UNDERSTANDING EDITORIALS: THE PROCESS OF REASONING COMPREHENSION

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The Process of Reasoning Comprehension *

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Abstract

In this paper, we present a theory of reasoning comprehension which is currently being implemented in OpEd, a computer system that reads and answers questions about short politico-economic editorials. We discuss: (a) the knowledge and processes necessary to understand people's opinions and reasoning, and (b) the relation of our research to previous work in natural language understanding. A description of OpEd and an example of its actual input/output behavior are also presented here.

1. Introduction

An intelligent computer program must be able to understand people's opinions and reasoning. This requires a theory of the processes and knowledge sources used during reasoning comprehension. To develop such a theory, we have studied the problems that arise in understanding newspaper and magazine editorials which convey writer's opinions on politico-economic issues.

Which are the computational issues that must be addressed in handling editorials? To illustrate the nature and complexity of the issues, consider the following editorial segment by Milton Friedman (1982):

EDITORIAL-1: Protection That Hurts

Recent protectionist measures by the Reagan administration have disappointed us ...

... [voluntary] limits on Japanese exports of automobiles ... are ... bad for the nation, ... workers and consumers ... They do nothing to promote the long-run health of the industries affected ...

The basic problem of the auto ... industries is clear: ... average wage rates are twice as high as the average wage rates of all workers ... As a result, it has become more expensive to produce automobiles in the United

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States than to acquire them by producing other products ..., exporting them ... and using the proceeds to purchase Japanese ... cars ...

Far from saving jobs, the limitations on imports will cost jobs. If we import less, foreign countries will earn fewer dollars. They will have less to expend on U.S. exports. The result will be fewer jobs in export industries ... And given the wage differential, for every job saved in autos ..., nearly two jobs will be lost in other industries that produce exportable goods.

Understanding EDITORIAL-1 requires: (1) having a large amount of world knowledge, (2) recognizing beliefs and belief relationships, (3) following belief justifications, (4) representing in memory the conceptual contents of belief and belief justifications, and (5) dealing with interactions between reasoning and world knowledge.

World Knowledge: In general, the reader must know about nations, consumers, workers, jobs, wage rates, imports, and exports. The reader must also be able to handle references to abstract concepts such as saving jobs, the health of an organization, and protection. Finally, the reader must have some commonsense knowledge in politics and economics. For instance, this includes knowing that:

Countries export and import products.

Governments can impose or negotiate quotas on imports.

An industry's rate of employment depends on its volume of sales.

Recognizing Beliefs and Belief Relationships: The reader must be able to identify the editorial writer's beliefs. For example, after reading the first sentence of EDITORIAL-1, we have already inferred that Friedman is against the Reagan administration's protectionist measures, although this opinion is not explicitly stated. The reader must also be able to recognize other individuals' beliefs and how they are supported or attacked by the writer's beliefs. For instance, in the sentence "[These limitations] do nothing to promote the long-run health of the industries affected ...," Friedman attacks the implicit belief of the Reagan administration that the limitations will help the automobile industries.

Following Belief Justifications: The reader must be able to identify and keep track of the arguments that justify the writer's and other individuals' beliefs. For example, the reader easily perceives "... the limitations on imports will cost jobs" as part of the argument that justifies Friedman's belief about import restrictions.

Representing Beliefs and Belief Justifications: The reader seldom remembers the exact wording of an editorial segment. Rather, he remembers the concepts that were stated and their relationships. Understanding editorials requires building *argument graphs* (Birnbaum, 1982; Flowers et al., 1982) which conceptually represent beliefs, belief relationships, and belief justifications. Such

graphs aid the understanding process and are accessed during summarization and question answering.

Interactions between Reasoning and World Knowledge: Reasoning cannot be applied independently of other knowledge sources. For instance, the reader must realize that the mention of "limits on Japanese exports" does not constitute a sudden topic shift, but rather is a coherent continuation of Friedman's opinion concerning protectionist measures. Applying world knowledge makes such connections possible.

