What is an Information System?
Another Small Step Toward
The Philosophy of Information Systems

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Abstract

The term “Information System” is so common that one can use the term in ordinary conversation without anyone ever asking for a definition or a clarification. Sadly, in research settings, where there should be a more rigorous examination of the meaning of the terms we use, the term is used indiscriminately as well. However, if the field of Information Systems is, indeed, about Information Systems, one would hope that there is a clear definition otherwise critics could rightly claim that we don’t even know what our field is about. The purpose of this paper is to clarify the concept of an “Information System” in an attempt to clarify what we are studying, so that we can advance our knowledge of information systems and advance the intellectual content of the field.

Keywords

Information, Philosophy of Information, Philosophy of Information Systems, Information Systems, Concept Analysis

Introduction

The importance of well-defined concepts in advancing scientific knowledge was recognized by Francis Bacon in the very early days of modern science and articulated in the early 17th century in his landmark book Novum Organum (The New Organon). Bacon named the problem Idols of the Marketplace and strongly suggested that the use of poorly defined concepts was one of four key factors inhibiting the advance of knowledge. The charge for clarity was picked up by Analytical philosophers in the 20th century who saw refining language and clarifying concepts of one of the central roles of philosophy. [Rorty] But the news has not reached the field of information systems where poorly defined concepts abound. For example, the field of Information Systems is, presumably, about Information Systems. That is, they are the focus of our research, study and discourse. But, what exactly is an “Information System”? What properties or characteristics do all information systems have in common? How do we distinguish between information systems and things that might be mistaken for an information system but are not? If a new thing comes along and claims to be an information system, how do we determine whether or not it is one? If we determine that it is one, can we apply what we know about existing information systems to this new thing in order to gain some deeper understanding of it?

The purpose of this paper is to explore the concept of Information System in order to gain greater insight into our objects of study, and, hopefully, provide a definition that provides greater utility and intellectual economy in our pursuit of understanding this elusive phenomenon. We begin by establishing criteria for a good definition and then examine a few definitions from widely used textbooks. Finding existing textbook definitions wanting we then proceed to construct a definition which is more suitable given the criteria provided.
What Should a Good Definition of Information Systems Look Like?

Definitions that are found in the dictionary are derived from a very different standard than definitions that are useful in research. Dictionary definitions, generally, reflect conversational usage which is exactly what Bacon was warning against in the New Organon. Why is this a problem? In everyday discourse people use words with imprecise meanings to facilitate conversation. This is reasonable because requiring everyone to memorize and understand more precise meanings would inhibit conversation entirely. However, in science, precise definitions are necessary to advance our knowledge. Attempting to understanding the properties of a well-defined element such as gold is much more likely to be productive than an attempt to understand the properties of a poorly defined substance such as mud or body fluids. A recent example of this can be seen when Pluto was unceremoniously booted out of the concept of planets because, if it were included, the number of planets would exceed 100. [See Rincon, BBC News Website]

In research we want precise definitions that include everything that is an instance of the concept at hand while excluding everything that is not. To put this in more formal logical terms we want necessary and sufficient conditions for an instance to be included in the concept. And we want all instances of the concept to be essentially the same kind of thing with the same properties about which we can abstract general principles.

But we do not have to get into formal logic to express this. Our familiar criteria for defining entity classes, which most IS researchers are already familiar with, will provide a more than adequate starting point. Entity types are, after all, just a specialize kind of concept and what is true for entity types is true for other concepts as well. At the same time, concepts are more general than entity classes. So, the requirements are a little less rigid.

The rules for including entity types in an entity relationship model are: membership, identity, internal consistency, and external consistency. Membership requires that there be a clear membership rule for determining which entities belong to a given entity type. This is the same as the criteria mentioned above that we need a definition that includes everything that is an instance of the concept at hand while excluding everything that is not. The definition should be precise enough to serve as a membership rule. The identity rule requires that entities can be uniquely identified as individuals. This is not necessary for concepts. If we are attempting to define the properties of a new element, we do not need to name the individual atoms; knowing the properties that they share is enough. Internal consistency requires that all occurrences be the same kind of thing. This matches the second criteria from above. Finally, the external consistency rule requires that the instances that make up the entity class all perform the same role in the domain. From the perspective of concepts for research, we can dismiss this rule as well. Gold atoms are gold atoms where they are used for jewelry or dental fillings. So, for the sake of simplicity, we can think of our criteria for a good definition as satisfying the membership and internal consistency rules. How do we come up with such definitions? We use a technique called concept analysis which is based on the dialectic approach used by Socrates to refine concepts such as justice and virtue. While this dialectic approach can get complicated, we can think of it in more simplistic terms for our analysis as the following steps: look for exemplars of the concept and identity essential features that they share; test the boundaries by considering instances that look similar but are not really instances; test the definition against the two criteria provided above. Repeat the process until a definition emerges that meets those two criteria. This is not an algorithmic process. A lot of creativity and testing is needed along the way. But, an example of it follows shortly.

