DEIXIS IN NARRATIVE
A Cognitive Science Perspective

Edited by

Judith F. Duchan
Gail A. Bruder
Lynne E. Hewitt
State University of New York at Buffalo

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CHAPTER

5

COGNITION AND FICTION

William J. Rapaport
Stuart C. Shapiro
State University of New York at Buffalo

This chapter is on *computational philosophy*: the investigation of philosophical issues using computational methods as well as the application of philosophy to problems in computer science. The philosophical issues we explore include predication and fiction. The computational issues are primarily in artificial intelligence (AI). This chapter assumes knowledge of SNePS, an intensional, propositional, semantic-network "knowledge"-representation and reasoning system that is used for research in AI and in cognitive science. The uninitiated reader will benefit from reading Shapiro and Rapaport (this volume).

"Knowledge" representation is the study of the representation of information in an AI system (because the information need not be true, a more accurate name would be "belief" representation; cf. Rapaport, 1992). Shapiro and Rapaport (this volume) look at how predication is represented in such a system when it is used for cognitive modeling and natural-language competence (by which we mean both natural-language understanding and generation; cf. Shapiro & Rapaport, 1991). This chapter discusses appropriate means of representing fictional items and fictional predication in such a system.

FICTIONAL PREDICATION

In Shapiro and Rapaport (this volume), we saw how Cassie (the computational cognitive agent implemented in SNePS) can construct a mental model of a narrative. More specifically, we and our colleagues have been investigating how a cognitive agent is able to read a narrative and comprehend the indexical information in it: *where* the events described in the narrative are taking place (i.e., where in the "story world"—a semantic domain corresponding to the syntactic narrative text), *when* they take place (in the time-line of the story world), *who* the participants are in these events (the characters in the story world), and *from whose point of view* the events and characters are described.

In order to do this, Cassie has to be able to read a narrative (in particular, a fictional narrative), construct a mental representation or model of the story and the story world, and use that mental model to understand and to answer questions about the story. To construct the mental model, she needs to contribute something to her understanding of the narrative. One contribution is in the form of the *deictic center*—a data structure that contains the indexical information needed to track the who, when, and where.

Another contribution is background knowledge about the *real* world. For instance, if Cassie is reading a novel about the Civil War, she would presumably bring to her understanding of it some knowledge of the Civil War, such as that Abraham Lincoln was the 16th president and was assassinated in 1865, even if that information is not explicitly stated in the novel. The novel might go on to make other claims about Lincoln, such as that he was tall or that he had a particular conversation with General Grant on a particular day in 1860 (even if, in fact, they never talked on that day—this is a novel, after all). Such a claim would probably not be inconsistent with anything Cassie antecedently believed about Lincoln. But some claims in the novel might be inconsistent in this way, for example, if she read that Lincoln was re-elected to a third term in 1868. So Cassie has to be able to represent the information presented in the narrative, keep it suitably segregated from her background knowledge, yet be able to have information from her antecedent real-world beliefs "migrate" into her model of the story world, as well as to have information from the story world "migrate" back into her store of beliefs about the real world: There must be a semi-"permeable membrane" separating these two subspaces of her mental model (Yordy, 1990–1991).

There are a number of theories in philosophy about the nature of fictional objects. All of these are *ontological* theories concerned with such questions as: What are fictional objects? How are properties predicated of them? How are fictional objects related to nonfictional ones? However, for the purposes of our project, we need to be more concerned with epistemological or processing/computational/interpretive issues: How does a reader understand a (fictional) narrative? How does a reader decide whether and to what extent it is fictional? How does a reader construct a mental model of the story world? How does a reader represent fictional entities and the properties predicated of them? How do readers integrate their knowledge of the real world with what they read in the narrative? And so on. Some of these are, indeed, ontological issues, but they are what we have elsewhere termed issues in *epistemological ontology* (Rapaport, 1985/1986).

Corresponding to the purely or metaphysically ontological question, "What are fictional objects?," we ask the epistemologically ontological question, "How does a cognitive agent represent fictional objects?". And corresponding to the purely ontological question, "How are properties predicated of fictional objects?," we ask the epistemologically ontological question, "How does a cognitive agent represent the predication of properties of fictional objects?"

In this chapter, we examine several philosophical theories of fiction to see what aspects are useful for our cognitive/computational project, and we propose a SNePS representation scheme that answers most of the kinds of questions raised above (and that incorporates an exciting, albeit counterintuitive, proposal for the remaining questions). The proposed representational scheme is to embed the propositions of the fictional narrative in a "story operator" that is formally akin to the belief representations we already have in SNePS (Rapaport, 1986a; Rapaport, Shapiro, & Wiebe, 1986; Wiebe & Rapaport, 1986). We show how SNePS's propositional and fully intensional nature, plus the story operator, allow the best aspects of the philosophical theories to be implemented.

Four Ontological Theories of Fiction

Let us begin by briefly surveying four (out of many more) philosophical theories of the ontological status of fictional objects. We are not concerned as much with criticizing them as with finding what aspects might be useful for our, rather different, purposes.

Castañeda's Theory. Hector-Neri Castañeda's theory of guises and consubstantiation is an all-encompassing theory of the objects of thought and of objects in the world (Castañeda, 1972, 1975a, 1975b, 1977b, 1980, 1989); it includes a theory of fictional objects (Castañeda, 1979, 1989). We discussed the full theory in detail elsewhere (Rapaport, 1978, 1985a), so here, we will content ourselves with a presentation of his theory of fiction.

