Logic and **L**ogical **P**hilosophy
Online First Articles (2025)
DOI: 10.12775/LLP.2025.007

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On What There Is Not
Extensible markup language and rules for making inferences

Abstract. This paper investigates how the use of different rules for making inferences affects our understanding of what certain Extensible Markup Language (XML) documents do not represent. The aim is to show that we can infer different, contrasting things from the same XML documents, thereby weakening the communication that XML is supposed to support. There are three main reasons why the paper focuses on XML. First, XML, as a metalanguage, has no inherent rules for making inferences, but it also has no constraints on the technologies, systems, or theories that support or define the rules that can be used in conjunction with it. Second, XML is still widely used, and there are many other markup languages based on XML. This means that the critical analysis of these pages is, in principle, extendable to contexts where XML is involved and/or the rules for making inferences are not inherently supported. Third, since XML is explicitly intended to support communication between people, between software applications, and between people and software applications, this analysis may also shed new light on some of the theoretical assumptions behind such communication.

Keywords: philosophy of language; markup languages; rules for making inferences; philosophy of computer science

1. In addition to representing data, one of the main reasons for developing Extensible Markup Language (XML) is to support communication between people, between software applications, and between people and software applications (Salminen and Tompa, 2011).

Received December 10, 2024. *Accepted* March 19, 2025. *Published online* March 26, 2025

In any XML document, data are represented by elements. Elements consist of contents, tags, and attributes (name-value pairs), but they can also be empty or contain other elements. (For this reason, XML documents are generally conceived of as element trees, starting with the root elements and branching out from the roots to child elements.) Contents indicate data. Tags label data. Attributes (name-value pairs) provide additional information about the element for which they are declared (Dykes, 2005; Canducci, 2022). Below is an example of an XML document where "John Doe" and "30" are the contents, "person", "name" and "age" are the tags, "gender" and "male" are the name and value attributes, respectively, and the second and the third lines are the child elements of the root element formed by the entire four lines.

```
<person gender="male">
  <name>John Doe</name>
  <age>30</age>
</person>
```

Now, although XML does not inherently support any rule for making inferences[1] (both about what an XML document represents and about what it does not), we *could* consider several things to be true in the example, such as that it refers to a person named John Doe, and that this person is a male, aged 30. We make these considerations from both contents and tags, name-value attributes, and element hierarchy. However, all of these considerations assume and require knowledge of at least one thing that is not in the XML document, such as how to read it. And we cannot even exclude the possibility that such considerations might also benefit from our knowledge of the meaning of the words in the example, a knowledge that allows us not to turn up our noses at the links between tags and content, and between name and value attributes that the example presents.

To generalize, one could say that the communication between people, between software applications, and between people and software applications that XML is supposed to support also depends on something that

[1] Note that these rules are not to be confused with the rules of inference. Rules of inference are formal, logical principles used to derive conclusions from premises. Examples include modus ponens, modus tollens, disjunction elimination, and so on. Rules for making inferences are metarules that specify (high-level) assumptions under which the rules of inference are applied. Although I do not intend to deny the interrelationship between rules for making inferences and rules of inference, in this paper I will focus only on the former.

the XML document does not represent. In other words, something that is not in the XML document becomes the implicit reason behind what the XML document represents — and therefore behind the communication that XML is supposed to support. And this may also be true for to what an XML document does not represent. To demonstrate this last point, we can simply go back to the example and suppose that it contains all the elements of the XML document. Even though the example does not give us the following data, we could say, from the example, that John Doe's age is not 28. But we would say this not (only) because in the example John Doe's age is 30, but (also) because we know and above all assume that a person (like John Doe) cannot be both 28 and 30 (at the same time). If this were the case, what is not in an XML document (the fact that a person cannot have different ages at the same time) would become fundamental to knowing more about what there is in an XML document (the fact that John Doe is only 30). It would also become fundamental to knowing more about what is not in the XML document, but which we might be able to assert (like the fact that John Doe is not 28).

