On the usefulness of conceptual graphs in representing knowledge for intelligent retrieval

Judith P. Dick
Sandford Fleming Bldg., #3212,
10 King's College Rd.,
University of Toronto
Toronto, Ont.,
Canada M5S 1A4.
e-mail: dick@ai.toronto.edu
Fax: 416-978-1931

Abstract

A conceptual, case-relation representation of contract law cases has been written to show the advantages of conceptual retrieval over keyword Boolean retrieval. Sowa's conceptual graphs were used in writing the kr and supplemented with Harold Somers's linguistic cases. The cases are described and compared with the conceptual relations used by Sowa. The domain is characterized by abstract concepts, not elephants and birds, but intentions and considerations. Some discussion of the representation of complex sentences and the use of embedded contexts in the kr. Although a frame matching algorithm was described in the original work to demonstrate how retrieval would work, the description is not included here.

1. Introduction

Sowa's conceptual graphs (cgs) have been used to construct a knowledge representation (kr) for the retrieval of contract law cases (Dick 1991). The purpose of the work was to show that conceptual analysis makes it possible to retrieve ideas and arguments from a body of text and to demonstrate that we should be looking beyond keyword indexes if we are to be able to build intelligent retrieval systems that free users to develop their ideas while searching for information.

Cgs were chosen for a number of reasons. In the first place, they constituted a fully developed notational system especially suited to the analysis of natural language text.[1] Cgs have a mnemonic aspect and are exceptionally easy for the uninitiated to read. Their use has made bridging the gap between IR and AI audiences much easier. Although the graphic format was more readily comprehensible to readers, the linear format was quickly understood,

The expressiveness of the graph notation was seen as especially attractive, as was the capacity for disambiguation of terms by the proper use of diverse symbols. Semantic analysis was the focus of the work behind cgs and was important in my own research. The use of cgs did not bind one to any single linguistic theory or rigid syntactic formulation. The graphs appeared to be suitable for the representation of highly abstract ideas like 'intention', for example, intention to contract, and for legal concepts such as the 'foreseeability of consequences'. Also, I chose cgs anticipating the need to represent highly complex sentential structures. I later became less concerned with sentential structure and more with concept extraction. It was clear from the start that well-defined contextual boundaries would give me an advantage and were not so readily available in most other notations. Finally, there is an

[1] It may be noted that law cases provide a particularly difficult problem in retrieval partly because of the complexity of the subject matter and the need for a high recall, but as well because textual analysis in this domain is especially challenging since each case is unique. Patterns of literary similarity are not common. The reasoning is diffuse, dense, and original. Although reasons for judgement are formally written, the vocabulary of the law is derived from everyday language. Distinguishing the technical meanings of common words is exacting.

established user community and I thought that employing cgs would bring the construction of an interpreter closer because of current software development. Although the focus of my research was on the target of retrieval, rather than the process, the development of a representation for retrieval is appropriate only if it can be seen to ultimately lead to a practicable implementation.

Cgs did fulfill some of their promise and it rapidly became very clear to me, that what I was using was not just a notation. Before using cgs, I had been making attempts at representing the contract cases in FOL with fairly standard predicate notation with very little success. Details of what began as a rather harrowing experience, attempting to represent legal arguments derived from contract cases in a logic notation, to write anglicized logic, are given in my thesis (Dick 1991) and to my surprise have interested a number of others whom I suspect are suffering similar hardships.[2] Upon realizing that I should focus less on sentence structure and then discovering and making use of cgs, I began to focus much more on the conceptual content of the legal arguments in the cases. The text analysis went more smoothly. The resulting representations were significantly improved — they actually became meaningful — and I arrived at the realization that cgs were more than a notation. They were aiding me in analyzing and expressing the informational content of the text.

Cgs proved to be a happy choice for my work. Their strong logic foundation and the fact that they were not tied to a particular linguistic theory made them especially useful. Nevertheless, using cgs did not solve all the representational problems. It was necessary to supplement them with some additional sources (Dick 1991). Two aspects of their use in particular were important in the development of a kr for intelligent retrieval, the definition of conceptual relations and the representation of complex assertions in embedded contexts.

2. Conceptual relations

Conceptual relations (conrels) are tremendously important in making an accurate conceptual representation of textual meaning. Sowa provided a catalog of fundamental conrels (Sowa 1984, 415-419) to give the user a start. They proved to be extremely useful, however, the need for semantic precision made it necessary to reach beyond the original catalog. Among the conrels Sowa defined are a number of linguistic cases, *deep cases*, such as the traditional 'agent', 'patient' and 'instrument'.

Case theory was introduced in 1968 by Fillmore. As Hirst explains

> In its most basic form, case theory views a sentence as an assertion whose predicate is denoted by the verb of the sentence and whose arguments are denoted by the noun phrases. (1987, 7)

The most successful krs that have been developed for language processing are strongly rooted in an understanding of linguistic case theory. Sowa included the most commonly used traditional cases and presumably left it to the user to apply them as suited his need. Since we had found case to be a fundamental component of the most robust NLP applications we decided to strengthen the kr considerably in this respect. Recall that IR systems to be practically successful must be able to access a large volume of text. For this reason, also it seemed important to produce a kr based on linguistic principles. However, the traditional case conrels were not adequate to the task of text analysis in this instance. They were too few, and too general in nature. Since case had been found to be fundamental to the analysis of text it was decided to supplement the original catalog.