Castañeda took a uniform viewpoint, with which we agree: All objects in fiction are to be treated alike, whether they are real or fictional (cf. Rapaport, 1985a; Scholes, 1968). They are, in his terminology, *guises*, that is, intensional objects of thought. But there are different modes of predication of properties to guises. If one reads in a narrative about the Civil War that Lincoln died in 1865, this would be analyzed in Castañeda's theory as a *consubstantiation* (C*) of two guises, the guise c{being Lincoln} (i.e., the intensional object of thought whose sole internal property is *being Lincoln*) and the guise c{being Lincoln, having died in 1865} (i.e., the intensional object of thought whose sole internal properties are *being Lincoln* and *having died in 1865*):

C*(c{being Lincoln}, c{being Lincoln, having died in 1865}).

Consubstantiation is an existence-entailing equivalence relation. On the other hand, if one reads another narrative, in which the author has stated that Lincoln was re-elected in 1868, this would be analyzed as a *consociation* (C**) of two guises:

C**(c{being Lincoln}, c{being Lincoln, having been re-elected in 1868}).

Consociation is an equivalence relation that does not entail existence, among guises that are joined together in a mind. But it is the same Lincoln (i.e., c{being Lincoln}) in both cases.

That is an oversimplification, but it raises the following concern: How is the reader to decide whether a sentence read in the course of a narrative is to be analyzed by consubstantiation or by consociation? In fact, we claim, the uniformity with respect to the objects should be extended to the mode of predication: All predications in narrative are consociational, even the true ones.

Castañeda also admitted the existence of story operators into his theory, but found them otiose. A *story operator* is a (usually modal) operator that prefixes all sentences in a narrative: "In story S, it is the case that φ." Not all theorists of fiction find them attractive (cf. Rapaport, 1976, 1985b), but, as Castañeda pointed out, one can hardly deny that they exist. One can take the operator to be the title page of the narrative! His claim was that story operators fail to account for the interesting or problematic aspects of fiction.

An example in the context of SNePS might clarify this. Consider the situation illustrated in Fig. 5.1. Suppose that Cassie has a background belief ("world knowledge," we might say) that: (1) George Washington was the first president. This would be analyzed as a consubstantiation. Suppose that Cassie next reads in a narrative that: (2) George Washington chopped down a cherry tree. This would be analyzed as a consociation. The processing problem is this: If both sentences were to have occurred in the narrative, they would have to be treated alike, using the same mode of predication, namely, consociation. But this is a reasonable modification of Castañeda's theory, and there are no other problems so far, so all is well.

Lewis's Theory. David Lewis's theory of fiction (1978) made essential use of the story operator, and, despite earlier misgivings about them (see previous references), we find they have a useful role to play. But Lewis's version has some problems. He allowed his story operator to be dropped by way of abbreviation. Thus, we might say, "Sherlock Holmes lived at 221B Baker Street," but what we really mean is, for example, "In *The Hound of the Baskervilles*, Sherlock Holmes lived at 221B Baker Street," because, after all, the former is false and the latter is true.

There is an evident advantage to this, for it enables us to distinguish between facts about fictional and nonfictional entities—a worthy endeavor, and one that

Background belief:
(1) GW was the first president (C*)
Narrative claim:
(2) GW chopped down a cherry tree (C)**

Processing problem:
In narrative, both have to be treated alike;
same mode of predication (C)**

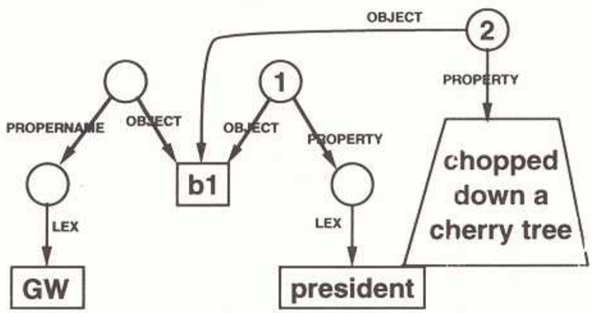

FIG. 5.1. A narrative for Castañeda's theory.

Cassie must be able to do. In fact, she will do it much the way that Lewis recommended. Consider the following argument:

Lived-at(221B Baker St., Sherlock Holmes)
221B Baker St. = a bank
∴ Lived-at(a bank, Sherlock Holmes)

Although the first premise is true in the story world (but false or truth-valueless in the real world), and the second is factually true (cf. Rule, 1989), the conclusion is false in both the real world and the story world. But merely replacing the story operator will not help:

In *The Hound of the Baskervilles*, Lived-at(221B Baker St., Sherlock Holmes)
221B Baker St. = a bank
∴ In *The Hound of the Baskervilles*, Lived-at(a bank, Sherlock Holmes)

fares no better, since 221B Baker St. is not a bank in *The Hound of the Baskervilles*. Nor does:

In *The Hound of the Baskervilles*, Lived-at(221B Baker St., Sherlock Holmes)
221B Baker St. = a bank
∴ Lived-at(a bank, Sherlock Holmes)

fare any better, since the conclusion is false with or without the story operator. But a uniform application of the story operator works fine:

In *The Hound of the Baskervilles*, Lived-at(221B Baker St., Sherlock Holmes)
In *The Hound of the Baskervilles*, 221B Baker St. = a bank
∴ In *The Hound of the Baskervilles*, Lived-at(a bank, Sherlock Holmes)

and:

Lived-at(221B Baker St., Sherlock Holmes)
221B Baker St. = a bank
∴ Lived-at(a bank, Sherlock Holmes)

are both valid, albeit unsound. The former is unsound, because the second premise is false; the latter is unsound, because the first premise is false.