Studying the process of reasoning comprehension from the perspective of editorial understanding is a natural and logical challenge for research in natural language understanding. Current text understanding programs are capable of reading stories involving stereotypic situations, goal and planning situations, and complex human interactions (Cullingford, 1978; DeJong, 1979; Dyer, 1983; Lebowitz, 1980; Wilensky, 1978). However, those programs cannot read editorials since they lack basic mechanisms for: (a) understanding and keeping track of beliefs and belief justifications, and (b) using world knowledge during reasoning comprehension.

In this paper we discuss our theory of reasoning comprehension and its implementation in OpEd.

2. The Process of Reasoning Comprehension

In general, understanding editorials requires applying various knowledge sources: mundane physical actions (Schank, 1973, 1975); basic social acts (Schank and Carbonell, 1978); goals and plans (Carbonell, 1981; Schank and Abelson, 1977; Wilensky, 1978, 1982, 1983); scripts (Schank and Abelson, 1977); MOPs (Schank, 1982); ideologies (Carbonell, 1981); affective reactions (Dyer, 1983); adversary arguments (Crossley and Wilson, 1979; Flowers et al., 1982; Toulmin, 1979; Toulmin et al., 1958); reasoning scripts (Flowers, 1985); and knowledge of reasoning comprehension. Here we focus on the processes of recognizing beliefs, attacks, and supports, along with how these processes interact with other knowledge constructs.

2.1. Recognizing Beliefs and Belief Relationships

Obviously, beliefs can be *directly recognized* if they are explicitly mentioned as such. For example, the following sentence:

> The current administration believes that unilateral disarmament is bad for the U.S.

indicates the belief of the current administration with respect to unilateral disarmament. However, editorial writers seldom state their beliefs explicitly. As a result, their beliefs must be inferred from other explicit standpoints, from affective reactions, and from various argument units.

2.1.1. Inferring Beliefs from Explicit Standpoints

Beliefs can be directly inferred from explicitly stated standpoints. For instance, from the following excerpt:

> Those of us who have opposed export quotas on grain, ...
> have defended [the] administration opposition to the pipe-
> line deal (from Friedman, 1982).

we infer that Friedman believes that the export quotas are bad and that both Friedman and the administration believe that the pipeline deal is a bad idea. Those inferences are based on the following rules:

> *If X supports SITUATION S, infer that X believes that S is good.*
>
> *If X opposes SITUATION S, infer that X believes that S is bad.*
>
> *If X supports Y's attack of SITUATION S, infer that X believes that S is bad.*
>
> *If X opposes Y's attack of SITUATION S, infer that X believes that S is good.*
>
> *If X supports Y's support of SITUATION S, infer that X believes that S is good.*
>
> *If X opposes Y's support of SITUATION S, infer that X believes that S is bad.*

2.1.2. Inferring Beliefs from Affective Reactions

Affective reactions help signal beliefs. The belief inference rules organized by affective reactions are as follows:

> *If a SITUATION S produces a negative affective reaction for X (due to X experiencing a goal or expectation failure), infer that X believes that S is bad.*
>
> *If a SITUATION S produces a positive affective reaction for X (due to X experiencing a goal or expectation achievement), infer that X believes that S is good.*

For example, the first sentence from EDITORIAL-1:

> Recent protectionist measures by the Reagan administra-
> tion have disappointed us.

indicates that Friedman believes that the protectionist measures are bad.

2.1.3. Inferring Beliefs from Argument Units

Argument units are structures that organize support and attack relation-ships in arguments. Argument units convey implicit beliefs and are often cued by specific linguistic expressions. As a result, following an argument involves recognizing these linguistic constructs, accessing the conceptualizations they refer to, and mapping from them into their the appropriate argument unit. Below we discuss seven argument units (AUs): AU-ACTUAL-CAUSE, AU-OPPOSITE-EFFECT, AU-EXPECTATION-FAILURE, AU-HYPOCRISY, AU-

ACTUAL-EFFECT, AU-EQUIVALENCE, and AU-RELEVANT-ISSUE. Each Argument Unit contains one or more conceptualizations which index, or trigger, the application of the entire Argument Unit.