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[2] In a recent transmission in the Conceptual Graphs Newsletter, Sowa talked about the difficulty of choosing predicates and discussed how little that difficulty is realized. I felt, upon reading that comment, that it was a problem that was too seldom recognized and one I had had a tremendous struggle with with very little help from the literature.

No single case grammar has emerged as clearly superior. Nor has a consensus been achieved on a list of fundamental cases. However, Harold Somers had designed a grid of cases in an attempt to answer some of the criticisms of case theory (Somers 1987). The grid is intended to be useful in computational linguistics. And that is the case grammar I chose to supplement cgs. It appears in Figure 1 below.

As Somers put it, "Case is altogether a question of making significant generalizations", (1987, 119). He attempted to solve three specific problems with case that were widely recognized: the degree of specificity of the commonly used cases, the assignment of arbitrary case names for exceptions and, role duality. By specifying cases that combined grammatical relations and semantic realizations, he was able to resolve many troubles that had resulted in the undesirable, haphazard proliferation of non-standard cases.

The most obvious dual role problems were similarly solved by combining related functions. A common example involves the verbs of transfer of possession, 'buy' and 'sell', which both indicate as well as the agent, a source, or original possessor, and a goal, or final possessor, in their noun phrase attachments. The agent of buy is the goal, while the agent of sell is the source.[3] In the domain of contracts, 'offer' and 'accept' constitute a similar verb pair, as for example, in the following sentences.

Oliver offered Beau a good deal.
Beau accepted Oliver's offer.

In the first sentence, Oliver is both agent and source, while in the second Beau is both agent

	Source	Path	Goal	Local
Active	instigator of action +/-volitive +/-animate	instrument or means	intended result (-animate) active recipient (+animate)	non-passive patient
Objective	original state (-concrete) material (+concrete)	counter-instrument passive means	result state (-concrete) factitive (+concrete)	undergoing change-of-state
Dative psychological:	stimulus	medium	experiencer +/-dynamic	content
possessive:	original owner	medium/price	recipient	thing transferred
Locative	place from where	space traversed	final destination	static position
Temporal	time since	duration	time until	time at which
Ambient	reason	manner	aim(+volitive) consequence (-volitive)	condition

Figure 1 Somers's case grid.

[3] Other arguments such as instrument and patient may be included in the verbs valency patterns, but are not relevant here.

and goal. By divising a way to represent both roles in a single case, Somers was able to answer one of the most ringing criticisms of case theory, the problem of source-goal directionality, which, as he perceived, involved not only agent, but other cases as well.

Somers case theory grew out of his fondness for valency, a theory of linguistic analysis that is particularly verb-centered. The focus of that syntactic analysis is the distinction between complements, sentence elements governed by the verb, and adjuncts, sentence elements that fall outside the verb's governance. Different approaches to valency variously deal with the problem of defining the scope of the verb's governance.

Somers made an analogy between chemical valency and linguistic valency. When an element, *a*, combines with another element, *b*, the atoms of element *a* have a capacity to form a specific number of bonds, indicating the valency of the *a* atom. That same atom may have the capacity to form a different number of bonds, may have a different valency, when combining with the atoms of another element, *c*. As the valency of the *a* atom can change in response to the *b* and *c* atoms so, Somers theorized, could the verb's capacity to attach cases change in response to the semantics of the NPs in a given sentence. A verb might in one sentence have two NP attachments and might in another sentence, accompanied by other NPs, require a third attachment to complete its meaning.

Somers did a more penetrating analysis of the cases deriving from complements than he did of those deriving from adjuncts. The peripheral cases in the grid were not expected to be as satisfying or as precise the central cases, and indeed, our expectation was justified.

Sowa had demonstrated an awareness of verb-centered sentence analysis (1984). His inclusion of the most traditional deep cases among the conrels made it appear that he would not regard the use of Somers's cases as antagonistic to the objectives of cgs representation. It was hoped that they would help to refine its capabilities for semantic representation.

Somers stated repeatedly throughout his book that the grid of cases was to be interpreted for use in relation to the domain and to the need. It was also clearly intended that the grid should function as a unit and not be augmented. A decision was made to use a grid case wherever it was possible to find an appropriate one. However, the cases had to fit into the overall cgs system.

The application of Somers's cases was successful in that it was not necessary to add any cases in order to complete the work; and some of the cases were very clearly on the mark. As I began to use the cases, it became apparent that among the other conrels in the 1984 catalog there were many more case-like relations than the few traditional case relations that had been identified. There was a significant amount of overlap between the grid cases and the catalog of conrels. Bearing in mind that the peripheral cases of the grid are less potent than the central ones, a comparison of Somers's cases with Sowa's conrels is enlightening. Figure 2 shows such a comparison.