The difficulty with Lewis's proposal is that "Sherlock Holmes is fictional" is false either way. It is false *with* the story operator restored, because, within the story, Holmes is as real as is anyone. And it is false (or at least truth-valueless) *without* it, because "Sherlock Holmes" is a nondenoting expression. This difficulty is unacceptable.

Parsons's Theory. Terence Parsons's theory of fiction (1975, 1980) was based on his theory of nonexistent objects. In contrast to Castañeda, whose theory had one kind of property but two modes of predication, Parsons's had two kinds of properties (nuclear and extranuclear), but only one mode of predication. Rather than rehearse his full theory of fiction here (see Rapaport, 1985b for a summary and critique), we focus on a distinction he makes between *native*, *immigrant*, and *surrogate* fictional objects.

Native fictional objects are those who originate in the story in which they are found, such as Sherlock Holmes in *The Hound of the Baskervilles*. Immigrant fictional objects are those who have migrated into a story from elsewhere, such as London in *The Hound of the Baskervilles*, or Sherlock Holmes in *The Seven Per Cent Solution* (Meyer, 1974). But, of course, the London of *The Hound of the Baskervilles* has properties that the real London lacks (and vice versa), which raises obvious difficulties. So the London-of-*The-Hound-of-the-Baskervilles* is a surrogate fictional object, distinct from the real London.

Such distinctions can be made and are useful. But there are a number of questions to be answered before one can accept them: Which London did Conan Doyle discuss? Which London did Sherlock Holmes and Dr. Watson discuss? When is one discussing London and when the London-of-*The-Hound-of-the-Baskervilles*? In general, how does the reader distinguish properties of the "real" London from properties of the London-of-*The-Hound-of-the-Baskervilles*? These are questions that can be dealt with, we believe, in the SNePS proposal to be introduced later.

Van Inwagen's Theory. The final theory of fictional objects in our brief survey is one that we find quite congenial in many respects, though it, too, falls short. Peter van Inwagen's theory (1977), like Castañeda's, distinguished between two modes of predication, and, like Lewis's, it used something like a story operator.

Van Inwagen's two modes of predication were *predication* and *ascription*. "Sherlock Holmes is fictional" expresses a property "predicated of" an existing theoretical entity of literary criticism, namely, Sherlock Holmes. (Other kinds of theoretical entities of literary criticism include novels, short stories, etc.) In contrast, "Sherlock Holmes is a detective" expresses (perhaps elliptically) a property "ascribed to" the same theoretical entity of literary criticism "in" a work of fiction:

A(detective, Sherlock Holmes, *The Hound of the Baskervilles*).

Note that the story is not a logical operator, but an essential argument place in a 3-place predication relation.

There are two problems with this theory. They are, we believe, not serious problems and could be easily resolved. First, in "Sherlock Holmes Confronts Modern Logic" (Hintikka & Hintikka, 1983), the authors called Holmes a "great detective" (p. 155). According to van Inwagen's theory, contrary to what one might expect, it is not the case that:

A(great detective, Sherlock Holmes, "Sherlock Holmes Confronts Modern Logic").

Why? Because "Sherlock Holmes Confronts Modern Logic" is not literature and, hence, not a theoretical entity of literary criticism. This strikes us as an unnecessary aspect of van Inwagen's theory.

Second, assume that in Tolstoy's *War and Peace* it is stated that Napoleon is vain.[1] According to van Inwagen's theory and contrary to what one might expect, it is not the case that:

A(vain, Napoleon, *War and Peace*),

because Napoleon is not a theoretical entity of literary criticism! Again, this strikes us as unnecessary.

A SNePS Approach to Fiction

In order for Cassie to read a narrative, the representations she should construct include a story operator (as in Lewis's or van Inwagen's theory), only one mode of predication (as in Parsons's theory), and only one kind of property (as in Castañeda's theory). Because, at the time of writing, this theory is only beginning to be implemented, there is a strong possibility that this will prove insufficient. The one addition we foresee (urged in earlier writings, e.g., Rapaport, 1976, 1985b, and suggested in conversation by Johan Lammens) is the need to distinguish between real-world entities and their surrogates; but it must be kept in mind that all entities represented in Cassie's mind are just that—entities in her mind—not entities, some of which are real and some of which are fictional.

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[1]It may in fact be so stated; one of the co-authors confesses to not (yet) having read it; the other has read it but does not recall whether it is so stated. It might suffice for van Inwagen's example that it follow (logically) from what is stated in *War and Peace* that Napoleon is vain; no matter.

The story operator sets up a "story space" that is formally equivalent to a belief space (cf. Rapaport, 1986a; Shapiro & Rapaport, 1991; Shapiro & Rapaport, this volume; Wiebe & Rapaport, 1986). It allows Cassie to distinguish her own beliefs about London from claims (or her beliefs about claims) made about London in a story in precisely the same way that belief spaces allow Cassie to distinguish her own beliefs about John from her beliefs about Mary's beliefs about John (cf. Rapaport, 1986a; Shapiro & Rapaport, 1987; Shapiro & Rapaport, this volume).