(1) AU-ACTUAL-CAUSE:

If X expresses that:

> *PLAN P by Y does not help achieve GOAL G. The problem is SITUATION S.*

we understand that:

> *X believes that P does not achieve G (X's specific belief).*

and we infer that:

> *Y believes that P will achieve G.*
>
> *X believes that S thwarts G.*
>
> *X believes that P is bad (X's general belief).*
>
> *X's belief about S supports X's specific belief about P.*
>
> *X's specific belief about P supports X's general belief about P.*
>
> *X's specific belief about P attacks Y's belief about P.*

When using AU-ACTUAL-CAUSE, X can *support* his general belief about P by emphasizing P's actual effects. In that case, AU-ACTUAL-CAUSE has the following form:

> *PLAN P by Y does not help achieve GOAL G. On the contrary, P thwarts GOALS G-1, ..., G-N. The problem is SITUATION S.*

For example, Friedman uses AU-ACTUAL-CAUSE in EDITORIAL-1 to argue against import restrictions:

> [These protectionist measures] do nothing to promote the long-run health of the industries affected ... The basic problem of the auto ... industries is clear: ... average wage rates are twice as high as the average wage rates of all workers ...

(2) AU-OPPOSITE-EFFECT:

If X expresses that:

> *Far from achieving GOAL G, PLAN P by Y thwarts GOAL G.*

we understand that:

> *X believes that P thwarts G (X's specific belief).*

and we infer that:

> *Y believes that P achieves G.*
>
> *X believes that P is bad (X's general belief).*
>
> *X's specific belief about P attacks Y's belief about P.*
>
> *X's specific belief supports X's general belief.*

For instance, AU-OPPOSITE-EFFECT is also used in EDITORIAL-1:

> Far from saving jobs, the limitations on imports will cost jobs.

Notice that AU-OPPOSITE-EFFECT is cued by the linguistic construct:
<"far from" x, y>, where x is an opposite effect from y.

(3) AU-EXPECTATION-FAILURE:

If X expresses that:

> *X expects and favors SITUATION S-1. Unfortunately, SITUATION S-2 (which is the opposite of S-1) happens.*

we infer that:

> *X believes that S-1 is good.*
>
> *X believes that S-2 is bad.*

Similarly, if X expresses that:

> *X expects and opposes SITUATION S-1. Fortunately, SITUATION S-2 (which is the opposite of S-1) happens.*

we infer that:

> *X believes that S-1 is bad.*
>
> *X believes that S-2 is good.*

For instance, Morrow (1983) uses AU-EXPECTATION-FAILURE to argue against protectionism:

> There are two basic visions of [the protectionist temptation]. Protectionism, in the free trader's eyes ... Or else, the protectionist happy dream ... The first is closer to the truth. Unfortunately, the months of recession and traumatic unemployment have begun to attract many Americans to the second vision ...

(4) AU-HYPOCRISY:

If X expresses that:

> *Y professes his BELIEF B about SITUATION S-1. Yet, Y makes possible SITUATION S-2 which is the opposite of S-1.*

we understand that:

> *Y believes B.*

and we infer that:

> *X believes that Y does not believe B.*
>
> *X's belief attacks Y's belief.*

For example, Thurow (1983) uses AU-HYPOCRISY to argue against protectionism:

> The Reagan administration argues that America does not need an industrial policy since all government has to do to guarantee economic success under capitalism is keep out of the way. Yet the Reagan administration has just ... increase[d] tariffs on large motorcycles ...

Notice that in AU-HYPOCRISY, X shows Y's hypocritical behavior by contrasting Y's belief and Y's actions. Consequently, the theme of hypocrisy (Dyer, 1983) is inferred from AU-HYPOCRISY.

(5) AU-ACTUAL-EFFECT:

If X expresses that:

> *PLAN P by Y achieves GOAL G-1, but thwarts a higher level GOAL G-2.*

we understand that:

> *X believes that P achieves G-1 and thwarts G-2 (X's specific belief).*

and we infer that:

> *Y believes that P achieves G-1.*
>
> *X believes that P is bad (X's general belief).*
>
> *X's specific belief attacks Y's belief.*
>
> *X's specific belief supports X's general belief.*

Similarly, if X expresses that:

> *PLAN P by Y thwarts GOAL G-1, but achieves a higher level GOAL G-2.*

we understand that:

> *X believes that P thwarts G-1 and achieves G-2 (X's specific belief).*

and we infer that:

> *Y believes that P achieves G-2.*
>
> *X believes that P is good (X's general belief).*
>
> *X's specific belief supports Y's belief.*
>
> *X's specific belief supports X's general belief.*

AU-ACTUAL-EFFECT is frequently used to contrast long-term effects and short-term effects. For example, Morrow (1983) uses AU-ACTUAL-EFFECT to argue against protectionism:

> Protectionist laws can indeed give short-term relief to some targeted industries. But protectionism amounts to a subsidy that is financed by the U.S. consumer and other industries.