In applying the relations, that is, in building the kr, it was necessary to examine the conrels where there were apparent conflicts. Decisions about conflicts were made arbitrarily, but with the intention of making adjustments suitable to the domain rather than against the spirit of cgs.

The first decisions had to do with agency. The cases along the active parameter of the grid express agency, in particular, the active source case (ACTS) was commonly used. As the feature markings in the cell (Figure 1) indicate, the case may be used where the agent is either animate or not. Also, where there is an animate agent, he may or may not act willfully, with intent. This interpretation of agency extends the concept well beyond the scope of the traditional use of the agent case. In contrast, the conrel definition is as follows:

> **agent.** (AGNT) "links [ACT] to [ANIMATE], where the ANIMATE concept represents the actor of the action. Example: *Eve bit an apple.*
> [PERSON: Eve]←(AGNT)←[BITE]→(OBJ)→[APPLE]."

Sowa's case	reads	Somers's case	reads	Comment
ACCM	accompaniment	ACTL	active local	
AGNT	agent	ACTS	active subject	
ATTR	attribute	AMBL	ambient local	a condition
CAUS	cause	AMBS	ambient source	any path or source case
CHRC	characteristic	AMBL	ambient local	a condition
DEST	destination	LOCG	locative goal	
DUR	duration	TEMPP	temporal path	
EXPR	experiencer	DATPSYG	dative psycho-logical goal	
GOAL	goal	___G	goal	any goal case
INIT	initiator	ACTS	active source	
INST	instrument	ACTP	active path	or any path case
LOC	location	LOCL	locative local	
MANR	manner	AMBP	ambient path	
MATR	material	OBJS +concrete	objective source	
METH	method	ACTP	active path	
PATH	path	LOCP	locative path	
POSS	possession	DATPOSSL	dative possessive local	
PTIM	point in time	TEMPL	temporal local	
PTNT	patient	OBJL	objective local	
RCPT	recipient	DATPOSSG	dative possessive goal	
RSLT	result	OBJG +concrete	objective source	
SRCE	source	___S	source	any source case
STAT	stative	OBJL	objective local	
UNTL	until	TEMPG	temporal goal	

Figure 2 Sowa's and Somers's semantic relations compared.

(Sowa 1984, 415).

However, there is an additional conrel for initiator, which is clearly a part of agency as defined in the source parameter.

> **Initiator.** (INIT) "links an [ACT] to an [ANIMATE] who is responsible for initiating it, but who does not perform it directly. Example: *Tony boiled the potatoes.*
> [PERSON: Tony]←(INIT)←[BOIL]→(OBJ)→[POTATO: {*}]." (Sowa 1984, 416).

The cases on the source parameter adequately expressed these concepts although presenting them in a different way. In addition, the active local case worked exceptionally well. It was described in the cell as a non-passive patient, a kind of reflexive. It functions usefully to designate what have commonly been called co-agents. It was defined[4] as follows:

> **active local.** (ACTL) links an [ANIMATE] to an [EVENT] where the animate is the non-passive patient, or the co-agent of the event. The case is often marked by the preposition 'with'. (Somers 1987, 203, 206) Example: *Aronstad rules with the Blue Dragons.*
> [ARONSTAD]←(ACTS)←[RULE]→(ACTL)→[BLUE_DRAGON: {*}].

[4] The grid cases were not defined as were the Sowa conrels. The definitions included have been put together from the commentary in Somers 1987. The examples are my own unless otherwise indicated.

The source-goal directionality is a fundamental principle of the grid. The conrel catalog did include the ideas of source and goal but the use of the idea was not so pervasive.

> **source.** (SRCE) "links an [ACT] to an [ENTITY] from which it originates. Example: *The pail was carried from the shed.*
> [PAIL: #]←(OBJ)←[CARRY]→(SRCE)→[SHED]." (Sowa 1984, 419)

This appears to be correlative with the locative source case.

> **locative source.** (LOCS) links a [PLACE] to an [EVENT] where the place is the spatial starting point of the event. (Somers 1987, 202, 206) Example: *The shuttles go from Cape Canaveral.*
> [SHUTTLE: {•}]←(ACTS)←[GO]→(LOCS)→[CAPE_CANAVERAL].

It is a physical, concrete description of a source as a place of origin rather more limited than the idea behind the grid. There are seven distinct cases along the source parameter.

Similarly, the catalog includes a goal-like conrel, destination, which seems to be correlative with the locative goal case, rather than to mean goal in the fuller, more abstract sense as demonstrated in the cases of the goal parameter.

> **destination.** (DEST) "links an [ACT] to an [ENTITY] towards which the action is directed. Example: *Bob went to Danbury.*
> [PERSON: Bob]←(AGNT)←[GO]→(DEST)→[CITY: Danbury]." (Sowa 1984, 416)

In a later paper, Sowa has used the term 'goal' itself as a conrel. The relation appears in a complex graph that illustrates use of anaphora and quantifiers in which it links one embedded graph to the verb 'try' in another (Sowa 1987, 26).