How Good are Current Definitions of Information Systems?

Here are a few definitions of Information Systems from widely used textbooks.

“An information system is a set of procedures that, when executed, provides information to support the organization.” [Lucus, H., pg 17]

“An information system can be defined technically as a set of interrelated components that collect (or retrieve) process, store and distribute information to support decision making and control in an organization.” [Lauden, K. and Lauden, J., pg. 14]
“An information system (IS) is a set of interrelated components that collect, manipulate, store and disseminate data and information and provide a feedback mechanism to meet an objective. It is the feedback mechanism that helps the organization achieve their goals.” [Stair, R. and Reynolds, G. pg. 4]

To avoid appearing snarky as we go through these definitions, it should be pointed out that they are all perfectly workable textbook definitions. They provide a general idea of what an information system is that can be built upon with examples to provide the student with a general idea of what information systems include. Since the students will not be in a position to decide if one instance is an information system and another is not, this general grasp of the concept is adequate. But, for research purposes, we must hold our definitions to a higher standard. So, let’s test these definitions to see how well they hold up.

The first definition is a bit vague. It says “An information system is a set of procedures that, when executed, provides information to support the organization.” First, it is unclear what is meant by ‘support the organization’. Suppose an organization has a department that trades financial derivatives to earn short term cash flow to support operations. This seems to meet the definition. Would it be considered an information system? Further, one could argue that every person in the organization executes procedures in support of the organization. Does that mean there is no difference between the collection of people in an organization and an information system? These are certainly not what the author of that definition intended. And yet, they cannot be excluded. The problem is that the definition is too vague and does not reveal anything about the essence of an information system.

The second and third definitions are similar so, for the sake of brevity, we can reduce them to two common elements: 1) a collection of interrelated components; and, 2) processing and dissemination of information to aid decision making. Now we can ask — is the Oracle at Delphi in Ancient Greece an information system. There is a collection of interrelated components — somebody travels to Delphi to ask a question; the Oracle answers it; the answer is used by the visitor to make a decision; the answer is also disseminated across the country side, interpreted and used in any number of other decisions.

Now, to push the example further, let’s update this scenario replacing the Oracle with a Magic Eight Ball and Ancient Greece with a modern organization. Any person in the organization can come to the Office of the Magic Eight Ball and ask any question. The curator of the Magic Eight Ball shakes the ball, turns it so that the window is on top, and waits for the answer to float up to view in the window. The answer is then read to the inquisitor and disseminated to the organization. In this scenario, we have to ask — is a Magic Eight Ball an information system? We could replace the Magic Eight Ball with a Ouija Board and repeat the question. But, at the risk of appearing silly, we should stop at this point and reflect on what we have done.

Clearly, standard textbook definitions of an information system fail to grasp the essence of an information system and fail the tests of both membership and internal consistency. Membership fails because we don’t know whether or not to include the Magic Eight Ball. And internal consistency fails because a concept that includes an enterprise information system, the Oracle at Delphi and a Magic Eight Ball clearly lacks any kind of internal consistency.

To be fair, we should acknowledge that there were elements in the above definitions that were not used such as using feedback and generalizing decision making to meeting objectives. However, more elaborate examples could have been easily constructed to account for these. But to avoid being tedious, we will leave those examples to the imagination of the reader.

**What is an Information System?**

If those textbook definitions do not explain what an information system is then we are still left with the question — what is an information system. We want a definition that satisfies the membership and internal consistency criteria. We want the definition to reveal the essence of an information system. We want the definition to include exemplars of information systems. And we want a definition that will agree, generally, with the intuition of information systems researchers as far as that is possible. Along the way we will have to make some decisions for the sake of this analysis which others may not agree with. That is not a problem because more refined definitions will certainly lie in the future. This is a first attempt at a
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A rigorous definition and it would be unlikely that it is fully correct on the first try. After all, Pluto was a planet for two and a half millennia before that definition was refined.

