms: Identifying the Theoretical Foundations of the IS Field.” In *Proceedings of the 18th European Conference on Information Systems*, 1–13. https://aisel.aisnet.org/ecis2010/43.

Murdin, P. (Ed.). 2001a. “Asterism.” In *Encyclopedia of Astronomy and Astrophysics*. CRC Press. https://doi.org/10.1888/0333750888/5181.

Murdin, P. (Ed.). 2001b. “Constellation.” In *Encyclopedia of Astronomy and Astrophysics*. CRC Press. https://doi.org/10.1888/033750888.

Myers, T. (n.d.). “Humanities Defined—Myers.” (Writing@CSU / The Writing Studio). https://writing.colostate.edu/guides/teaching/co301aman/pop6b.cfm.

Nederhof, A. J. 2006. “Bibliometric Monitoring of Research Performance in the Social Sciences and the Humanities: A Review.” *Scientometrics* 66 (1): 81–100. https://doi.org/10.1007/s11192-006-0007-2.

Neumeier, A., T. Wolf, G. Fridgen, H.-V. Müller, and C. Reith. 2017. “Natural and Design Science Perspective on the Business Value of IT.” In *Proceedings of the 23rd Americas Conference on Information Systems*, 1–10. https://aisel.aisnet.org/amcis2017/ITProjMgmt/Presentations/6.

Newman, M. 2007. “Context, Process and Outcomes of ISD: An Allegorical Tale.” In *Proceedings of the 13th Americas Conference on Information Systems*. https://aisel.aisnet.org/amcis2007/449.

Oates, B. J. 2006. “New Frontiers for Information Systems Research: Computer Art as an Information System.” *European Journal of Information Systems* 15 (6): 617–626. https://doi.org/10.1057/palgrave.ejis.3000649.

Ohlhorst, D., and S. Schön. 2015. “Constellation Analysis as a Means of Interdisciplinary Innovation Research: Theory Formation from the Bottom Up.” *Historical Social Research*, 40 (3): 258–278. https://doi.org/10.12759/hsr.40.2015.3.258-278.

Parmiggiani, E., T. Østerlie, and P. G. Almklov. 2022. “In the Backrooms of Data Science.” *Journal of the Association for Information Systems* 23 (1): 139–164. https://doi.org/10.17705/1jais.00718.

Percival, W. K. 1976. "The Applicability of Kuhn's Paradigms to the History of Linguistics." *The American Sociologist* 14 (1): 28–31. https://doi.org/10.2307/412560.

Piaget, J. 1972. "The Epistemology of Interdisciplinary Relationships." In *Interdisciplinarity: Problems of Teaching and Research in Universities*, 127–139, edited by L. Apostel et al. Paris: Organisation for Economic Cooperation and Development, Centre for Educational Research and Innovation.

Prahbat, S. 2011a. "Difference between Allegory and Metaphor." DifferenceBetween.net; http://www.differencebetween.net/language/difference-between-allegory-and-metaphor/.

Prahbat, S. 2011b. "Difference between Humanities and Social Sciences." DifferenceBetween.net: http://www.differencebetween.net/language/words-language/difference-between-humanities-and-social-sciences/.

Rivera-Illingworth, A., R. Heeks, and J. Renken. 2020. "Measuring the Global Broadband Divide using Aggregated Crowdsourced Big Data." In *Digital Development Working Paper Series* 87: 1–33. https://doi.org/10.2139/ssrn.3958051.

Sala, R. 2013. "One, Two, or Three Cultures? Humanities versus the Natural and Social Sciences in Modern Germany." *Journal of the Knowledge Economy* 4 (1): 83–97. https://doi.org/10.1007/s13132-012-0124-5.

Sarker, S., S. Chatterjee, X. Xiao, and A. Elbanna. 2019. "The Sociotechnical Axis of Cohesion for the IS Discipline: Its Historical Legacy and its Continued Relevance." *MIS Quarterly* 43 (3): 695–719. https://doi.org/10.25300/MISQ/2019/13747.