(6) AU-EQUIVALENCE:

If X expresses that:

> *PLAN P by Y achieves GOAL G-1, but thwarts GOAL G-2 which is as important as G-1.*

we understand that:

> *X believes that P achieves G-1 and thwarts G-2 (X's specific belief).*

and we infer that:

> *Y believes that P achieves G-1.*

X believes that P is bad (X's general belief).

X's specific belief attacks Y's belief.

X's specific belief supports X's general belief.

For instance, Zycher (1984) uses AU-EQUIVALENCE to argue against trade policies:

> ... the net effect [of trade policies] ... is to "save" jobs in the industries being protected but lose them in other export sectors.

(7) AU-RELEVANT-ISSUE:

If X expresses that:

> *SITUATION S-1 is already happening. The real question is whether SITUATION S-2 will happen.*

we infer that:

> *X believes that S-2 should be dealt with.*
>
> *X believes that nothing can be done with respect to S-1.*
>
> *X believes that S-1 diverts attention from S-2.*

For instance, Morrow (1983) uses AU-RELEVANT-ISSUE to argue against becoming more protectionist:

> All trading nations protect themselves, more or less ...
> The real question ... is whether the U.S. will ... become more protectionist than it is now.

These argument units are based on relationships among goals, plans, and beliefs. For example, the table belows summarizes these relationships present in AU-ACTUAL-CAUSE, AU-OPPOSITE-EFFECT, AU-ACTUAL-EFFECT, and AU-EQUIVALENCE.

ARGUMENT UNIT (used by X)	Y's Belief	X's Specific Beliefs	X's General Belief
AU-ACTUAL-CAUSE	P achieves G	P does not achieve G SITUATION S thwarts G	P is bad
AU-OPPOSITE-EFF	P achieves G	P thwarts G	P is bad
AU-ACTUAL-EFF	P achieves G1	P achieves G1 P thwarts G2 G2 > G1	P is bad
AU-ACTUAL-EFF	P achieves G1	P achieves G1 P thwarts G2 G2 < G1	P is good
AU-EQUIVALENCE	P achieves G1	P achieves G1 P thwarts G2 G2 as important as G1	P is bad

For instance, X uses AU-OPPOSITE-EFFECT when X states "although Y believes that plan will achieve that goal, it will actually thwart that goal and, therefore, it should not be employed."

Not all argument units are captured in the above table. For instance, there is also a logical class of argument units. Such argument units involve showing the logical errors (Geach, 1976) of an opponent's argument. For example:

1. AU-SELF-CONTRADICTION: Showing that an argument is logically contradictory.

2. AU-TAUTOLOGY: Showing that an argument is circular.

At this point in time, we are not focusing on the logical class since, in general, editorial attacks are more often based on disputes over credibility, unforseeable effects, and so on, rather than on logical errors per se.

2.2. Strategies for Following Belief Justifications

Once we have recognized a belief, we expect to hear its justifications. In general, the justifications of a belief are based on the goal situations (i.e., goal and expectation failures or achievements) associated with the belief. To recognize and follow belief justifications, it is necessary to trace the evolution of those goal situation throughout the editorial. Below we discuss four general strategies for recognizing and following belief justifications: specific-instance, explicit-chain, domain-knowledge, and implicit-cause.

(1) Specific-Instance Strategy:

> *If X has the general belief that a SITUATION S is good or bad, expect X to give specific details of the goal situations that S can cause.*

For example, when reading EDITORIAL-1, the specific-instance strategy helps fit "... the limitations will cost jobs" coherently into the argument of the author as the justification for Friedman's general belief that the limitations are bad. Friedman's specific belief provides information about the goal failures that these limitations will cause.