Some grid cases are surprisingly similar to conrels that are not defined as cases. The path parameter has a number of variant interpretations. Instrument cases are found along the path, as are cases indicating some persistence from source to goal.

> **temporal-path.** (TEMPP) links a [TIME] to an [EVENT] where the time describes the duration of the event. (Somers 1987, 203, 206) Example: *Felicity's fantasies flourish in adolescence.*
> [FLOURISH]–
> (ACTS)→[FANTASY: {•}]←(POSS)←[FELICITY]
> (TEMPP)→[ADOLESCENCE].

Sowa defined a conrel, duration, which appears to be at least similar to the temporal path case, also described as duration.

> **duration.** (DUR) "links a [STATE] to a [TIME-PERIOD] during which the state persists. Example: *The truck was serviced for 5 hours.*
> [TRUCK: #]←(OBJ)←[SERVICE]→(DUR)→[TIME-PERIOD: @5hrs]." (Sowa 1984, 416).

Since the temporal path case is not limited to states, it may have a different application in some representations. In the work at hand, it was always applied to show the time interval from source to goal.

Along with the temporal cases, the locatives display some differences in the approaches of Sowa and Somers to representation of concrete relationships. Admittedly, locatives are peripheral cases and have characteristics somewhat different from the central grid cases. Sowa defines the location conrel quite simply.

> **location.** (LOC) "links a [T] to a [PLACE]. Example: *Vehicles arrive at a station.*
> [VEHICLE: {•}]←(AGNT)←[ARRIVE]→(LOC)→[STATION]." (Sowa 1984, 417).

Later, he supplemented the original treatment with some other relations to deal with the problem of prepositions.

> "Spatial relations include the simple location (LOC) as well as more specific ones that correspond to spatial prepositions such as (IN), (ON), and (ABOV)." (Sowa 1987, 6).
> Example: "*A cat is on the mat.*
> [CAT]→(ON)→[MAT]." (Sowa 1988, 2-14).

This case corresponds to the traditional 'locative' case as it is commonly used in case-based representations. In contrast, the grid parameter includes four separate cases. The case most similar to the traditional locative case is locative local (LOCL)

> **locative local.** (LOCL) links a [PLACE] to an [EVENT] where the place is a static position at which the event occurs. (Somers 1987, 202, 206). Example: *Fire breaks out in The Cat's Pajamas.*
> [FIRE]←(ACTS)←[BREAK_OUT]→(LOCL)→[PLACE: The_Cat's_Pajamas].

The transitivity of the source-goal analysis is apparent in the following example that illustrates the use of both the locative source and the locative goal cases.

> Example: *Cunard ships rats from the old world to the new.*
> [SHIP]–
> (ACTS)→[CUNARD]
> (OBJL)→[RAT: *]
> (LOCS)→[OLD_WORLD]
> (LOCG)→[NEW_WORLD].

Since the source-goal arrangement is fundamental to spatial relations, it is not surprising that these are among the easiest to employ, in spite of their peripheral status in the case grid. Even when, as in many of the law cases, there were multiple levels of embedded locatives, to describe jurisdictional disputes, it was quite clear how they could be used to avoid ambiguity.

Dealing with individual prepositions as conrels proved to be another matter. Although Sowa has encouraged defining them as required, I found the task difficult. Furthermore, the prepositional relations could sometimes be expressed as a part of the concept in another way, by relating the objects so the use of a specific locative preposition was unnecessary.

One of the most difficult problems was the representation of relative spatial concepts. Representing 'near' was extremely difficult when determining a factual issue in a case made it an important relation. Another was 'local'. It occupied a large graph in its own right with an extremely difficult inner context that shifted a part of its description three times to accommodate the meaning of the factual dispute over jurisdiction in the case at hand.[5] Neither Sowa nor Somers conrels provided solutions. Conceptual representations were gerrymandered to suit the individual situations; and they were not entirely satisfactory.

2.1. Additions

Some additional conrels were gleaned from the text (Sowa 1984) and later works (Sowa 1987, 1988). Where there was an example or a definition, it was used according to the author's intent as far as it could be determined. I attempted, once again, to stay as close to the apparent meaning of the prescriptions as I could. One of the most interesting conrels, compare or comparison, was from Sowa 1984 although not defined there. It appears only in the definition of 'above'.

> **above.** (ABOV) links [ENTITY: *x] to [ENTITY: *y]. "The definition says that *x is above *y if *x is at a higher place than the place *y. *relation* ABOV(*x*,*y*) is
> [T: *x]→(LOC)→[PLACE]→(ATTR)→[HIGH]→(COMP)→[PLACE: *y]." (Sowa 1984, 226).

'Comp' is not unknown in case grammars. It was defined very generally for use in the kr.

> **comparison.** (COMP) links [ENTITY: *x] to [ENTITY: *y], where *x is said to be as or like *y. (Sowa 1984, 226).

However, I used it gingerly, only when nothing else would do. It indicated an attempt at analogical reasoning in the legal arguments and so obviously had a much stronger functional base than its simple literary definition displayed. It was regarded as designating an incomplete

[5] *Upton-on-Severn-Rural-District-Council* v. *Powell [1942] 1 All E.R. 220.*

match of entities that share attributes. Obviously, this conrel lends itself to further investigation.