Let’s begin cautiously by defining the two terms Information and System. A recent paper [Artz, 2016] took on the task of answering the question – What is Information – and defined it as “meaning or knowledge acquired through experience or encoded in symbols or visuals with the expectation that it will be decoded at some point in the future to extract some reasonable approximation of the original meaning or knowledge. And that meaning or knowledge is used to modify that internal model of the world we call consciousness.” Information according to Artz, ‘in-forms’ us or forms us inwardly. That is, it is the stuff that updates our internal conceptual model of reality. This internal conceptual model of reality is an important element in understanding information systems. While it is true that information systems provide information to be used in decision making, it is incomplete. Information systems provide information that updates our internal conceptual models of reality and decisions are made based on that updated internal model. It bears mentioning that this concept of information was re-engineer for the purpose of understanding information systems as the prevailing definition of information offered by Claude Shannon was inadequate for the task. It should also be mentioned that Claude Shannon re-engineered the concept of information for his purposes as well [Gleick]. So there is a lot conceptual re-engineering going on, as there should be [Floridi].

Defining a system is a little easier. We can take a couple of textbook definitions for guidance. McLeod states, “A system is a group of elements that are integrated with the common purpose of achieving an objective.” [pg. 3] and Jushi agrees, saying “A system is a set of elements that are combined together to achieve a common objective.” [pg. 7] These definitions were chosen because of their simplicity and clarity. The definition of a system is not something we need to haggle over when defining an information system. So, let’s put forth a tentative definition for an information system:

“An information system is an integrated collection of components created for the purpose of providing information to a person or group of people for the purpose of updating their internal conceptual models of reality so that they can make better decisions.”

A couple of items slipped into that definition which need some justification. First of all, the information is provided to people, and second it is provided so that they can make decisions. Does the information have to provide information to people in order to be an information system? And, do those people have to use the information to make decisions? We will posit that the answer to both questions is yes, although both are open for debate. For example, it is conceivable that an information system provides information to an artificially intelligent system to update its internal conceptual model of reality. But, until those systems come along, we will stick with what we have and hash it out when the time comes. It is also possible that one might interact with an information system for purposes other than making decisions. For example, they might interact with an information system to develop their intuition or problem solving skills. But, for now we will stick with more mundane examples involving decision making.

In the first case, if information is produced that nobody perceives, is it still information? This is a bit like the ‘tree falling in a forest’ problem. We take the position that the tree falling may perturb the airwaves but if no sound is perceived then there is no sound, only perturbed airwaves. Similarly, if information is not perceived by anyone, and thus does not ‘inform’ them (or does not modify their internal conceptual model of reality) then it is not information. And a system that does not produce information cannot be an information system. In the second case, if the information is gratuitously enjoyed but no decisions are made then this seems to be in conflict with our intuitive understanding of information systems in that they are created to support decision making and other similar objectives.

Now, let’s think of an Enterprise Information Systems as our exemplar and define some essential attributes. The definitions provided above do not say anything about the Information System being computerized. Is this essential? This is clearly a judgement call, but it seems like having the components be computerized information processing components is an essential feature of an information system because the system would not be able fulfill its role in meeting decision making objectives on a timely basis if the components were not computerized. Clearly, an 19th century spy network could be an example of an information system that does not use computerized information processing components. But, properties emerge from the computerized systems that do not emerge from the non-computerized system.
In addition, the definitions above don’t say anything about how the information is organized. Is that an essential feature? An Enterprise Information System has the information that it contains organized according to an information model. If the information were not organized according to some sort of information model, then it would also be difficult for the information system to meet decision making objectives. One could imagine, perhaps, an information system that uses an unorganized text file to support its delivery of information. But, the organization implied by the information model facilitates the derivation of new information much in the same way that the organization of the Periodic Chart of the Elements facilitates the creation of new knowledge in chemistry. The information model provides a way for users of the information system to think about the information they are receiving which, in turn, facilitates the formation of their internal conceptual model of reality which in turn improves their decision making. Users of relational models tend to think of their domain of interest in terms of categories while users of dimension models tend to think of their domain of interest longitudinally. So, it seems that the organization of the internal information according to an information model is a key feature of an information system.

The information model must ‘model’ something and that something that is being modeled should be considered an important aspect of an information system as well. What does the information model represent? Well, in the simplest terms possible, the information model models the application domain or the universe of discourse. In more general terms, there is some aspect of the real world that we would like to make more effective decisions about and that aspect of the real world is what the information model represents. So, our current definition of information system is as follows:

“An information system is a collection of information processing components, that maintain an information model which models some aspect of the world about which decisions must be made or other objectives must be met.”