But can we really assert from the example that John Doe's age is not 28? If so, what rules for making inferences have we used? Would we have reached the same conclusion if we had used different rules? More generally, what can we infer about what an XML document does not represent? And, most importantly, based on which rule for making inferences? Certainly, there can be many reasons why an XML document only focuses on what it actually represents. For example, what is not in the XML document could be outside the domain that the document is intended to represent, not of interest, not known, not considered important, (deliberately) omitted, and so on. It is not even excluded that an XML document may contain these and other reasons in some form, including the rules for making inferences to be used. But if it does not, then some of the previous questions simply remain unanswered. The main reason for this is that, as I have already noted, XML does not inherently support any rule for making inferences. XML is primarily a markup metalanguage designed to allow users to define their own customized languages (Attenborough, 2003) and to document and represent data in a hierarchical format. It defines rules for how elements should be structured within a document, but it does not contain any built-in mechanisms for making inferences. This does not mean that XML cannot be used in conjunction with other technologies, systems or theories

(Bauman, 2011) that support or define rules for making inferences. And such use would allow us to make inferences based on any XML document.

2. XML as a metalanguage has no rules for making inferences, nor does it impose any restrictions on the rules to be applied. This should guarantee a kind of theoretical and practical freedom in terms of what we can use in conjunction to XML, and therefore of what rules for making inference we can apply. This freedom, in turn, may reveal the epistemological attitude of the subjects (whoever and/or whatever they are) toward an XML document, an attitude which, we cannot even rule out, may vary not only from subject to subject, but also on the basis of their own relation to different documents and contexts.

On these grounds, the paper investigates how the use of different rules for making inferences affects the understanding of what certain XML documents do not represent. The aim is to show that we can infer different, contrasting things from the same XML documents, thereby weakening the communication that XML is supposed to support. There are three main reasons why I focus on XML in this paper. First, again, XML as a metalanguage has no inherent rules for making inferences, but it also has no constraints on the technologies, systems, or theories that support or define the rules that can be used in conjunction with it. Second, XML is still widely used, and there are many other markup languages based on XML. This means that the critical analysis of these pages is, in principle, extendable to contexts where XML is involved and/or the rules for making inferences are not inherently supported. Third, XML is explicitly intended to support communication between people, between software applications, and between people and software applications. And while supporting such communication is certainly not the prerogative of XML alone, this analysis may also shed new light on some of the theoretical assumptions behind such communication.

The next section presents three XML documents and raises a question about data that are not in the documents. Now, answering this question would not be a problem if only XML had rules for making inferences. Moreover, the fact that XML can be used in conjunction with any other technology, system, or theory that supports and defines its own rules would make the list of such answers potentially infinite. Far from exhausting such a list, Sects. 4 and 5 present some representative examples of what I consider to be an exhaustive and mutually exclusive distinction between two kinds of rules for making inferences. The former provide answers that depend only on what an XML document represents. The latter provide answers that may not depend on that alone. Finally, Sect. 6 explores another strategy for answering questions about data that are not in an XML document, an answer that does not bring those rules into play. The same section also shows how the communication between people, between software applications, and between people and software applications that XML is intended to support can be weakened by the fact that subjects confronted with the same XML document may use different rules for making inferences and thus infer different things.

Of course, there are some related issues that this paper does not address. For example, although the distinction between the two kinds of rules for making inferences is intended to be exhaustive, the paper does not focus on all instances of these kinds of rules. It does not even discuss whether, without recourse to a rule for making inferences, what an XML document represents can legitimately be taken to be true (at least for the same document), nor whether what is not in an XML document can somehow make us doubt data in the XML document. Furthermore, the paper does not consider the possibility that different rules can be applied to different parts of an XML document, nor that these rules can somehow be combined and/or hierarchized. Finally, the paper does not examine why the application of these rules, as well as subjects' epistemological attitudes toward an XML document, might vary from subject to subject, but also based on their own relation to different documents and contexts. I do not think that all of these issues are uninteresting, or that they do not deserve more attention. I simply believe that the thinking behind these pages can be done without further insight into these issues.

3. Let us take the following statement:

(1) Max Verstappen (Red Bull) won the 2024 Japanese Grand Prix, with Sergio Perez (Red Bull) and Carlos Sainz (Ferrari) completing the podium.

Now, (1) is factually true, meaning that it did happen that Max Verstappen (Red Bull) won the 2024 Japanese Grand Prix, with Sergio Perez (Red Bull) and Carlos Sainz (Ferrari) completing the podium. When I asked ChatGPT 3.5 to represent (1) using XML, it returned the XML document in Figure 1 (hereafter, XML document_1).