A conrel with similar potential with regard to reasoning was defined and used in the kr because of a need peculiar to the domain.

> **evidence.** (EVID) links [PROPOSITION: *x] to [PROPOSITION: *y] where *y bears evidence in relation to *x. Example: *The evidence that Jonathan is a female cat is that Jonathan has kittens.*
> [PROPOSITION: [CAT: Jonathan]→(CHRC)→[FEMALE]]–
> (EVID)→[PROPOSITION: [HAVE]–
> (ACTS)→[CAT: Jonathan]
> (OBJL)→[KITTEN: {*}]].

Within the kr as it stands, the conrel has been used to establish a relationship between propositions. Its potential for causing difficulty if used for deductive inference, rather than for simply linking related elements is recognized as a danger point. This is another conrel that needs further investigation and has been very useful.

A potentially useful conrel, description, appeared later but was not fully explained.

> **description.** (DSCR) "the relation between a situation and the propositions that describe it." Example: *"The cat on the mat.*
> [SITUATION]→(DSCR)→[PROPOSITION: [CAT]→(ON)→[MAT]]."
> (Sowa 1988, 2-7).

The relationship between [SITUATION] and [PROPOSITION] was described in several ways. Explication of this conrel would have been useful enough in that context. But it also might have been intended as an attempt to deal with the problem of expressing a modification relationship, which was not been done in enough detail for the work I attempted. Note that Sowa did define both attribute and characteristic conrels, which deal with modification but are not adequate to the need. However, they do not provide the expressiveness necessary for NL text containing information about restrictions and conditions of various kinds and degrees of stringency.

Another conrel of interest with regard to modification is manner.

> **manner.** (MANR) "links an [ACT] to an [ATTRIBUTE]. Example: *The ambulance arrived quickly.*
> [AMBULANCE: #]←(AGNT)←[ARRIVE]→(MANR)→[QUICK]." (Sowa 1984, 417).

Somer's correlative is ambient path (AMBP) case

> **ambient path.** (AMBP) links a [PROPERTY] to an [EVENT] where the property describes the way in which the event happens. (Somers 1987, 205, 206) Example: *Dulcie told Juan the truth, remorselessly.*
> [TELL]–
> (ACTS)→[DULCIE]
> (OBJL)→[TRUTH]
> (DATPOSSG)→[JUAN]
> (AMBP)→[REMORSELESS].

The grid description includes the precise word, 'manner'. Both these relations were used in the kr, as were the conrels attribute (ATTR) and characteristic (CHRC). However, the problem of adequately representing both the syntactic and semantic aspects of modification was not solved in this way. There were a number of other representational devices used to achieve some improvement. More may be said about these at another time. Whether or not grammatical case, even with a semantic component is the correct vehicle for the representation of modification is not clear to me. We have a number of precedents for using manner adverbs in the way these conrels do, but still, many modifying words, sentential elements, and intersentential elements do not fit the available slots.

2.2. Miscellaneous problems

Some conrels seemed to overlap in meaning with others. Their purpose was not readily apparent to me. When doubt occurred, I simply avoided using them, until I had some indication of what was intended.

The conrel (IDNT) was one of these. It appears only once and without definition or description. Its full name was not specified, so I used 'identity'. It is used as a part of the prototype for [ELEPHANT]. It is not clear to me why (NAME) or perhaps a lambda expression was not used.

> *A nose with the attribute prehensile is identified as a trunk.*
> "[NOSE]–
> (ATTR)→[PREHENSILE]
> (IDNT)→[TRUNK]." (Sowa 1984, 136)

The difficulty with this conrel is that it seems to afford an opportunity to create synonyms. However, that is a dangerous practice, and to be indulged in only with care.

Another instance of curious conrel use is the following example:

> **support.** (SUPP) "links an [ENTITY: *x] to another [ENTITY: *y] where *x has support *y.
> Example: *The frost is on the pumpkin.*
> [FROST]→(SUPP)→[PUMPKIN]." (Sowa 1984, 419).

It appears from the example that the meaning of support is simply to be physically on top of something else. It may be just that the example is unfortunate. On the other hand, we have seen repeatedly that the conrels are defined in very concrete, physical terms, especially contain, goal and so on. Is 'support' then also to be limited to such a simplistic physical interpretation. It seems unlikely that this should be so as the preposition 'on' is occasionally used as seen above, a conrel to express that physical relationship without any apparent variation or subtlety appears unlikely.

Some conrels have a purely physical description and would be useful if they could be in perhaps a slightly more metaphorical sense. For example, content is defined as follows:

> **content.** (CONT) "links [ENTITY: *x] to [ENTITY: *y], where *x has content *y. It may be defined in terms of the relations LOC and PART. Example: *A baby is in a pen.*
> [PLAYPEN]→(CONT)→[BABY]." (Sowa 1984, 416).

It appears that *x is expected to *physically* contain *y.