But how should this be handled? Consider Fig. 5.2. Suppose that one of Cassie's background beliefs is that Lincoln died in 1865, and suppose that she reads in a narrative that Lincoln was re-elected in 1868. There is a processing problem: Cassie is faced with an inconsistency. There are two solutions. First, the SNePS Belief Revision system (SNeBR; Martins & Shapiro, 1988)—a facility for detecting and removing inconsistent beliefs—can be invoked. The detection of the inconsistency will cause a split to be made into two consistent contexts. But note that the net effect of this is to embed the second statement (the re-election in 1868) in a story operator. So we could start with a story operator in the first place. This is the second solution, as shown in Fig. 5.3. (An implementation of the first solution is given in the next section.)

But now let us complicate the data. Consider Fig. 5.4. Suppose that Cassie's background beliefs include that Lincoln was the 16th president and that Lincoln died in 1865, and suppose that Cassie reads in a narrative that Lincoln was re-elected in 1868. The processing problem here is that we want the first of Cassie's two background beliefs to migrate into the story world. But this is not

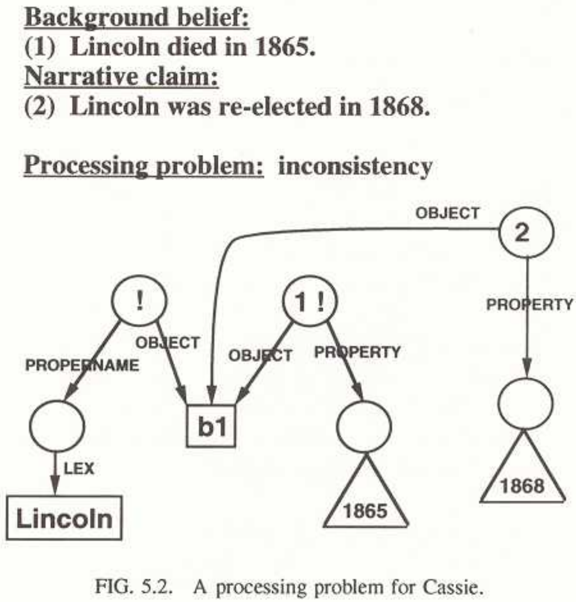

FIG. 5.2. A processing problem for Cassie.

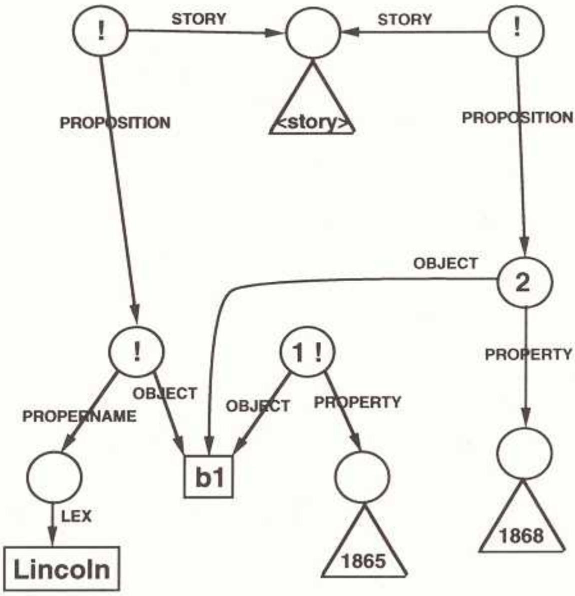

FIG. 5.3. A solution using a story operator.

<u>Background beliefs:</u>

(1) Lincoln was the 16th president.

(2) Lincoln died in 1865.

<u>Narrative claim:</u>

(3) Lincoln was re-elected in 1868.

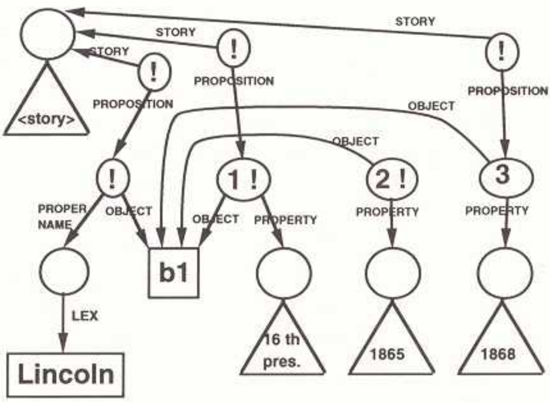

FIG. 5.4. A more complex narrative.

really a problem because those first two background beliefs are Cassie's beliefs and the third is not. The first one (that Lincoln was 16th president) is both believed by Cassie and is in the story world.

Consider Fig. 5.1 again. If Cassie knows that she is reading a narrative, we want it to be the case that she believes (1) (that Washington was the first president), and we want both (1) and (2) (that he chopped down the cherry tree) to be in the story world. How do we accomplish this? Under the first solution, all propositions from the narrative will be placed in a story context. Under the second solution, we start with a story operator on (2). In general, we put a story operator on *all* narrative predications.

But then we face two problems: Background beliefs of the reader are normally brought to bear on understanding the story, as we saw in Fig. 5.2. And we often come to learn (or, at least, come to have beliefs) about the real world from reading fictional narratives. Thus, we need to have two rules, which we put roughly, but boldly, as follows:

(R1) Propositions outside the story space established by the story context or the story operator (i.e., antecedently believed by the reader) are assumed, when necessary, to hold within that story space by default but defeasibly.

(R2) Propositions inside the story space are assumed, when necessary, to hold outside that story space by default but defeasibly.

