Goal-based Decision Strategies

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Abstract

We present a process model of decision making mediated by goals and relationships. The model is implemented in the VOTE computer program which simulates Congressional roll call voting. In this paper, we focus on VOTE's decision strategies, which are based on the need not only to arrive at a vote, but also to produce an explanation for each decision. We describe several typical strategies, as well as an indirect strategy, DEEPER ANALYSIS, that is invoked when the normal strategies fail to arrive at a decision.

The Process of Decision Making

Decision making is a complex cognitive process. A realistic model of decision making must account for a multitude of goals and limited resources. Many problems will not admit to perfect solutions. Practical decisions often involve trade-offs.

We have developed a goal-based model of decision making in which the relative priorities of goals drive the decision process. This model serves as the basis for the VOTE program which simulates Congressional roll call voting decisions on thousands of votes, based on the relative priorities of goals and constituent relationships, and the need to provide an explanation for the decision.

Alternative models of decision making have used prescriptive decision analysis [Raiffa, 1968], which uses estimates of payoffs and uncertainty of outcomes to arrive at an optimal result. The assumptions of decision analysis are inappropriate in many domains for which our goal-based, descriptive model may apply. Our model is an extension of the theory of goals developed by Schank and Abelson (1977), Wilensky (1978) and Carbonell (1979), and is compatible with the use of goals in case-based reasoning systems (Simpson 1985, Hammond 1986).

We define the priority or importance of a goal to be proportional to the resources that an agent may be

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Predictions	Individual		Deeper Analysis	
Correct	1738	77%	124	69%
Incorrect	532	23%	56	31%
Predicted Votes	2153	100%	181	100%
All Votes	2814		238	

Table 1: VOTE Summary Statistics

willing to allocate in service to that goal. Resources are viewed quite broadly to include not only time or money, but also cognitive resources, such as attention and memory. For example, an agent should think more about important matters than about trivial ones.

We extend the model of goals to include interpersonal relationships (Slade 1990). An agent adopts the goal agenda of another agent with a priority proportional to the importance of the relationship. For example, an agent is more likely to help a friend than a stranger. This extension permits the processing of adopted goals in a manner uniform with individual goals.

The VOTE program does not rely on a single method for ranking alternatives, but rather implements a collection of strategies that relate decisions to explanations. In this paper, we discuss a number of those decision strategies.

The VOTE Program

VOTE, written in T (Slade 1987), comprises over 14,000 lines of code, and over 9,000 lines of data. The VOTE program relies on a set of interrelated databases, including issues (over 200 currently in the database), constituency groups (150), bills (43), members (65), and decision strategies (16). We note that many decision strategies are required since the explanation of the decision depends on the strategy. It is not enough to use one simple strategy of summing the weights of the conflicting issues and relationships.

Table 1 provides a summary of VOTE's performance. We note that we do not have actual votes for all of the possible decisions. This is the case for hypo-

thetical bills, for bills that precede or follow a member's term, or for bills on which the member chose not to vote.

VOTE correctly predicts individual members' votes 77% of the time. Approximately 8% of those votes involve DEEPER ANALYSIS (discussed below), which arrives at the correct result 69% of the time. The net accuracy for bills not requiring DEEPER ANALYSIS is 82%.

In VOTE, we use the names and records of real members of Congress, and attribute relationships and issue stances to them. The coding decisions, though subjective, reflect the author's political experience as a campaign consultant and White House staff member. By way of disclaimer, we should state that these data are merely illustrative, and are not meant to represent the beliefs of actual members of Congress. The accuracy of the program is a reflection of the coding decisions. The primary purpose of VOTE is not to predict individual voting decisions, but rather to demonstrate the feasibility of a particular model of goals, relationships, and decision making.

Stances: Preferences and Consequences

In VOTE, goals are issues, such as gun control or affirmative action. A member's preferences are expressed as **stances**, which comprise an **issue**, a **side** (pro or con), and a level of **importance** (A, B, or C, where A is high and C is low). For example, a member who strongly supports affirmative action while opposing gun control might have preference stances such as the following.

```
(PRO A MEMBER:MEMBER.2319 AFFIRMATIVE-ACTION)
(CON B MEMBER:MEMBER.2319 GUN-CONTROL)
```

While VOTE prints stances as lists, the program actually uses a more complex object-oriented representation. Constituency groups have similar sets of preference stances to represent their issue agendas. Furthermore, VOTE associates normative stances with issues to reflect typical public opinion. For example, the flag burning norm is one of mild opposition:

```
        (CON C ISSUE:ISSUE.1077 FLAG-BURNING)
```

Stances are also used to represent justification consequences of legislation. For example, HR-2978, the 1989 bill which banned flag desecration, is represented with the following set of stances respectively favoring and opposing passage of the bill.

```
Stance-FOR:
  (((CON B BILL:HR-2978 FLAG-BURNING)
    (PRO B BILL:HR-2978 PATRIOTISM)))
Stance-AGN:
  (((PRO B BILL:HR-2978 CONSTITUTION)
    (PRO B BILL:HR-2978 FREE-SPEECH)))
```

VOTE has a natural language generation facility which can express the above stances in English.

Support of the flag desecration bill stands firmly against the right of burning the American flag in protest. It upholds patriotism and devotion to this country. Opposition to HR-2978 upholds the belief in the United States Constitution and the Bill of Rights, in addition to the right of freedom of speech.