(2) Explicit-Chain Strategy: Specific beliefs of the form *C causes E* are usually supported by chains of cause-effect relationships. The cause in the initial cause-effect relationship is C; the effect in the final one is E. Thus:

> *When following cause-effect chains, expect that the effect part in the present cause-effect relationship will be explicitly referred as the cause part in the next cause-effect relationship.*

For instance, the following excerpt from (Zycher, 1984) requires using the explicit-chain strategy to make sense of the cause-effect chain that supports Zycher's specific belief about trade policies:

> Trade ... policies ... can only shift ... [jobs] ... among industries and sectors ... If we protect some domestic industries by imposing import restrictions, fewer dollars are sent overseas, thus strengthening the dollar. This makes other export industries less competitive in world

markets, and the net effect therefore is to "save" jobs in
the industries being protected but lose them in other
export sectors.

(3) Domain-Knowledge Strategy: When the issues and their support or attack arguments are well known, editorial writers do not need to present complete cause-effect chains. Thus, some cause-effect relationships are omitted from the original chains. This results in cause-effect chains that contain structural gaps. Therefore:

To follow cause-effect chains, apply world knowledge to fill
in structural gaps.

World knowledge is provided by common-sense rules or by reasoning scripts (Flowers, 1985) that contain well-known justifications for general or specific beliefs. For example, understanding the following cause-effect chain from EDITORIAL-1:

... the limitations will cost jobs.[CAUSE-EFFECT GAP].
If we import less, foreign countries will earn fewer dollars.

requires using a common-sense rule such as:

If COUNTRY C imposes import restrictions, C will
import less.

(4) Implicit-Cause Strategy: Because of writing style, editorial writers often omit the cause of a given effect in cause-effect chains. In those cases, it is implicit that the missing cause corresponds to the effect part of the preceding cause-effect relationship. Thus:

When following cause-effect chains, infer that the missing
cause of a given effect is equal to the effect part of the
preceding cause-effect relationship.

For instance, understanding the following cause-effect chain from EDITORIAL-1:

If we import less, foreign countries will earn fewer dollars.
[IMPLICIT CAUSE] They will have less to spend on U.S.
exports.

requires inferring that foreign countries "will have less to spend on U.S. exports" because they "will earn fewer dollars."

2.3. Building Argument Graphs

Understanding an editorial requires parsing input text into an argument graph (Birnbaum, 1982; Flowers et al., 1982). Within this graph, beliefs are connected by links that indicate whether they support or attack one another. During text comprehension, every new belief or belief justification is integrated into the graph by using those links. The attack and support relationships are established from the application of the inference rules for: (a) recognizing beliefs and belief relationships, and (b) following belief justifications. For example, some of the attack and support relationships present in EDITORIAL-1 are:

Friedman's general belief that the limitations are bad is
supported by his specific belief that "the limitations on

imports will cost jobs in export industries."

Friedman's specific belief attacks the Reagan administration's belief that the limitations will save jobs.

Friedman's specific belief is supported by the relationship between the export industries' rate of employment and volume of sales.

3. Representing Politico-Economic Knowledge

The concept of protectionism can be represented by means of goals and plans (Schank and Abelson, 1977), basic social acts (Schank and Carbonell, 1978), ideologies (Carbonell, 1981), and reasoning scripts ($Rs) (Flowers, 1985). In general, when a domestic industry is threatened by better or cheaper imports, it means that the industry has an active preservation goal: PRESERVE-FINANCES. One of the PLANNING-STRATEGIES available to the industry is to seek protectionist policies (i.e., PROTECTION-PLANs) by the government. As a result, the industry will PETITION or PRESSURE for PROTECTION-PLANs by LOBBYING. The typical arguments of those who favor protectionism over free trade (i.e., those who have a PROTECTIONIST-IDEOLOGY) disguise that PRESERVATION-GOAL as a broad social goal (e.g., PRESERVE-JOBS) (Adams et al., 1979; Greenaway and Milner, 1979). Some of those arguments are so stereotypical that can be represented by reasoning scripts (e.g., $R-PRESERVE-JOBS-->PROTECTIONIST-POLICIES).