Let’s harden the definition by testing the membership of some things that may look similar to an information system but fall short somehow in order to strengthen the boundaries. Let’s consider a document retrieval system, a workflow system, and the World Wide Web. Each of these will satisfy one or more of the textbook definitions. Will they satisfy our evolving definition? The document retrieval system is a storage and retrieval system that helps locate documents referencing a particular concept as indicated by a keyword. But, there is no information model so the structure of the information does not represent any aspect of the real world. So, using this definition, a document retrieval system would not be considered an information system. This is not to say that document retrieval systems are not important. It is merely to say that if our goal is to abstract general properties of information systems, including document retrieval systems in the mix would inhibit our search. A workflow system would run into similar difficulty in lacking an information model. There is a model embodied in the system, but it is a procedural model which models and hence automates the way documents flow through the organization. If information were collected that was used to improve document processing in the organization then it may qualify as an information system. But that would be a secondary purpose. Generally, given our definition, a work flow system would not qualify as an information system either. Finally, what about the World Wide Web? Isn’t it just another document retrieval system on a much larger scale? The distinguishing feature of the World Wide Web is the internal structure created by hyperlinks which provides a rudimentary organization or rudimentary information model. That is, you can go from one idea to a similar idea with the click of a link. While document retrieval systems and workflow systems fall outside the boundary of the concept of information systems, the World Wide Web teeters on the boundary leaning a little more in than out.

It should also be mentioned that an information system is a teleological artifact meaning it is a thing created (hopefully designed) for a purpose. Information systems do not occur naturally in nature. They occur only in the world of things created by people for a purpose. And the thing created cannot be understood without understanding the purpose for which it was created. There are many, many teleological artifacts and the vast majority of them are not information systems. For example, skyscrapers, automobiles, transit systems, even immaterial artifacts such as the tax code or legal system. It may seem a little silly to make this distinction. But, it lays the foundation for the next point. An information system is also a computational artifact meaning that it is implemented in a computational environment. There are, of course, many, many other computational artifacts that are not information systems. Document retrieval systems and workflow systems are two examples just given. There are many, many others. In
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order to qualify as an information system, the system must be designed to provide information which update a person’s internal conceptual model of some aspect of reality for some specified explicit purpose. For example, a payroll system that receives timesheet information and produces paychecks would not qualify as an information system. It is merely a business process automated in a computational environment. However, if the payroll system also provided information about the payroll expenses of the organization so that decisions could be made regarding hiring, raises or cash flow, then it would qualify.

A subtle methodological point should be made to explain the preceding two points (excluding instances, and requiring a teleology). In one of the most famous examples of concept analysis, Ludwig Wittgenstein used games as an example of a concept held together by what he called Family Resemblances. That is, there are no attributes that all games have in common. In the case of concepts held together by Family Resemblances, it is not possible to make any general statements about instances of the concept. In order to clean up the concept, it is necessary to eliminate instances until the remaining ones do have common attributes.

For decades, Wittgenstein’s Family Resemblances yielded the concept of games as an exemplar of an unworkable concept. Or, more specifically, a concept about which general principles could not be derived due to the internal lack of cohesion of the instances. Yet, Bernard Suits, much later, managed to find a single definition that seems to cover all games. According to Suits, “playing a game is a voluntary attempt to overcome unnecessary obstacles.” (pg. 55) How did Suits succeed where Wittgenstein had failed? The answer is in the fact that Wittgenstein was looking for common attributes, whereas Suits identified a common purpose. Suits’ definition is teleological in that it relies on the purpose of a game rather than its attributes. For purposes of simplicity, we will refer to attributes of the instances as existential attributes and purposes as teleological attributes. Both are necessary in defining information systems.

The existential attributes of an information system are information, an information model into which the information is organized, something external to the information system that is being modeled by the information system, information processing components, and people who use the information for some purpose including but not necessarily limited to decision making.

The teleological attributes of an information system are that there is an expectation that it produces derived information as well as the basic input information (otherwise it would just be a storage and retrieval system), the information (basic and derived) is used to update the user’s internal conceptual model of some aspect of reality, and that updated internal conceptual model of reality will be used for some purpose that the user has, presumably but not limited to decision making.

Implications for the Philosophy of Information Systems

This paper builds on an earlier definition of information to construct a definition for an information system. Along the way, the concept of an information model was introduced which still needs to be more rigorously defined. For the present, our current and conversational understanding will have to do. But, the question – what is an information model? – is still a loose end. For example, does the hyperlink structure of the World Wide Web really count as an information model? Most people would be willing to allow relational and dimensional models as exemplars of the concept. But, what about deductive models or visual models such as we find in virtual worlds and massively multiplayer role playing games. And we need to ask if the things that we consider to be information systems have common properties. Can we draw some theoretical principles that apply to all information systems? There is much more to be done and, hence, this paper is only another small step toward the philosophy of information systems.

Conclusion

This paper has attempted to refine the concept of an Information System in order to provide a more rigorous definition for research in information systems. A more rigorous definition is needed so that it can be determined if a thing being studied is, indeed, an information system, to identify the essential characteristics of such a system, and increase the similarity of the instances of information systems so that more general statements can be made regarding information systems thus advancing our understanding of information systems and the increasing the body of knowledge with regard to them.
REFERENCES