Of course, there are many other ways to represent (1) using XML. However, regardless of our knowledge that (1) is factually true, we might

```xml
<GrandPrix>
  <Event>
    <Name>Japanese Grand Prix</Name>
    <Year>2024</Year>
  </Event>
  <Result position="1st">
    <Driver>
      <Name>Max Verstappen</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="2nd">
    <Driver>
      <Name>Sergio Perez</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="3rd">
    <Driver>
      <Name>Carlos Sainz</Name>
      <Team>Ferrari</Team>
    </Driver>
  </Result>
</GrandPrix>
```

Figure 1. XML document_1

also consider (1) to be somehow true within XML document_1. And "somehow" emphasizes that while, for example, ChatGPT 3.5 places Sergio Perez and Carlos Sainz in the 2nd and 3rd position respectively (a placement that is also factually true), (1) does not. Accordingly, there would be something that is true for both XML document_1 and the factual world that is not necessarily true for (1). Furthermore, there are things that are factually true and that neither (1) nor XML document_1 specifies, such as someone placed fourth in the same Grand Prix. Surely, we could enrich XML document_1 with these data; for example, we could write XML document_2 as in Figure 2. And XML document_2 represents something that is also factually true. But nothing prevents us from enriching XML document_1 with something that is not factually true. For example, we could write XML document_3 that enriches XML document, as in Figure 3.

Now, we could consider Ludwig Wittgenstein placing fourth in the 2024 Japanese Grand Prix to be true within XML document_3, even

```
<GrandPrix>
  <Event>
    <Name>Japanese Grand Prix</Name>
    <Year>2024</Year>
  </Event>
  <Result position="1st">
    <Driver>
      <Name>Max Verstappen</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="2nd">
    <Driver>
      <Name>Sergio Perez</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="3rd">
    <Driver>
      <Name>Carlos Sainz</Name>
      <Team>Ferrari</Team>
    </Driver>
  </Result>
  <Result position="4th">
    <Driver>
      <Name>Charles Leclerc</Name>
      <Team>Ferrari</Team>
    </Driver>
  </Result>
</GrandPrix>
```

Figure 2. XML document_2

though this is not factually true. But what about the fifth position? It is a fact that Lando Norris placed fifth. It is also a fact that there are no data about the fifth position in the three XML documents. Of course, we could add this or any other data to the XML documents. But if we did not, how would we answer a question like "Did Lando Norris place fifth in the 2024 Japanese Grand Prix?" (hereafter Q_1) based on the three XML documents?

4. XML is a metalanguage that allows users to define their own customized XML languages. XML document_1, XML document_2 and XML document_3 are three documents based on the same XML language. As a metalanguage, XML has no inherent rules for making inferences. This

```
<GrandPrix>
  <Event>
      <Name>Japanese Grand Prix</Name>
      <Year>2024</Year>
  </Event>
  <Result position="1st">
    <Driver>
      <Name>Max Verstappen</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="2nd">
    <Driver>
      <Name>Sergio Perez</Name>
      <Team>Red Bull</Team>
    </Driver>
  </Result>
  <Result position="3rd">
    <Driver>
      <Name>Carlos Sainz</Name>
      <Team>Ferrari</Team>
    </Driver>
  </Result>
  <Result position="4th">
    <Driver>
      <Name>Ludwig Wittgenstein</Name>
      <Team>University of Cambridge</Team>
    </Driver>
  </Result>
</GrandPrix>
```

Figure 3. XML document$_3$

implies that for none of the three XML documents does XML as such provide an answer to questions like Q_1, i.e., questions about data that an XML document does not represent. The fact that these rules are not inherent to XML as a metalanguage does not mean that they cannot be defined by an XML language. This is not the case for the XML language of the three documents, but XML as a metalanguage does not prevent it. For example, XML can be used to define ontology languages, which as ontology languages inherently have these rules (Tambassi, 2024). Note, however, that ontology languages are only a subset of the languages we can define using XML. Furthermore, none of the ontology languages necessarily must use XML as a serialization format, and some of them cannot even be expressed using XML. So there are languages that are not XML languages and that, because they have these rules, would provide an answer to questions like Q_1. And ontology languages are a good example.

