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Knowledge Bases

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# Danto's Recipe for Clio: Leveraging Narrativist Insights for Modeling Historiography in Symbolic Knowledge Bases

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*Abstract: It is an ongoing research issue how to appropriately model historiographical information and historiographical arguments in large-scale common sense symbolic knowledge bases that employ first or higher-order logic for deductive reasoning about historical events. Due to the heavy logic focus, it is highly fruitful to review the observations and suggestions made by Arthur C. Danto of the narrativist tradition of analytical philosophy. Danto identifies interpretation expectations, historical laws and a preliminary notion of types as the key elements for formalizing historiographical discourse. In the analysis, we show that the first two of these elements are provided for, but that the third one remains a desideratum. We propose the notion of a recurrent, a knowledge representation equivalent of an abstraction aware of its examples, as the solution to the problem of preliminary types.*

Keywords: Analytical Philosophy, Arthur C. Danto, Symbolic Reasoning, Knowledge Bases, Historiography

## Introduction

**D**ESPITE MODERN COMPUTER techniques, the question of effectively managing historical knowledge in an appropriate fashion remains open. Historians have amassed enormous amounts of historical interpretation that are amenable to textual search, but not to anything more semantically informed. The limitations of textual search become apparent when one attempts to compare feudal Japan and feudal Western Europe, or African-American slaves of the Antebellum Period and Muslim slaves of the 10<sup>th</sup>-13<sup>th</sup> century as reported in the documents of the Cairoer Geniza. Tools that treat documents as bags of words are no help for researching these problems.

One type of tools that could assist historians<sup>1</sup> are *symbolic knowledge bases*. Symbolic knowledge bases take sentences authored in a knowledge representation language akin to mathematical logic as their input (Brachman and Levesque, 2004). The meaning of the knowledge comes from the way the individual concepts are related to each other. The automatic reasoning operations available for these concepts bottom out in the rules of inference, as defined for the mathematical logic that provides the formal semantics for the knowledge representation language.<sup>2</sup>

However, using formal knowledge representation languages requires that historians give a *formal* account of their interpretations; it is this formal account that can be represented symbolically, and for which the rules of inference are defined. This requirement is notoriously difficult to accomplish: For any discipline, there are enormous difficulties in capturing expertise in formal terms (Russell and Norvig, 2002; Klein, 1999). Historians compound these issues by taking a research stance that is averse to “theories.”<sup>3</sup>

## Towards a Formalizable Account of Historical Interpretation

This “theory”-aversity of the historical community is understandable. In general, interpretation attempts to assign meaning to a set of data that is treated as given. Interpretation assigns meaning by selecting from a store of pre-existing conceptual models and modifying them to bring them into alignment with the data requiring interpretation.<sup>4</sup> These adjusted conceptual models are then, in turn, useful for identifying more data, or for adjusting the meaning of the “given” data. Put differently, the “Hermeneutic Circle of Interpretation” (Gadamer, 1990)—the fundamental paradigm of interpretation—states that it is the *continued interaction* between the existent

<sup>1</sup> The argument applies, *mutatis mutandis*, to other Humanities or Social Science researchers, but for the purposes of this exposition, focus will rest on the historical sciences.

<sup>2</sup> The theory underlying symbolic knowledge bases is the theory used in semantic web technologies, such as DAML, OWL/DL and the like.

<sup>3</sup> Consider *pars pro toto* (Horden & Purcell, 2000, 44): “To specify at this early stage the forms that our efforts to outwit [historiographical] tradition will take would be to offer something in the nature of a detailed programme or methodology. And that we prefer to avoid: there have already been too many in the history of Mediterranean studies.”

<sup>4</sup> “Both ancient and modern perceptions should, in the first instance, be seen as belonging equally to the history of ideas; before we test their applicability, that is, we should interrogate their sources.” (Horden and Purcell, 2000, 13).



conceptual models of the researcher and the sources (in the broad sense of the term) which generates understanding—as well as better data and conceptual models for the next round of interpretation.