The "when necessary" clause is there to prevent an explosion in the size of belief and story spaces. The migrations permitted by these two rules would only take place on an as-needed basis for understanding the story or for understanding the world around us. The "by default" clause is there for obvious reasons. We wouldn't want to have Lincoln's dying in 1865 migrate into a narrative in which he is re-elected in 1868. The "defeasibly" clause is there to undo any damage that might be done at a later point in the narrative if such a migration had taken place, innocently, at an earlier point. Rule (R1) (or such refinements of it as will, no doubt, be necessary as implementation of the theory proceeds) aids in our understanding of the story. Rule (R2) (or such refinements of it as will also, no doubt, be necessary as implementation of the theory proceeds) allows us to enlarge our views of the world from reading literature, yet to segregate our real-world beliefs from our story world beliefs. In this manner, we facilitate the membrane whose semipermeability allows us to understand narratives using our world knowledge, and to learn from narratives—indeed, to understand the real world in terms of narratives (cf. Bruner, 1990).

We close with three final remarks. First, to see how the story operator solves the problem with Lewis's theory, look at Fig. 5.5. (How it solves the problems with van Inwagen's are left as exercises for the reader.) Second, in Figs. 5.1–5.5, we used the linguist's triangle to hide irrelevant details; however, Fig. 5.6 shows how the story operator looks in detail. Finally, a preliminary implementation using SNeBR is presented in the next section.

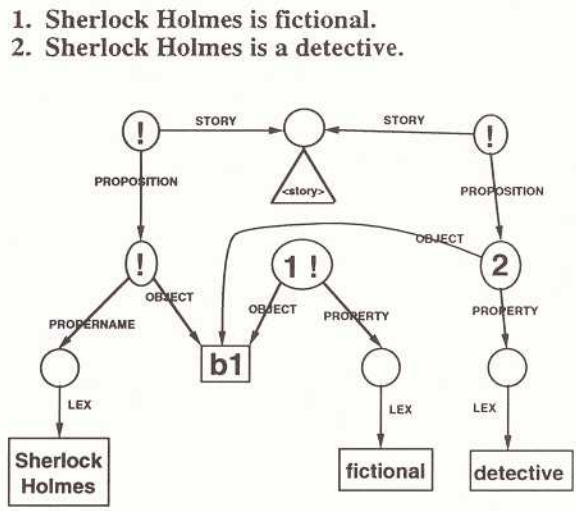

FIG. 5.5. Handling the problem with Lewis's theory.

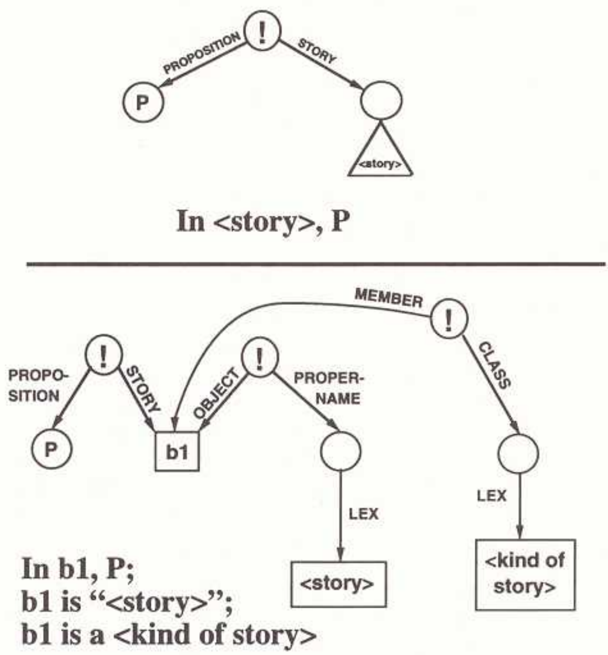

FIG. 5.6. Details of the story operator.