If, for example, (all and only) the data of the three XML documents were represented using an ontology language such as Prolog, the answer to Q_1 would be "false". The reason for this is that the semantics of Prolog is that of the closed world assumption, according to which:

(2) Any statement that is not known to be true is assumed to be false.

Now, (2) is a rule for making inferences related to the completeness principle. Such a principle generally states that the data in x should be exhaustive for the domain that x is intended to represent (Russell and Norvig, 2020; Tambassi, 2022). While "x" here can be replaced by any database, system, and/or document, "exhaustive" refers to the metaphysical criterion of exhaustivity (Thomasson, 2019; Cumpa, 2020), which in terms of data representation sounds like this: any data that x is intended to represent should find its place in x. Since XML has no inherent rules for making inferences and imposes no restriction on the rules that can be applied, nothing prevents us from using (2) in conjunction with XML. And that would mean answering Q_1 with "false", because it is not known to be true in the three XML documents that Lando Norris placed fifth in the 2024 Japanese Grand Prix. Therefore, according to (2), such a statement should be assumed to be false.

Not all ontology languages assume (2). The Web Ontology Language, for example, is based on the open world assumption, a rule for making inferences according to which:

(3) Any statement that is not known to be true or false is assumed to be unknown.

So, if the data of the three XML documents were represented using the Web Ontology Language, the answer to Q_1 would be "unknown". Unlike (2), (3) is not associated with the principle of completeness; rather, (3) considers data to be potentially incomplete (Baader et al., 2004; Henley, 2006; Porello and Endriss, 2014; Baader et al., 2017; Rector et al., 2019). As with (2), there is nothing stopping us from using (3) in conjunction with XML. This would mean answering Q_1 with "unknown", because it is not known to be true or false in the three XML documents whether

Lando Norris placed fifth in the 2024 Japanese Grand Prix. Therefore, based on (3), we should assume that it is unknown.[2]

But the XML language of three documents is not an ontology language. And although (2) and (3) can be used in conjunction with such an XML language, neither (2) nor (3) are intrinsic to it, i.e., they merely provide two possible (not necessary) ways of answering questions like Q_1. Such ways, I argue, have something in common: that is, both (2) and (3) belong to the kind of rules for making inferences that provide answers depending only on what they are applied to — in our case, what the XML documents represent. This means that such answers cannot be changed under any circumstances, except by changing the XML documents. In other words, the answers can change if and only if the XML documents change. This is not always the case. In fact, there are also rules that provide answers which may not depend solely on this. Accordingly, the answers may change not only because the XML documents change, but also because something external to the XML documents changes (Li et al., 2018). The fact that XML imposes no restrictions on the rules to be adopted means that we cannot help but explore rules of this kind as well. And so we do in the next section.

5. Philosophers have already done something similar. Specifically, they have drawn and justified inferences about what is true in fiction by postulating rules for making inferences from what is explicit to what is fictionally the case (Friend, 2017). The idea here is to do something similar for XML, using two of the most famous examples of such kind of rules applied to fiction: the reality principle RP and the mutual belief principle MBP.

RP and MBP state, respectively, that:

(4) A fictional world is as similar to the factual world as the explicitly stated fictional truths allow.
(5) It is not reality that licenses integrations, but the common beliefs shared at the time the fiction was written.

[2] The associations between (2) and completeness and between (3) and incompleteness do not imply that there cannot be intermediate grounds between (2) and (3), and between completeness and incompleteness. An example is the partial closed world assumption, according to which any database, system, and/or document may be complete in some parts and incomplete in others, e.g., where their data are unknown or potentially missing (Lutz et al., 2012; Razniewski et al., 2016).

Now, without considering any criticism of (4) and (5),[3] we can easily affirm that the data in an XML document can be fictional, as is the case for the part of XML document$_3$ concerning the fourth position. Of course, there can be XML documents without any fictional data, such as XML document$_1$ and XML document$_2$. However, regardless of the inclusion of fictional data in an XML document, nothing prevents us from answering Q_1 on the basis of rules for making inferences such as RP and MBP. In fact, since XML imposes no restriction on the rules to be applied, the possibility of integrating the data of an XML document by means of rules that license integrations from something external to the XML document cannot be ruled out.