For example, a historian might at first interpret documents from feudal Europe with conceptual models developed in the research of feudal Japan. Sources from Western Europe's feudal period will describe problems that are alien to the Japanese context, such as the presence of an increasingly influential Roman Catholic Church. As the historian adapts the conceptual models to make sense of the Western European sources, some of the adaptations will impact the interpretation of Japanese feudal society. Thus, the historian might return to search Japanese feudal documents for structural equivalents to the roles of the Roman Catholic Church. This research agenda cannot be stated in the context of the Japanese sources alone.

During the process of hermeneutic research, then, the data and the conceptual models co-evolve, as the researchers uncover over-generalizations or omissions in their prior conceptualizations, or recognize new data in the sources, brought into relief by their adapted conceptual models. "Theories" that are resistant to this dynamic feedback cycle between data and conceptual models are suspicious from the beginning. Formalization attempts such as Hempel's covering law unintentionally sent the wrong signals to a community already rebelling against claims of "eternal laws" espoused by orthodox Marxist historians.

The question then is whether—and if so, how—historical knowledge could be represented appropriately in symbolic knowledge bases.

### Guidance on Formalizing Historical Knowledge

Those interested in formalizing historical knowledge receive a helping hand from Arthur C. Danto's seminal *The Analytical Philosophy of History* (1968). Danto has the credentials to bridge the gap between the two communities: He is an accomplished art historian as well as an analytical philosopher of the first rank. Fortuitously, the *Analytical Philosophy* is foremost a demolition of any "eternal laws" approaches to historiography. In thought experiments such as the "ideal chronicler" (149–181) and in the identification of the historical tool of the narrative sentence (143–181), Danto argues that historical interpretation is fundamentally open toward the future

(195–198)—unlike eternal laws. At the same time, Danto provides formal interpretations for the kinds of natural language descriptions that historians utilize in their work. Specifically, Danto establishes three critical insights that form the foundation for any serious effort to formalize historical knowledge: interpretative expectations, historical laws and preliminary types. These contributions provide a blueprint for formalization, derived from the kinds of problems historians deal with and the natural language descriptions they employ.

The remainder of this essay is devoted to a discussion of these three critical insights. This will include a preliminary survey of the existing representation approaches that could fit the formal structures Danto identifies. While much is available, a critical lacuna remains. In the conclusion, we will therefore describe a novel representation structure, the *recurrent*<sup>5</sup>, which captures the hermeneutic circle in its essence and is the appropriate amalgamation of existing knowledge representation infrastructure and Danto's insights.

### Interpretative Expectations

Danto describes the role of interpretative expectations in the context of the thought-experiment of the "ideal chronicler" (149ff). The "ideal chronicler" is an abstraction that simulates the predicament that the historian faces vis-a-vis the historical sources: the descriptive "granularity" of a particular source is fundamentally atomic and cannot be subdivided by the historian *using that source alone*. Consider Samuel Johnson's remarks on the Irish education of Jonathan Swift: "... [Jonathan Swift] was sent at the age of six to the school at Kilkenny, and in his fifteenth year [1682] was admitted into the University of Dublin." (Johnson, 1781, vol.I) The exposition treats Swift's school time at Kilkenny as a unit that permits no introspection. It is the literary convention of the biography that allows Johnson to employ this atomic unit as a building block for narrating the education of Swift.

This operation—inserting informational units into larger interpretative structures shared by the historian and the audience—is one of the fundamental tools of historiography. But in the rigorous analysis of what he terms "project verbs" (161ff), Danto shows how complex this operation is from the perspective of formalization. The example that Danto uses to expose these problems bears quoting in full:

<sup>5</sup> The German equivalent, *Rekurrenz*, is a technical term from textual linguistics and denotes the accurate or allusive repetition of a language surface structure, as in: "My opponent increased the taxes. My opponent increased the influence of the Federal Government." The notion of applying recurrences as a technical notion on the problem of interpretation, especially of social and historical data, was inspired by Hermann Lübbe's analysis of historiography (Lübbe 1977), which in turn looks at the contributions of Arthur C. Danto's *Analytical Philosophy of History* to philosophy of history. However, the way the term "recurrents" is employed here intentionally does not follow Lübbe.