A SNePS IMPLEMENTATION OF FICTIONAL REPRESENTATION AND REASONING

In this section, we present an interaction in SNePSLOG (Shapiro & the SNePS Implementation Group, 1989; Shapiro, McKay, Martins, & Morgado, 1981), a Prolog lookalike interface to SNePS–2.1 (which incorporates the SNeBR belief-revision system), demonstrating the current implementation of parts of the theory of fiction outlined in a previous section. Explanatory comments are added (signalled by "`*** COMMENT ***`"). After SNePS is invoked, user input follows the "`:`" prompt, and subsequent lines show Cassie's output. (Some irrelevant information was deleted or edited for ease of readability.)

```
 Welcome to SNePSLOG (A logic interface to SNePS)
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University of New York.
```

```
*** COMMENT ***: Let the current belief space be the real world.
```

```
: set-context real-world ()
((ASSERTIONS NIL) (RESTRICTION NIL) (NAMED (REAL-WORLD DEFAULT-
DEFAULTCT)))
: set-default-context real-world
((ASSERTIONS NIL) (RESTRICTION NIL) (NAMED (REAL-WORLD DEFAULT-
DEFAULTCT)))
```

```
*** COMMENT ***: We begin by giving Cassie some background
                 knowledge about the real world. First, she is
                 told (using SNePSLog) that all persons who are
                 assassinated in some year are dead in that year.
                 As a result, Cassie believes that proposition.
```

```
: all(p,y)(Assassinated(p,y) => Dead(p,y))
  all(P,Y)(ASSASSINATED(P,Y) => DEAD(P,Y))
```

```
*** COMMENT ***: Cassie is told that if a person, p, is dead in
                 some year y1, and y1 is before year y2, then p
                 is dead in y2 (a "no-resurrection" hypothesis;
                 see Acknowledgments section):
```

```
: all(p,y1,y2)({Dead(p,y1), Before(y1,y2)} &=> {Dead(p, y2)})
  all(P,Y1,Y2)({DEAD(P,Y1),BEFORE(Y1,Y2)} &=> {DEAD(P,Y2)})
```

```
*** COMMENT ***: Cassie is told that if a person is elected in
                 some year, then it is not the case that that
                 person is dead in that year (a "neither Chicago
                 nor Philadelphia" hypothesis):
```

```
: all(p,y)(Elected(p,y) => ~Dead(p,y))
  all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
```

```
*** COMMENT ***: Cassie is told that 1865 is before 1868:
```

```
: Before(1865, 1868)
  BEFORE(1865,1868)
```

```
*** COMMENT ***: Next, we tell Cassie some specific facts about
                 Lincoln. After each one, Cassie performs for-
                 ward inference, signalled by the "!", in order
                 to draw conclusions. If she has to reason, she
                 "thinks out loud". First, she is told that Lin-
                 coln was elected in 1860, from which she infers
                 that Lincoln was not dead in 1860:
```

```
: Elected(Lincoln, 1860)!
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1860)
I infer ~DEAD(LINCOLN,1860)
  ELECTED(LINCOLN,1860)
  ~DEAD(LINCOLN,1860)
```

```
*** COMMENT ***: Cassie is told that Lincoln was assassinated in
                 1865, from which she infers that Lincoln was
                 dead in 1865, hence also in 1868. ("BS" is a
                 "belief space"; for its definition in SNeBR,
                 see Martins & Shapiro, 1988.)
```

```
: Assassinated(Lincoln, 1865)!
Since all(P,Y)(ASSASSINATED(P,Y) => DEAD(P,Y))
and ASSASSINATED(LINCOLN,1865)
I infer DEAD(LINCOLN,1865)
I wonder if DEAD(LINCOLN,Y1)
holds within the BS defined by context REAL-WORLD
I wonder if BEFORE(Y1,Y2)
holds within the BS defined by context REAL-WORLD
I know DEAD(LINCOLN,1865)
I know BEFORE(1865,1868)
I know it is not the case that DEAD(LINCOLN,1860)
I wonder if ASSASSINATED(LINCOLN,Y)
holds within the BS defined by context REAL-WORLD
Since all(P,Y)(ASSASSINATED(P,Y) => DEAD(P,Y))
and ASSASSINATED(LINCOLN,1865)
I infer DEAD(LINCOLN,1865)
I wonder if ELECTED(LINCOLN,Y)
holds within the BS defined by context REAL-WORLD
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1860)
I infer ~DEAD(LINCOLN,1860)
I know ASSASSINATED(LINCOLN,1865)
I know ELECTED(LINCOLN,1860)
```

```
DEAD(LINCOLN,1868)
BEFORE(1865,1868)
~DEAD(LINCOLN,1860)
ASSASSINATED(LINCOLN,1865)
DEAD(LINCOLN,1865)
```

*** COMMENT ***: So, Cassie's background, or real-world, beliefs consist of six hypotheses—that assassination implies death (WFF1), that death in year y1 implies death in all later years (WFF2), that elected people aren't dead (WFF3), that 1865 is before 1868 (WFF4), that Lincoln was elected in 1860 (WFF5), and that Lincoln was assassinated in 1865 (WFF8)—together with all propositions inferred from these:

```
: describe-context
((ASSERTIONS (WFF1 WFF2 WFF3 WFF4 WFF5 WFF8)) (RESTRICTION NIL)
  (NAMED (REAL-WORLD)))
```

*** COMMENT ***: Next, the story world context is defined, following Rule (R1), to consist, by default, of all of Cassie's current hypotheses. (This implementation of the story world operator does not use an explicit story node; rather, it uses SNeBR's mechanism of contexts; cf. Martins & Shapiro, 1988.):

```
: set-context story (wff1 wff2 wff3 wff4 wff5 wff8)
((ASSERTIONS (WFF1 WFF2 WFF3 WFF4 WFF5 WFF8)) (RESTRICTION NIL)
  (NAMED (STORY REAL-WORLD)))
```

*** COMMENT ***: The story world context is entered; from here until that context is left, Cassie should be thought of as reading a narrative about Lincoln, the Lincoln about whom she believes WFFs 1–5, 8, and all beliefs that she has inferred from them:

```
: set-default-context story
((ASSERTIONS (WFF1 WFF2 WFF3 WFF4 WFF5 WFF8)) (RESTRICTION NIL)
  (NAMED (STORY REAL-WORLD)))
```

*** COMMENT ***: Cassie reads that Lincoln was tall in 1860, from which, being an intelligent reader who thinks about what she reads, she infers nothing:

```
: Tall(Lincoln, 1860)!
```

```
TALL(LINCOLN,1860)
```

*** COMMENT ***: Cassie reads that Lincoln was elected in 1868 (thus, Cassie is clearly reading a work of historical fiction) ...:

```
: Elected(Lincoln, 1868)!
```

*** COMMENT ***: ...from which she infers that, in the story world, Lincoln is not dead in 1868. Since this is inconsistent with her beliefs that Lincoln is dead in 1865 and that anyone who is dead in 1865 is dead in the later year 1868, SNeBR, the interactive belief-revision system, is invoked:

```
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1868)
I infer ~DEAD(LINCOLN,1868)
  A contradiction was detected within context STORY.
  The contradiction involves the newly derived node:
   ~DEAD(LINCOLN,1868)
```