Protectionist policies can be imposed through legislation (i.e., they are AUTHORIZEd) or through executive agreements (i.e., through NEGOTIA-TIONs) (Adams et al., 1979; Greenaway and Milner, 1979; Yoffie, 1983). The former includes tariffs, quotas, and subsidies; the latter, voluntary export restraints and orderly market agreements.

4. The OpEd Program

OpEd is a computer program that reads short (under 300 words) politico-economic editorial segments and demonstrates its comprehension by answering questions on the editorial contents. OpEd uses the same processes to read editorial segments and questions, i.e., OpEd is an integrated system. Input editorial segments are in English and contain the essential issues and arguments of the original editorials. OpEd reads sentences in a left-to-right manner and integrates into its memory the conceptual contents (i.e., the argument graph) of the editorial contents. During the question answering process, it is that conceptual representation which is queried, since OpEd cannot remember the original wording of the editorials. Input questions are in English and the answers retrieved are converted from memory representation to English by an English generator.

OpEd is written in T (a lexically-scoped, Scheme-based dialect of Lisp) on an Apollo workstation. Currently, OpEd handles a short version of EDITORIAL-1 and a few conceptual question categories (Lehnert, 1978). We are in the process of increasing OpEd's vocabulary, world knowledge, and reasoning comprehension skills. As an initial test of the theory being developed in OpEd,

the program will be expected to read and answer questions for different editorials without requiring program modifications.

OpEd's conceptual parser uses the managing and execution mechanisms of McDYPAR (Dyer, 1983). McDYPAR is a micro version of DYPAR (Dyer, 1983), a demon-based conceptual parser. Memory and inference tasks are performed by demons on a word-by-word (or phrase) basis. Those tasks include: interactions of knowledge sources, role binding, word disambiguation, concept references, belief inferences, inference of belief relationships, justification tracing, question categorization, and answer retrieval. The theory of question answering implemented in OpEd is based on the work by Lehnert (1978) and Dyer (1983).

4.1. OpEd's Input/Output Behavior

Below is an actual sample of OpEd's current input/output behavior. Input text and questions are shown in lower-case letters; the output is in upper case. A brief analysis of the relevant problems solved by OpEd during parsing and question answering also follows.

> Recent protectionist measures by the Reagan administration have disappointed us.
> Voluntary limits on Japanese exports of automobiles are bad for the nation.
> Far from saving jobs, the limitations on imports will cost jobs.
>
> Q1: What has disappointed Friedman?
>
> A1: VOLUNTARY EXPORT RESTRAINTS ON AUTO-MOBILES FROM JAPAN NEGOTIATED BY THE REAGAN ADMINISTRATION
>
> Q2: Why have the limitations disappointed Friedman?
>
> A2: MILTON FRIEDMAN BELIEVES THAT VOLUN-TARY EXPORT RESTRAINTS ON AUTOMO-BILES FROM JAPAN NEGOTIATED BY THE REAGAN ADMINISTRATION WILL CAUSE THE LOSS OF JOBS IN THE U.S.
>
> Q3: Who believes that the limitations will ~~cost~~ *save* jobs?
>
> A3: THE REAGAN ADMINISTRATION

(1) Parsing the First Sentence

Top-Down Disambiguation: OpEd understands "protectionist measures" as PROTECTION-PLANs. "Protectionist" has at least two different meanings:

> It indicates that HUMANS, AUTHORITIES, and ORGANIZATIONS have a PROTECTIONIST-IDEOLOGY.
> It indicates that GENERAL-PLANs, such as policies, achieve protectionism (i.e, they are PROTECTION-PLANs).

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"Measure" has at least three different meanings:

1. A QUANTITY of a LIQUID or FOOD.

2. A MEASURING-PLAN.

3. A GENERAL-PLAN.

After reading the word "protectionist," OpEd expects a HUMAN, an AUTHOR-ITY, an ORGANIZATION, or a GENERAL-PLAN. The last expectation uniquely matches one of the meanings of measures. As a result, the correct meaning (i.e., 3) is selected automatically.