“... [S]uppose Jones in temporal succession puts a seed into the ground, scratches his head, strikes a match, blows a smoke ring, thinks of his wife and shifts his foot. Asked at any moment during this stretch of time, \*what\* he is doing, Jones will answer correctly, ‘Planting roses.’” (162)<sup>6</sup>

The first observation is that the project of “planting roses” that Jones is pursuing is *not observable*. What is observable is merely that Jones’ self-interpretation (as reported) of planting roses is not *immediately rejected* by the description of the acts Jones is performing.<sup>7</sup> Notice how weak a statement “not immediately rejected” is. It needs to be weak; as Danto points out (163), it is in general extremely difficult to disprove that Jones was “planting roses”. At the same time, the description is exceedingly believable: Human beings often do a number of things in the course of their actualizing a project—Swift was not just at Kilkenny’s school during those years from 1673 to 1682. Such “multi-tasking” is especially true for long-term projects, discussed in more detail below.

The second observation is that the conceptual model of “planting roses” functions like a *filter* (165) when used in interpretation: It classifies the actions that Jones takes into (1) actions relevant to this goal, and (2) actions that occur because Jones is also other things than a rose planter, e.g. bipedal, married, or a cigarette smoker. Cultural knowledge shared among Jones, Danto and the reader supports this classification, and that knowledge colours the interpreter’s perceptions. Jones might belong to a horticultural tradition that uses cigarette ashes as fertilizer. He may believe foot shuffling and/or head-scratching brings about good growth. If Jones adhered to a fertility religion, he might expect the thoughts expended on his wife to amplify the generative powers of the rose seed.

Typically, historians discover mismatches between their cultural expectations and the ones presumed by the sources through atypically frequent occurrences of actions their conceptual model would have filtered: If several sources on gardening mentioned foot shuffling, historians might begin to suspect that this was part of the conceptual model of flower planting. Alternatively, parallelizing constructions

might indicate that these actions were meaningful. If a source contained a simile such as, “Next to the bar, Miller was smoking his cigarette as if he was planting daffodils,” historians could emend their conceptual models accordingly.

The third observation highlights the *ubiquity of these conceptual models*, to the point where their use almost goes unnoticed. Careful reading of the rose-planting example reveals that Danto does not give all the information for a conceptual model of “smoking.” Nothing is ever put into the mouth; the match is never brought into contact with anything smokable. Danto never even tells his readers what it is that Jones might be smoking.<sup>8</sup> Thus, even the assumption that the striking of the match and the blowing of the smoke ring belong together to match a conceptual model of lighting a smokable substance is just that: an assumption licensed by a particular conceptual model, whose appropriateness is open to challenge. Since the range of conceptual models familiar to Danto’s readership will not allow associating the striking of the match with any other activity—e.g., as a contribution to the fertility thoughts, perhaps—the “chunking” of the atomic actions is such that match striking and smoke-ring blowing are paired off as partial descriptions of a specific conceptual model.

Some might protest that the proximity in the description of the match-striking and the smoke-ring-blowing lends strong credence to the conceptual model of Jones lighting a smokable substance; linking the match-striking with thoughts of Jones’ wife, as in the fertility model, would have to explain why the author chose to insert the smoke ring blowing between these two actions.<sup>9</sup> But proximity is primarily useful as a *preference* mechanism once conceptual models have been identified; the proximity of the head scratching and the match striking, for example, is deemed irrelevant because fitting conceptual models are absent. Furthermore, the demand for an explanation might be simple to justify: The very mention of an ill-fitting action might in fact be a pointed criticism of Jones. This indicates that the earlier description of the filtering mechanism was overly sketchy: Some actions might be neutral with respect to the project, while others are actually counter-productive according to the conceptual

<sup>6</sup> Notice that Danto in this example also plays the role of a source, forcing us to accept his atomic units as the basis of the discussion.

<sup>7</sup> For this analysis, we ignore the problem of how the source knows that Jones was thinking of his wife.

<sup>8</sup> It is not even certain that the match *lighting* succeeded; only the match *striking* is recorded. However, the following discussion will simplify matters by assuming—without warrant—that the failure to light would have been reported in the source.