However, in the domain of contracts, for example, it would be very useful to be able to state that information or even an idea was contained in an agreement with the understanding that what was meant had nothing to do with the paper that the agreement was written on. If the agreement is understood as an abstract entity, and it were possible that this conrel may be used in this kind of context, the kr could be improved. Because cgs lacked this representational capacity, for the purpose of representing contracts, promises and other agreements, I added a concept [TERMS] which served to group together the propositions describing the *contents* of a given agreement. The device worked quite well. Nevertheless, my first choice would have been a conrel representation expressing the idea of 'contains'.

2.3. Causes and consequences

The problem of representing the meaning of causation was one of the most difficult problems encountered in this work. Quite clearly, the kr is not suitable, as it stands, for dealing with the highly complex issues of causation to be found in law cases dealing with such matters as negligence. Here, my intention is simply to recount the various aspects of causation that were recognized in the conrels used, and to point out some of their strengths and weaknesses.

> **ambient source.** (AMBS) links an [ENTITY] to an [EVENT] where the entity designates a reason or abstract cause for the event. (Somers 1987, 205, 206) Example: *Time flies, spurred by the moments.*

[FLY]–
(ACTS)→[TIME]
(AMBS)→[SPUR]–
(ACTS)→[MOMENT: {*}].

Note that in this instance, the case is on the source parameter. Causation is commonly taken to be a case of instrumentality, rather than of agency. Yet it seems sensible that the agent, the initiator, the source, should also be implicated in causing. This was a very useful interpretation of cause. It appeared to me to be one of the cases, that even though it was in a peripheral row, was right. Still it is not clear that it is essentially an expression of causal relations. Its primary meaning is 'reason'.

Similarly, Sowa has used a conrel called purpose (PURP) to link an [EVENT] to an [ENTITY] where the entity is the reason for the event. Sowa includes the relation without name, definition or discussion. The following example is found in a schema for the concept [DEMONSTRATE], and says that the purpose of the act of demonstrating is a set of demands.

"[DEMONSTRATE]–
(PURP)→[DEMAND: {*}]." (Sowa 1984, 262).

It is interesting that both 'reason' and 'goal' have something to do with the interpretation of this conrel. Still it appears to be closest in meaning to the ambient goal case, which may be interpreted as either an aim or a consequence, depending on the presence or absence of intention.

ambient-goal. (AMBG) links an [EVENT: *x] to an [EVENT: *y] where *y is an intended aim or an unintended consequence of *x. (Somers 1987, 205, 206) The goal may be an intended aim. Example: *John eats to live.*
[JOHN]←(ACTS)←[EAT]→(AMBG)→[LIVE].
The goal may be an unintended consequence. Example: *The student failed so he left.*
[STUDENT: #]←[FAIL]→(AMBG)→[LEAVE]. Ambient cases are typically more abstract and distant from the verb than the active and objective cases. (Somers 1987, 205, 206)

Sowa defined a causation relation directly but in very general terms.

cause. (CAUS) "links [STATE: *x] to [STATE: *y], where *x has a cause *y. Example: *If you are wet, it is raining.*
[STATE: [PERSON: You]←(EXPR)←[WET]]
→(CAUS)→[STATE: [RAIN]]." (Sowa 1984, 415-416). (CAUS) is an intersentential relation (Sowa 1988, 9).

Such a general definition results in a strangely ambivalent reaction. At first it appeared to be a useless thing. Also an expression of the concept of causation was needed for acts and events as well as states. Nor was the need for causal representation always an intersentential matter. As I encountered more and more difficult instances of causation problems, complex especially in the aspects of time and intentionality that needed to be associated with them, the more reliant I became on having the very general (CAUS) relation to fall back on. Nevertheless I felt, every time I was compelled to use it, that I had failed to properly analyze the language, that indeed I was using the conrel as a sort of wastebasket for a category of problems. On reflection, however, it is not clear to me that the answer to representing this difficult relation lies in the correct analysis of grammatical case. Certainly, with regard to the highly complex factual situations in law cases dealing with causative issues, case relations provide an exceedingly superficial kr.

The path parameter is the line of instrument cases which clearly have a semantic relationship to causation. But other cases along the goal parameter may be regarded as having an element of causation or more accurately, they represent objectives and consequences. Both the ambient goal, above, and the active goal express planning in some sense.

active-goal. (ACTG) links an [ENTITY] or an [ANIMATE] to an [EVENT] where the entity or animate designates the end point of the act. (Somers 1987, 202, 206).

The end may be an intended result that is an entity. (Somers 1987, 202) Example: "*The wine travels well.*" (Somers 1987, 177).
[WINE: #]←(ACTG)←[TRAVELS]→(AMBP)→[WELL].

Some conrels express similar meanings.

> **consequence.** (CNSQ) is an intersentential relation, which may be defined in terms of more primitive relations (Sowa 1987, 8).

Sowa gives neither a definition of this relation, nor an example of its use. It is not clear how it relates to result (RSLT). The correlative Somers case is ambient goal discussed above, with the volitivity feature marked negatively. Sowa's other similar conrel, result, is more precisely defined.