Pronoun Reference: OpEd realizes that the actor experiencing the disappointment is Friedman by using the following reference rule:

> *Search for a previously mentioned HUMAN-GROUP that includes the editorial writer. If none is found, assume that the pronoun refers to a HUMAN-GROUP that includes the editorial writer.*

Belief inference: From Friedman's disappointment, OpEd infers that Friedman believes that the PROTECTION-PLANs are bad.

(2) Parsing the Second Sentence

Concept Reference: At the lexical level, OpEd knows that "voluntary limits" correspond to PROTECTION-PLANs. Thus, OpEd binds the conceptualization of those limits to the existing PROTECTION-PLANs. Furthermore, using its knowledge of "voluntary limits," OpEd establishes that the PROTECTION-PLANs were implemented through NEGOTIATIONs between the U.S. and Japan.

OpEd also realizes that "the nation" refers to the U.S. by using the following reference rule:

> *Search for a previously mentioned COUNTRY. If none is found, assume that it is the COUNTRY where the editorial was written.*

Belief Justification: OpEd uses the specific-instance strategy to infer that the U.S. is the character of the goal failures produced by the PROTECTION-PLANs.

(3) Parsing the Third Sentence

Bottom-Up Disambiguation: OpEd understands that "far from" introduces AU-OPPOSITE-EFFECT. In general, "far from" can introduce:

1. A SPACE-RELATION (i.e., far from LOCATION L, ...) or

2. AU-OPPOSITE-EFFECT.

After reading the phrase "far from," OpEd expects either a location or a cause-effect relationship. The latter expectation matches the meaning of "saving," so the second meaning is automatically selected.

Concept Reference: As in the previous sentence, OpEd binds the conceptualization of "limitations on imports" to the existing PROTECTION-PLANs.

Concept Inference: It is implicit that "saving jobs" was the expected result of the PROTECTION-PLANs. OpEd uses the AU-OPPOSITE-EFFECT to discover that fact.

Belief Inference: AU-OPPOSITE-EFFECT allows OpEd to infer that the Reagan administration believes that the PROTECTION-PLANs will save jobs.

Belief Justification: OpEd uses the specific-instance strategy to infer that Friedman believes that the PROTECTION-PLANs will cost jobs; this belief supports Friedman's general belief that the PROTECTION-PLANs are bad. Also, OpEd uses AU-OPPOSITE-EFFECT to infer that the Reagan administration's belief attacks Friedman's specific belief.

(4) Question Answering Process

To answer questions Q1 (a causal-antecedent question) and Q3 (a concept-completion question), OpEd retrieves the antecedent of the given cause-effect relationship and the character of the given belief, respectively. To answer question Q2 (a specific-belief question), OpEd retrieves Friedman's specific belief about the PROTECTION-PLANs. This is done by applying the following retrieval rule:

> *Search for the specific belief associated with the given affective reaction. If found, retrieve it. Otherwise, retrieve the general belief associated with the given affective reaction.*

The above heuristic is used by OpEd to answer question Q2 using answer A2 rather than using a more general, weaker answer, such as:

> Friedman believes that the voluntary export restraints negotiated by the Reagan administration are bad.

5. Conclusions and Future Work

We have presented a theory of reasoning comprehension being implemented in OpEd to understand short editorial segments. Four points have been emphasized:

> *Understanding people's opinions requires: (1) recognizing beliefs and belief relationships, and (2) recognizing and following belief justifications.*

> *Belief justifications are based on the goal/plan situations associated with the corresponding beliefs.*

> *In order to recognize and follow belief justifications, it is necessary to trace the evolution of the goal/plan situations associated with the corresponding beliefs.*

> *Understanding people's opinions requires building conceptual graphs of interconnected beliefs.*

We believe that the theory presented here constitutes the foundation for an integral theory of reasoning comprehension. Such a theory should ultimately help explain not only how people's opinions are understood, but also:

Reasoning Intentionality: Whether the reasoning is intended to explain or to convince.

Reasoning Errors: Whether the reasoning is sound.

Reasoning Agreement: Whether agreement or disagreement can be established.

Persuasion: Whether a consistent revision of previous beliefs is needed.

Reasoning Strategies: Whether induction, deduction, generalizations, analogies, or refutations are being used.

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