<sup>9</sup> This claim partially depends on the fact that historians prefer to interpret their sources as maximally intentional. While the possibility of a clumsy author always exists, the interpretative stance is very difficult to control technically: It becomes difficult to separate the ignorance of the author of the source from the ignorance of the interpreter.

model. We consider such counter-indicators to be part of the conceptual model.

So far the discussion has assumed that our source (here, Danto) shares the cultural models that Jones employs, and applied them as Jones would have.<sup>10</sup> This is the problem of the *conceptual bias of the source*, the fourth observation to make. Danto, as the observer of Jones, is in the same position as Danto's reader when reading Danto's narrative. Danto *also* decodes Jones' behaviors in terms of conceptual models, albeit at a lower, more sensory level, which is even more challenging to unravel. Because of this, even though historians prefer to treat their sources as authoritative when possible, the existence of additional sources might enable them to question the correctness of the application of conceptual models recorded in the source. Under any conceptual model that interprets the striking of the match as a necessary component of the proceedings, a historian might suggest that Danto incorrectly decoded the extinction of the match with the foot as a foot-shift. The historian first generalizes the observed action to a more generic one, such as "foot motion", and then looks for more specific action types that have a tighter connection to the local context.

The fifth and final observation to make is tied to the problem of *long-term projects*. A conceptual model for a "project verb", such as planting, comes with an expectation of the amount of time the project will take. Danto illustrates this point with reference to writing a book or courting another person (165), both activities that can take significant amounts of time. Long term projects have a much more permissive identification function with respect to actions that do not contribute to the long-term project. Most historians' conceptual model of book writing would permit for someone to "take time off" without considering the project abandoned.<sup>11</sup>

## Representing Conceptual Models of Interpretation

The knowledge representation community recognized early on the need for conceptual models to assist in the interpretation of natural language and the everyday world. Knowledge representation pioneer Marvin Minsky (Minsky, 1974) borrowed British psychologist Sir Frederick Bartlett's notion of schemas (Bartlett, 1932) to define frames of knowledge, highly correlated pieces of information in a sense

that generalized to physical structures and situations. Cognitive scientists and psychologists (Schank and Abelson 1977; Rumelhart 1980), coming to the problem from the side of natural language understanding, proposed the use of a hierarchy of information-organizing constructs—scripts, plans, goals, and themes—to capture the conceptual models that formed the backdrop of reading comprehension in story understanding.<sup>12</sup> In natural language discourse, sub-scenes of a conceptual model are referenced *pars pro toto* for the conceptual model itself (e.g. "striking a match" instead of "lighting a cigarette"); the role of striking a match in lighting a cigarette, therefore, needs to be represented.

Knowledge that is heavily dependent on events, such as historiographical information, can benefit from a proposal by Donald Davidson (Davidson 1967) for formalizing the semantics of action verbs. Davidson treats the event as an integral part of the represented knowledge, and treats additional information about the event (such as who performed an activity or how the activity was performed) as properties of the event itself. This so-called Davidsonian representation of events aligns well with the intentions behind Schank and Abelson's script representation—it includes universally quantified statements about the event types; the roles and the actors that can play; the pre-conditions for instances of this event type; the relationships between various role assignments across sub-scenes; and the post-conditions and world state changes affected by the script's execution.

As far as the knowledge representation community is concerned, the proposals of Schank, Minsky and Rumelhart failed to make sufficient headway in the hard problems of artificial intelligence, such as natural language understanding. The necessary level of detail for representing the scripts to process arbitrary newspaper articles, for example, proved elusive.<sup>13</sup> However, for the purposes of the representation of historical knowledge, where the humans are authoring the knowledge, this is less of a concern. Suffice it to say then that the knowledge representation community has developed types of representational vocabulary (Forbus et. al., 2005; Kahlert et. al., 2006) appropriate to the needs of the historical community for dealing with the interpretative expectations as outlined by Danto.

<sup>10</sup> We bracket here the problem that Jones, as the "author" of a sequence of actions, is himself not a privileged interpreter of that sequence (Eco, 1998). While this is a valid issue, it only raises more problems of the same type, not qualitatively different ones. A similar argument holds for all issues of philology, which have been bracketed here equally.