Applying (4) to XML would result in something like:

(6) An XML document is as similar to the factual world as the explicitly stated truths of the XML document allow.

Therefore, based on the data in the three XML documents and (6), the answer to Q_1 is "true": even though none of the XML documents contain any data about Lando Norris and the fifth position, in the factual world to which (6) refers, it is true that Lando Norris placed fifth in the 2024 Japanese Grand Prix.

Conversely, applying (5) to XML would result in something like:

(7) An XML document must be integrated with the common beliefs shared at the time the XML document was written.

So, based on the data in the three XML documents and (7), the answer to Q_1 is "true". Indeed, although the XML documents do not provide any data about Lando Norris and the fifth position, I think it is fair to say that it is a shared common belief that (it is true that) Lando Norris placed fifth at the 2024 Japanese Grand Prix.

I claimed that (6) and (7) belong to the kind of rules for making inferences that provide answers that may not depend solely on what an XML document represents. Such answers, I added, may also change because something external to the XML document changes. To prove this, let is focus on (6) and suppose that someone asks the following question (hereafter Q_2): "Based on (6) and the three XML documents, is 90377 Sedna a planetary-mass object?". Answering Q_2 with "true"

[3] Other classic formulations of RP and MBP are provided by Lewis (1978); Ryan (1980); Wolterstorff (1980); Walton (1990). For more recent discussions and criticism of these principles, see (Friend, 2017; Franzén, 2021).

should be fairly straightforward. Indeed, it is true that 90377 Sedna is a planetary-mass object in the factual world, and the data in the three XML documents allow 90377 Sedna to be a planetary-mass object. However, it is also true that the answer to Q_2 should be "false" if, for example, 90377 Sedna was destroyed or never existed. In the example, such an answer would differ from the previous one not because the data in the three XML documents have changed, but because something outside the XML documents has changed: namely the "factual world" to which (6) refers. And this possibility is excluded by rules of the other kind, which lacks any external reference to the XML documents.

6. Sect. 4 presented (2) and (3) as examples of the kind of rules for making inferences that, for our purposes, provide answers that depend only on the data that an XML document represents. Conversely, Sect. 5 presented (6) and (7) as examples of the kind of rules for making inferences that provide answers which may not depend solely on them.

Since XML as a metalanguage has no inherent rules for making inferences and imposes no restrictions on the rules that can be applied, applying (2), (3), (6), or (7) to an XML document (whose XML language does not define these rules in advance, see Sect. 4) simply means providing four possible strategies for answering questions for which an XML document does not represents any data. This means that it is in principle possible to apply other rules for making inferences, rules that are ultimately other instances of the exhaustive and mutually exclusive distinction I presented at the beginning of this section. This also means that "true", "false", and "unknown" do not exhaust the list of possible answers, and that the list could also include degrees of truth to allow for a gradual transition between "true" and "false", modal operators to represent concepts such as necessity, possibility, etc., and to interpret true values differently depending on the possible world we are considering, or again probability to allow for a more precise representation of uncertainty, and so on, depending on the rules for making inferences we apply.

Since XML as a metalanguage has no inherent rules for making inferences, and the use of XML in conjunction with (technologies, systems, or theories that support or define) rules for making inferences is only a possibility, someone might also argue that it is simply misleading to perform a query on an XML document about something about which it represents no data. In other words, these questions are not worth answering. Even if they were, not answering them would still reveal the subjects' epistemological attitudes toward these questions and, more generally, toward an XML document. And we cannot even rule out the possibility that these attitudes — which, as I have noted, may vary from subject to subject, but also based on one's relationship to different documents and contexts — apply not only to XML, but also to any situation in which the rules for making inferences are not specified. In this sense, the considerations behind these pages are, in principle, generalizable. Moreover, insofar as XML is intended to support communication between people, between software applications, and between people and software applications, these considerations may also reveal a limit to such communication: the simple fact that, on this basis, any subject may infer different, contrasting things from the same XML document.

Funding. This paper has received funding from the European Research Council under the European Union Horizon Europe Research and Innovation Programme (GA no. 101041596 ERC – PolyphonicPhilosophy).

Disclamer. Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them

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