> **result.** (RSLT) "links an [ACT] to an [ENTITY] that is generated by the act. Example: *Erich built a house.*
> [PERSON: Erich]←(AGNT)←[BUILD]→(RSLT)→[HOUSE]." (Sowa 1984, 419).

This conrel has a correlative in Somers's active goal case. It differs in that it specifies that the case may apply to animate entities, that is, active recipients. It appears likely that the choice of conrel for that sort of entity among Sowa's relations would be 'recipient'.

In general, the representation of 'result' was a little tricky. Choices may not have been as consistent as is desirable. However, the difficulty of classifying objectives, goals, and results did not begin to approach the degree of difficulty experienced with regard to the representation of causation.

2.4. Datives and genitives

The representation of concepts involving possession was nearly as challenging as causation. Once again, Somers has distinguished a whole row of cases, the dative possessive, which certainly helped in the representation of transfers. But other problems arose. There was never a suitable way to represent possessory genitive syntactic structures. The grid cases simply did not work. Furthermore, the parameter seemed to definitively require the transfer of something. Sometimes there was a transfer, but often possessory relations were static.

Another complication arose in dealing with verbs of communication. Although information, messages, and so on are transferred, do move from source to goal, they never really complete the transfer. The original owner still retains possession of the information after transfer. Does that mean that verbs of communication cannot express possessory concepts or perhaps cannot express transfer concepts?

Sowa has defined a very general to deal with possession.

> **possession.** (POSS) "links an [ANIMATE] to an [ENTITY], which is possessed by the animate being. Example: *Niurka's watch stopped.*
> [PERSON: Niurka]→(POSS)→[WRISTWATCH]←(OBJ)←[STOP]." (Sowa 1984, 418).

Once again, the analysis has to do with physical possession. In law, there are many kinds of possession and ownership that do not involve physical possession. I was at a loss once again to represent the shade of meaning. The Sowa conrel was used as a wastebasket to take the possessory relational concepts I could not otherwise cope with. It is my intention to shake out the contents of both the possession wastebasket and the cause wastebasket and see if some patterns cannot be distinguished among the castaway graphs inside.

Another interesting point about possession is that there seems to be very little difficulty in representing givers and takers. In neither the original conrel catalog, nor the case grid was there any apparent ambiguity about the description of the functions of recipient. Since Somers prescribed the use of the agentive active cases over the use of the dative sources, there was no difficulty there, although the resulting kr was occasionally a little awkward to read, rather counter intuitive.

The possessory problems are especially notable because they show clearly that the source-goal directional relation, although very powerful, is not the answer to all of our complex interchange relationship problems, not even to all of our transfer problems, which in fact one might have expected it to solve!

In Somers grid, the dative cases relegated to psychological matters worked quite well. Passive and dynamic features categorized experiencers to advantage. Sowa has provided a traditional experiencer conrel. The advantage here I found in using the grid was it made me recognize more experiencers. It drew my attention to the psychological nature of the act or event more frequently.

However, the rest of the dative psychological cases were very difficult to apply on occasion. It was almost impossible to know whether a thought was stimulus, medium or content. In cases involving intention to contract, the argument often involves interpretation of what was being thought, intended, wanted, etc. as judged by an individual's actions. Very often the confusion ran over into the experiencer role analysis. Where intention was a significant factor, I made the decision to represent psychological activity, and especially cognitive activity as intentional, agentive, active acts rather than something affecting an experiencer. The decision was intended to reflect a particular need within the domain. The dative psychological cases appear to be suited to the use of everyday language as they are written.

2.5. Objective case relations

Although the case grid was generally a happy choice for supplementing the conceptual relations there was a particularly severe problem representing grammatical objects. Sowa began by defining an objective case, the traditional patient, and later changed it to object and then voiced some regret over the change. To be sure, under either name, it does not entirely suit the need.

The objective parameter of cases in the grid is described very much in terms of process and passivity. Still there was a considerable problem finding an appropriate case to represent the recipient NP of the verb's action or effect. The most frequent choices, the objective local and objective goal cases, did not convey very much and commonly turned into traditional objects. Sowa has the same complaint about the use of his object case. Within the grid, I was unable to find a solution for the problem. Occasionally I was able to find a seldom used case for exactly the right effect, such as the active goal, or even the factitive version of the objective goal. Otherwise, I tried in vain to feel some pattern of interpretation evolving from the analysis of multiple sentences. The problem became most severe when faced with long complex sentences, it was necessary to build multiple levels of embedded objects that were not simple graphs, but complex representations in their own right.

There appears to be a fundamental weakness here in the strongly verb-centered case representation. The objective cases would be much more informative, representative and satisfying I suspect if they had a component representing the NP's semantics that is more sensitive to meaning than the simple directional analysis related to local and goal semantic realizations. An analysis of the case roles that took account of the meaning of the verbs attachments in a way that expressed the result of the transitive function of the verb seems to be necessary. The valency-based representation was largely successful in other respects, but since it failed to adequately represent the effect of the verb in the sentence, I felt the coarse-grained representation that was built displayed the advantages and disadvantages of a deluxe index. The strongly informative terms from the text were available in combination with other important, associated concepts, but there persisted a certain disconnected aspect that reminded one of information tags and catch words, of concepts extracted from a narrative, rather than of concepts forming an intense integrated mosaic as a kr of the content. I attribute the disjointedness of the resulting representation in part to the failure to find a solution for dealing with objective grammatical relations with an appropriate representation for their semantic

content.