*** COMMENT ***: That is, the contradiction involves the proposition that it is not the case that Lincoln is dead in 1868, which Cassie has just inferred in her real-world-augmented story world, ...

```
  and the previously existing node:
   DEAD(LINCOLN,1868)
```

*** COMMENT ***: ... and the proposition that Lincoln is dead in 1868, which Cassie had inferred to hold in the real world.

```
  You have the following options:
  1. [C]ontinue anyway, knowing that a contradiction is de-
     rivable;
  2. [R]e-start the exact same run in a different context
     which is not inconsistent;
  3. [D]rop the run altogether.
  (please type c, r or d)
=><= r
```

*** COMMENT ***: That is, we choose to eliminate the inconsistencies.

```
In order to make the context consistent you must delete at
least one hypothesis from each of the following sets of
hypotheses:
```

```
  (WFF1 WFF12 WFF2 WFF3 WFF4 WFF8)
```

```
*** COMMENT ***: WFF12 = Lincoln was elected in 1868.
```

```
    In order to make the context consistent you must delete
  some hypotheses from the set (WFF1 WFF12 WFF2 WFF3 WFF4
  WFF8)
  You are now entering a package that will enable you to
  delete some hypotheses from this set.
  Do you need guidance about how to use the package?
=><= n
Do you want to take a look at hypothesis WFF1?
=><= y
  all(P,Y)(ASSASSINATED(P,Y) => DEAD(P,Y))
  There are 3 nodes depending on hypothesis WFF1:
   (WFF1 WFF10 WFF9).
```

```
*** COMMENT ***: WFF9 = Lincoln is dead in 1865.
                 WFF10 = Lincoln is dead in 1868.
```

```
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF1?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= k
```

```
*** COMMENT ***: We choose to keep within the story world the be-
                 lief that assassinated people are dead.
```

```
Do you want to take a look at hypothesis WFF12?
=><= y
  ELECTED(LINCOLN,1868)
  There are 2 nodes depending on hypothesis WFF12:
   (WFF12 WFF13).
```

```
*** COMMENT ***: WFF13 = Lincoln is not dead in 1868.
```

```
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF12?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= k
```

```
*** COMMENT ***: We keep in the story world that Lincoln was
                 elected in 1868. (After all, this is a fact in
                 the story world and must be accepted.)
```

```
Do you want to take a look at hypothesis WFF2?
=><= y
  all(P,Y1,Y2)({DEAD(P,Y1),BEFORE(Y1,Y2)} &=> {DEAD(P,Y2)})
  There are 2 nodes depending on hypothesis WFF2:
   (WFF10 WFF2).
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF2?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= k
```

```
*** COMMENT ***: We keep in the story world that once dead, al-
                 ways dead.
```

```
Do you want to take a look at hypothesis WFF3?
=><= y
  all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
  There are 3 nodes depending on hypothesis WFF3:
   (WFF13 WFF3 WFF7).
```

```
*** COMMENT ***: WFF7 = Lincoln is not dead in 1860.
```

```
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF3?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= k
```

```
*** COMMENT ***: We keep in the story world that elected people
                 are not dead.
```

```
Do you want to take a look at hypothesis WFF4?
=><= y
  BEFORE(1865,1868)
  There are 2 nodes depending on hypothesis WFF4:
   (WFF10 WFF4).
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
```

```
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF4?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= k
```

*** COMMENT ***: We keep in the story world that 1865 is before 1868.

```
Do you want to take a look at hypothesis WFF8?
=><= y
  ASSASSINATED(LINCOLN,1865)
  There are 3 nodes depending on hypothesis WFF8:
   (WFF10 WFF8 WFF9).
  Do you want to look at [a]ll of them, [s]ome of them, or
  [n]one?
  (please type a, s or n)
=><= n
  What do you want to do with hypothesis WFF8?
  [d]iscard from the context, [k]eep in the context,
  [u]ndecided, [q]uit this package
  (please type d, k, u or q)
=><= d
```

*** COMMENT ***: That Lincoln was assassinated in 1865 is *defeated*; that is, we remove it from the story world as being the cause of the inconsistency; that is, everything that Cassie antecedently believed about Lincoln is assumed to hold in the story world, except for this belief.

```
  The following (not known to be inconsistent) set of
  hypotheses was also part of the context where the
  contradiction was derived:
   (M11! M5!)
  Do you want to inspect or discard some of them?
=><= n
```