Savelieva, I. 2015. "Two-faced Status of History: Between the Humanities and Social Sciences." *Working Papers, Basic Research Programme, Humanities (WP BRP 83/HUM/2015), National Research University Higher School of Economics (HSE)*, (83). https://doi.org/https://dx.doi.org/10.2139/ssrn.2552448.

Siponen, M., and T. Klaavuniemi. 2020. "Why is the Hypothetico-deductive (H-D) Method in Information Systems not an H-D Method?" *Information and Organization* 30 (1) (100287): 1–14. https://doi.org/10.1016/j.infoandorg.2020.100287.

Sitze, A., A. Sarat, and B. Wolfson. 2015. "The Humanities in Question." *College Literature: A Journal of Critical Literary Studies* 42 (2): 191–220. https://doi.org/10.1353/lit.2015.0016.

Snow, C. P. 1961. *The Two Cultures and the Scientific Revolution: The Rede Lecture, 1959*. New York, NY: Cambridge University Press.

Staal, F. 2001. "Noam Chomsky between the Human and Natural Sciences." *Janus Head GWU (Janus Head: Journal of Interdisciplinary Studies in Literature, Continental Philosophy, Phenomenological Psychology, and the Arts);* (GWU Issue 2001). http://www.janushead.org/gwu-2001/staal.cfm.

Thatcher, J., W. Pu, and D. Pienta. 2018. "Is Information Systems a (Social) Science?" *Communications of the Association for Information Systems* 43*:* 189–196. https://doi.org/https://doi.org/10.17705/1CAIS.04311.

The Human Sciences Theoryofknowledge.net. (n.d.). Theory of Knowledge.net website. http://www.theoryofknowledge.net/areas-of-knowledge/the-human-sciences/.

The Humanities and the Social Sciences: Contrasting Approaches; Developed for ISEM 101 Integrative Seminars. 2013. https://www.scribd.com/document/300640252/Humanities-Social-Sciences-Distinctions.

The National Academies of Sciences Engineering and Medicine. 2006. "Taxonomy List with Sub-fields." http://sites.nationalacademies.org/pga/resdoc/pga_044522.

Travica, B. 2003. "Information View of Organizations: Contextualizing Technology—Technologizing Context." In *Proceedings of the Ninth Americas Conference on Information Systems*, 2813–2820. http://aisel.aisnet.org/amcis2003/368.

Van der Merwe, D. 2015. "Reading the Bible in the 21st Century: Some Hermeneutical Principles: Part 1." *Verbum et Ecclesia* 36 (1): 1–8. https://doi.org/10.4102/ve.v36i1.1391.

Vardi, M. Y. 2004. "Model Checking for Database Theoreticians." In *Database Theory-ICDT 2005. ICDT 2005. Lecture Notes in Computer Science*, 3363, edited by T. Eiter, and L. Libkin. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-30570-5_1. (Author accepted version: https://www.researchgate.net/publication/221322465_Model_Checking_for_Database_Theoreticians.)

Varghese, G. K. 2011. "Rethinking Social Sciences and Humanities in the Contemporary World." *Economic and Political Weekly* 46 (31): 91–98. https://www.researchgate.net/.

Veldwijk, R. J., E. R. K. Spoor, M. Boogaard, and M. V. van Dijk. 1991. "On the Expressive Power of the Relational Model: A Database Designer's Point of View." In *Proceedings of the 1991 International Conference on Information Systems*, 65–73. http://aisel.aisnet.org/icis1991/18.

Waguespack, L. J., J. S. Babb, and D. J. Yates. 2018. "In Search of a Cure for a Psychosis in Information Systems Design: Co-created Design and Metaphorical Appreciation." In *Proceedings of the 51st Annual Hawaii International Conference on System Sciences*, 4443–4452. https://doi.org/10.24251/hicss.2018.561.

Zemanek, H. 1966. "Semiotics and Programming Languages." *Communications of the ACM* 9 (3): 139–143. https://doi.org/10.1145/365230.365249.

Zuccala, A., and T. van Leeuwen. 2011. "Book Reviews in Humanities Research Evaluations." *Journal of the American Society for Information Science and Technology* 62 (10): 1979–1991. https://doi.org/10.1002/asi.21588.