3. Complex assertions and embedded contexts

The other difficulty with the notation involved the transcription of complex sentences. A single example is given below, but many sentences more complex in meaning as well as structure, were found in the sample contract cases used in the research. The problems involved simply controlling the sprawl of the linguistic expression in a reasonably compact, manageably way. It also involved the careful analysis of sentence complements as the representation of complex objects became a matter of concern.

The difficulty of controlling multiple-level embedded clauses, made the implementation of a number of structuring devices necessary. For example, some additional subtypes were created in order to add structure to the analyzed text. In my work, the essence of the structure was the representation of arguments. However, in relation to a more general approach to text analysis, it might be regarded as discourse analysis or structuring. From the excerpt below, you will see that I have defined a subtype [HYPO] to set apart hypothetical situations described in legal argument from factual situations reported in the case.

[TERM] was defined, as discussed above, to encompass the contents of an agreement and [INFO] was used to describe items of information communicated in various ways. As well as defining subtypes, I defined a number of complex legal concepts using lambda expressions. Some definitions built upon others repeatedly so that there were layers of description. This is the way in which the legal concepts, relating to damages for breach of contract, were structured. Some such multi-layered definitions were restricted to individual arguments, intermediate contexts, others were generally applicable throughout the knowledge base still others used some of the general concepts with locally defined restrictions to express modified ideas.

The problem of dealing with multiple-nested clauses was never adequately solved. These and other devices took us part of the way. Some devices were more useful than others in particular instances. Nevertheless, it did provide an insight into the strengths and weaknesses of using cgs for realistic text analysis preparatory to practical IR.

4. Conclusion

The kr has not been implemented, however, it was possible using a suitable structure matcher, to show how natural language queries (derived from law cases following the contract cases in the knowledge base) in the same notation could be used to retrieve relevant frames from our original contract cases. The ability to perform inferences demonstrates the power of conceptual retrieval in comparison with traditional IRS. Using cgs with Somers's cases, it is clear that a verb-centered approach to text analysis resulted in a powerful representation for intelligent retrieval.

Ideally the work will proceed. There will be some elements of legal reasoning involved in achieving conceptual retrieval. The manipulation of concepts within complex, multi-layered contexts is one of the biggest and most interesting challenges on the horizon.

TURLEY, J.: "We are constrained to believe that what is called an offered reward of $200. was nothing but a strong expression of his feelings of anxiety for the arrest of those who had so severely injured him, and this greatly increased by the distracted state of his own mind, and that of his family; as we frequently hear persons exclaim, 'Oh, I would give a thousand dollars if such an event were to happen or vice versa'.

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(JD)→[[PROMISE-n: #S1]–
(~EQUIV)→[OFFER: #S1]

```
(CHRC)→[[PHRASE: "EXPRESSION OF STRONG FEELING"]–
        (EQUIV)→[EXPRESSION: #S1]–
                (OBJG)→[[[FEELING: #S1]→(ATTR)→[STRONG: #S1]]
                or [ANXIETY: #S1]]]
    (CAUS)→[ANXIOUS_FOR: #S1] [STATE_OF_MIND: #S1]
[HYPO: [PROMISE-n: #S2]→(CONT)→[TERM:          if [HAPPEN: #S1]–
(ACTS)→[EVENT: *a]
    then [GIVE: #S2]–                    (ACTS)→[PROMISOR: *m]
(DATPOSSL)→[REWARD: #S2]→(MEAS)→[MONEY: @$1,000]].
    [PROMISE-n: #S3]→(CONT)→[TERM:
     if ~[[HAPPEN: #S2]–
          (ACTS)→[EVENT: *b]]
     then [GIVE: #S3]–
          (ACTS)→[PROMISOR: *n]
          (DATPOSSL)→[REWARD: #S2]–
                (MEAS)→[MONEY: @$1,000].]]]
    [PROMISE-n: #S1]→(COMP)→[PROMISE-n: #S2]
    [PROMISE-n: #S1]→(COMP)→[PROMISE-n: #S3]
    [PROMISE-n: #S2][PROMISE-n: #S3]→(EVID)→[EXCITEMENT: *]–
(ATTR)→[STRONG: #S2]
    [PROMISE-n: #S2]→(~EVID)→[INTENTION_TO_CONTRACT: *]
    [PROMISE-n: #S3]→(~EVID)→[INTENTION_TO_CONTRACT: *]
    [PROMISE-n: #S1]→(EVID)→[INTENTION_TO_CONTRACT: ~]
]                          ;end of (JD)
```

Stamper v. *Temple*, (1845)
6 Humph. 113 (Tennessee).

Figure 3 A case excerpt and some of its cg representation

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