<sup>11</sup> Danto proposes "temporal structures" (161) for situations where the covering event is temporally discontinuous while the individual sub-events are temporally contiguous.

<sup>12</sup> This description follows (Brewer, 1999) and (Brewer et al, 2000).

<sup>13</sup> For Wendy Lehnert's assessment of her graduate student days in Roger Schank's artificial intelligence lab at Yale, see Lehnert (1994, 150-163).

## The Clarification of Historical Laws

Danto's contribution to the nomological debate of the late 1960s is effectively a clarification of the debate that makes the problem go away. This clarification interprets the different positions of nomologists like Hempel on the one side and historians like Dray on the other side as parts of a coherent overall argument. Danto localizes the source of confusion in the problem of interpretative explanations.

Danto agrees with Hempel that explanation means alignment of data with a model, in this particular case with universally quantified variables in a deductive rule. The determination of the relevant data and its alignment with the model is the historian's interpretative contribution, and is therefore compatible with Hempel's analysis. However, what makes the discussion confusing is the linguistic encoding of that alignment. When historians write about these explanations, they do not give deductive proofs; they use conceptual shorthands that give enough of the relevant data and the model alignment for the readers to work out the proof for themselves (222f). Thus, one source of the confusion is that the writing is merely detailed enough to satisfy the interpretative expectations of the readership. Danto shows (223) that there is always a reformulation of a historical explanation that has the property that it makes the alignment of the data with the deductive rule—and thereby the deductive inference and its proof steps—explicit.<sup>14</sup>

It is easy to underestimate the contribution that Danto made to the discussion of historical laws, mainly because the then-existing context of discourse has lost relevance. The theoretical programs that attempted to formalize the philosophical underpinnings of the empirical sciences are no longer appreciated (Laudon, 1996) and have been largely abandoned as programs. The heavy focus on deduction for evidence generation has given way to a plurality of quantitative and qualitative approaches and a philosophy of science discourse based around task-appropriate model building (Giere, 1988) and conceptualizations (Van Frassen, 1980). Data is now aligned with these approaches, without much regard for the epistemological status of such models and conceptualizations.

But for the dialog between the historiographical community and the knowledge representation community, Danto's observations are a relief. Danto effectively identified the intermediate points of stability in the hermeneutical process—the structure of the

conceptual models that confront the data and vice versa—as bundles of deductive rules with universal quantification. Such rules form the logical backbone of the knowledge representation endeavour, and are therefore compatible with the expertise of the knowledge representation community. Historical explanation is rife with deductive rules, even if historians' objections to nomological approaches to historiography suggest otherwise. And the knowledge representation community knows exactly how to model deductive rules.

## The Preliminary Structure of Historical Explanation

The third and final contribution that Danto makes to the discussion between historians and the knowledge representation community is an analysis of the preliminary properties that organize the structure of historical explanation. To complicate matters further, these preliminary properties have projections onto the temporal structure of historical arguments as well.

In the context of an analysis of how narratives are structured by preconceptions (120–129), Danto proposes the thought experiment of imagining that as little was known about Leonardo da Vinci as is about the Greek painters of Antiquity (123). The critical observation that Danto makes is that this thought experiment is not really executable, because one's notion of what an artist is contains so much of what Leonardo da Vinci was (123). Put differently, *exemplary instances of specific types have the property that they influence the type they illustrate in such a manner as to colour it with their peculiarities*. This has important ramifications for the temporal structure of historical explanation. Because of our familiarity with Leonardo da Vinci, there are now conceptual aspects of the type 'artist' that are distinctly Renaissance. These conceptual aspects could not have held prior to the Renaissance, and in fact eventually ceased to hold. The type itself, then, initially treated as a given, allows one to identify exemplars, but in turn sees its conceptual semantics modified by the examples. The type becomes a cursor that sweeps over a temporally ordered example sequence, conforming to the exemplars or statistical averages of times and places in turn.<sup>15</sup>

In a narrative sentence (143–181), a past event is analysed from the vantage point of a more recent (but still past) time point that explains the significance of the prior event.<sup>16</sup> (Danto explicates this

<sup>14</sup> Danto warns that the recovery of the deductive rule from the narrative *qua* proof fragment need not be straightforward (223) and possibly not amenable to an algorithmic discovery process (250).