*** COMMENT ***: The propositions that Lincoln was elected in 1860 (WFF5, represented by node M5!) and that Lincoln was tall in 1860 (WFF11, represented by node M11!) were not listed as among the hypotheses responsible for the inconsistency, so they remain in the story world by default.

```
  Do you want to add a new hypothesis?
=><= n
```

```
*** COMMENT ***: Cassie's reasoning about Lincoln's properties
                 in the story world continues:
```

```
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1868)
I infer ~DEAD(LINCOLN,1868)
  ELECTED(LINCOLN,1868)
  ~DEAD(LINCOLN,1868)
```

```
*** COMMENT ***: Cassie has just inferred, again, that, in the
                 story world, Lincoln was not dead in 1868. This
                 is no longer inconsistent with her other be-
                 liefs about the story world. We now interac-
                 tively ask Cassie questions about what she
                 believes, including what she has read.
```

```
: ?P(Lincoln,?y)?
```

```
*** COMMENT ***: Cassie begins to reason within the story world,
                 but also using her real-world beliefs. By Rule
                 (1), they were assumed to hold in the story
                 world by default, but defeasibly—as we just
                 saw.
```

```
I wonder if ?P(LINCOLN,?Y)
holds within the BS defined by context STORY
I know ELECTED(LINCOLN,1860)
I know ELECTED(LINCOLN,1868)
I know TALL(LINCOLN,1860)
I know it is not the case that ASSASSINATED(LINCOLN,1865)
I know it is not the case that DEAD(LINCOLN,1860)
I know it is not the case that DEAD(LINCOLN,1868)
I wonder if DEAD(LINCOLN,Y1)
holds within the BS defined by context STORY
I wonder if BEFORE(Y1,Y2)
holds within the BS defined by context STORY
I wonder if ASSASSINATED(LINCOLN,Y)
holds within the BS defined by context STORY
I wonder if ELECTED(LINCOLN,Y)
holds within the BS defined by context STORY
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1868)
I infer ~DEAD(LINCOLN,1868)
I know BEFORE(1865,1868)
I know ELECTED(LINCOLN,1860)
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1860)
I infer ~DEAD(LINCOLN,1860)
I know ELECTED(LINCOLN,1868)
```

```
*** COMMENT ***: Following is Cassie's reply to our question.
                 She believes that, in the story world, Lincoln
                 was tall in 1860, he was elected in 1868, he is
                 not dead in 1868, he was not assassinated in
                 1865, he was elected in 1860, and he was not
                 dead in 1860:
```

```
  TALL(LINCOLN,1860)
  ELECTED(LINCOLN,1868)
  ~DEAD(LINCOLN,1868)
  ~ASSASSINATED(LINCOLN,1865)
  ELECTED(LINCOLN,1860)
  ~DEAD(LINCOLN,1860)
```

```
*** COMMENT ***: Now we tell Cassie to think about the real
                 world, in which she believes the propositions
                 represented by WFFs 1, 2, 3, 4, 5, and 8:
```

```
: set-default-context real-world
((ASSERTIONS (WFF1 WFF2 WFF3 WFF4 WFF5 WFF8)) (RESTRICTION
((WFF12)))
  (NAMED (REAL-WORLD)))
: %(clear-infer)
(Node activation cleared. Some register information retained.)
```

```
*** COMMENT ***: If we just add WFF11 to the real world, follow-
                 ing Rule (2), Cassie tries to believe, by de-
                 fault, but defeasibly, that what she read in the
                 story is true in the real world. No inconsis-
                 tency is detected, so, because Lincoln's being
                 tall in 1860 is consistent with her real-world
                 beliefs, she believes it:
```

```
: Tall(Lincoln, 1860)!
  TALL(LINCOLN,1860)
```

```
*** COMMENT ***: But if we then add WFF12 an inconsistency is
                 created. What she has learned in the story world
                 is inconsistent with what she antecedently be-
                 lieved in the real world, so SNeBR is invoked:
```

```
: Elected(Lincoln, 1868)!
Since all(P,Y)(ELECTED(P,Y) => (~DEAD(P,Y)))
and ELECTED(LINCOLN,1868)
I infer ~DEAD(LINCOLN,1868)
  A contradiction was detected within context REAL-WORLD.
  The contradiction involves the newly derived node:
   ~DEAD(LINCOLN,1868)
```

```
  and the previously existing node:
   DEAD(LINCOLN,1868)
  You have the following options:
  1. [C]ontinue anyway, knowing that a contradiction is de-
     rivable;
  2. [R]e-start the exact same run in a different context
     which is not inconsistent;
  3. [D]rop the run altogether.
  (please type c, r or d)
=><= d
```

```
*** COMMENT ***: So WFF12 is not added. The following message,
                 however, is printed, because we attempted to
                 add WFF12. That fact that it was not success-
                 fully added to the real-world context will be
                 apparent below.
```

```
ELECTED(LINCOLN,1868)
```

```
*** COMMENT ***: We ask Cassie again what she believes about Lin-
                 coln in the real world (this time, her reasoning
                 has been edited out, for readability):
```

```
: ?P(Lincoln,?y)?
```

```
*** COMMENT ***: Note that Cassie now believes, on the basis of
                 the story, that, in the real world, Lincoln was
                 tall in 1860. Note, too, that she does not be-
                 lieve that Lincoln was elected in 1868. She in-
                 fers the following:
```

```
  DEAD(LINCOLN,1868)
  TALL(LINCOLN,1860)
  ELECTED(LINCOLN,1860)
  ~DEAD(LINCOLN,1860)
  ASSASSINATED(LINCOLN,1865)
  DEAD(LINCOLN,1865)
```

CONCLUSION

This brings to an end our essay in computational philosophy. We explored knowledge-representation and reasoning issues surrounding fictional entities and their fictional (and nonfictional) properties, as well as their interaction with nonfictional entities. We showed how Cassie could read a narrative and construct and reason about her mental model of the story expressed by the narrative, and how information can selectively flow between general real-world knowledge and story world knowledge.

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"Cognition and Fiction"

William J. Rapaport and Stuart C. Shapiro
Department of Computer Science and Engineering
and Center for Cognitive Science
State University of New York at Buffalo, Buffalo, NY 14260-2000

{rapaport | shapiro}@cse.buffalo.edu

http://www.cse.buffalo.edu/sneps

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