<sup>15</sup> This observation differs from an ideal-type (in the sense of Max Weber's *Objektivitätsaufsatz*) in that Danto is explicitly interested in the temporal properties.

<sup>16</sup> Danto initially develops this argument to show that the interpretation of the past must be open toward the future, because future events can change how the past will be perceived and interpreted in the future. Danto illustrates this fact through an example with reference to the verb "anticipate" (169).

concept with the example of referring to the birth house of Isaac Newton as the birth house of the author of the *Principia*<sup>17</sup> (158.) However, the same principle holds with regards to the modifications to the conceptual semantics of a type. When deciding what conceptual elements Leonardo da Vinci contributes to the type “artist”, large subranges of the temporally ordered example sequence, starting with Leonardo and potentially extending as far up as the historian’s own time, are taken into consideration. That which is shared over periods and regions becomes part of the type; that which is not becomes curiosity—artists still fill sketch books, but they do not write in mirror-image cursive.

For the knowledge representation community, this is an unusual situation, because the type information usually forms the backbone of the inference process. Type reasoning is computationally fast and can reduce the inferential search space through early pruning. Specifically, the oscillation of the type’s extension over time is also outside the ordinary, to say the least. Here, Danto’s observations trigger no recognition of ready-made solutions, only the parameters for a detailed description of what is needed.

### **Towards Recurrents as Formal Building Blocks for Historiography**

While the knowledge representation community is able to describe the interpretative expectations required by historians in a universally quantified form—as type level script representations in the Schankian tradition, for example—this capability only covers the intermediate steps in hermeneutical interpretation, which tend toward interpretative quiescence. As the description of the derived types shows, however, the types that the knowledge representation community prefers to consider primary and fixed are more fluid and provisional in the changing process of interpretation, where data and models should influence each other.

This is where *recurrents* come in. A recurrent is a conceptual model, encoded using universally quantified interpretation expectations, that retains knowledge about its own evolution in the interpretation process—specifically, about the data set that drove its hermeneutic transformations. It has information about how it was abstracted away from the data

set and thereby can justify its own appropriateness. The features that recur in the data make up the conceptual semantics of the recurrent.

As Danto’s analysis of the temporal structures in historiography show, these data sets exhibit change over time. Therefore, the types must be revised as the data sets change. In historiography, data sets are fundamentally incomplete. Few experiments can generate new data; rather, it is new documents, new research or new excavations that might bring to light new information at any point in time. And for historiography, new information means new data. That new data might require re-doing the abstraction process and force a reconceptualization of what it means, for example, to be an artist. This in turn could influence the data set that the recurrent contains: Some data might now be eliminated as no longer applicable; alternatively, new data, excluded earlier for lack of relevance, might be added. Furthermore, the conceptual re-adjustment of the recurrent cannot be limited to the internal composition of the data supporting the recurrent. The recurrent of a Renaissance artist would be linked to such recurrents as artistic styles and fashions, materials and techniques, funding, military and political views, and the like—each appropriately temporalized and abstracted from data sets.

Changes to any of these recurrents would propagate outward to other recurrents, causing them to undergo reconsideration themselves, consequently becoming the source of reconsiderations in their own right. Adjustments would continue to trickle through the semantic network of recurrents until some form of quiescence were achieved, i.e. there being no remaining way to make progress on either the conceptual models or the data items.

The knowledge representation community has much to offer to the historiographic community in terms of its formalisms for capturing interpretation expectations and its facility with formal rules. It is in the realm of representing the temporally mutable and preliminary, however, that the necessary infrastructure is missing. Elements such as forward-concluding rules or automatic truth maintenance systems to support type modifications do exist, but a holistic model of the recurrent as the formal building block of a knowledge representation approach to historiography remains a desideratum.

<sup>17</sup> The reference is to Newton’s main work, the *Mathematical Principles of Natural Philosophy*, in Latin *Philosophiae Naturalis Principia Mathematica*, 1687.

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