The process of decision making requires matching preference stances with consequence stances. In VOTE, members ignore consequence stances that do not match any of their preference stances. That is, members only pay attention to those consequences about which they or their constituents care.

Choices and Explanations

Stated generally, VOTE tries to choose the outcome that most closely matches a member's preferences. However, given the conflicts that often arise, VOTE must be able to resolve, or at least address, the conflicts. The VOTE model of decision making assumes that there are many ways of arriving at a decision which may differ significantly in their underlying structure and rationale. Our decision making model focuses on two questions.

- *Choice:* What does the agent want to do?
- *Explanation:* How can the agent justify his decision?

These questions depend on an agent's preferences and an action's consequences. The basic VOTE decision making algorithm is as follows.

1. Extract preference stances from voting record and constituent relationships, and combine with member's personal ideology or "credo" stances.

2. Match Bill consequence stances for/agn with the member's composite preference stances.

3. Analyze relative importance of for/agn stances with respect to norms, voting record, groups, and personal beliefs.

4. Apply decision strategies until one fits.

5. If no strategy fits, then use DEEPER ANALYSIS to expand the implications of the for/agn stances to include the important consequences of the current decision stances. Go to step 2.

6. Update decision database, adding new vote, and print the result.

7. Produce an English summary of the decision.

In this paper, we focus on steps 4 and 5: the application of decision strategies. We note the following general points.

- A specific strategy does not always guarantee a specific result. The same strategy can be used on the same bill by different members of Congress to arrive at different conclusions.

- Decision strategies are driven by the need to explain a decision. Each strategy is tied to a specific type of explanation.

- Given a member of Congress and a bill, different strategies may result in different conclusions. That is, in some cases, VOTE can generate plausible reasons for both sides of a bill for the same member of Congress.

- One decision strategy, DEEPER ANALYSIS, is an indirect strategy used in step 5, above. It provides a mechanism for VOTE to consider further consequences of a decision. The DEEPER ANALYSIS strategy takes advantage of the cognitive assumptions behind the importance accorded issue stances.

- We do not claim that the strategies presented here are either necessary or sufficient. We present them as being illustrative to demonstrate the feasibility of our decision making model.

A key feature of these strategies is the role of explanation. Not all decisions require explanations. However, we can identify two broad categories of decisions that generally do require justification.

- Decisions that violate expectations.
- Decisions that have adverse consequences.

If an agent makes a decision that differs from what others have expected, then it is reasonable for the agent to offer an explanation. For example, if we observe someone walking around the office barefooted, we might reasonably ask the person for an explanation. We would not require someone to explain why he is wearing shoes at the office. Wearing shoes is the expected behavior, while going barefoot is unusual.

If an agent chooses a course of action which has adverse consequences for another agent (and even for himself), he might be expected to justify his actions. For example, if a man decides to refuse a promotion and raise, his spouse might expect him to provide an explanation, e.g., he would have to travel too much. If he accepts the promotion and raise, no justification would be required – unless of course his wife had *expected* him to refuse the promotion.

In the Congressional roll call voting domain, explanation plays a central role. In our model, the adverse consequences of a vote are represented as downside stances from constituency groups. Unexpected votes are those in which the downside stances include positions from the member's voting record or credo stances. That is, we expect a Congressman to vote in a manner consistent with his voting record and his personal beliefs. Thus, decisions involving downside stances suggest the need for an explanation. The political science literature (Kingdon 1973, Fenno 1978) indicates that members of Congress are cognizant of the role of explanation in decision making.

We note that this type of explanation is different from the usual sense of explanation found in the case-based reasoning literature (Schank 1986, Ram 1989, Kass 1990, Leake 1990). Previous researchers have focused on explanation of anomalous observed events as part of the process of learning. Our present use of explanation is complementary to that process: decision makers offer explanations for the benefit of observers who may find the decision to be anomalous.

Strategy application proceeds with the following tests for choice.

1. *Unanimous.* The first step is always to check for a unanimous decision – one in which all the stances fall on one side of the bill. In such a case, the explanation is the self-evident one that the choice was a popular decision.

2. *Consensus.* We define a consensus to obtain when the most important preference stances all fall on the same side of the bill. That is, the most important group stance, member credo stance, and member voting record stance are all either FOR or AGN the bill. At this stage of the process, we do not have unanimity, so we try to develop a suitable explanation for the consensus choice. There are five possible strategies, the last of which is simply to state that there is a consensus.

3. *Majority.* In the absence of a consensus, there may still be a majority of stances on one side or the other. As with the consensus, we again try to develop an appropriate explanation to justify the choice. Again, there are five possible strategies, the last of which states that there is a majority of opinion for this bill.

4. *Other.* There are three other strategies that use special conditions for choice. We shall discuss one of those below.

5. *Deeper Analysis.* If none of the previous strategies have triggered, then VOTE tries an indirect strategy, DEEPER ANALYSIS, which infers additional consequences of the bill. VOTE then begins the strategy application process over again.

6. *No Decision.* The DEEPER ANALYSIS process will always terminate. If it has not succeeded in arriving at a decision, then VOTE will return the failure condition of NO DECISION.

In this paper, we present examples of several representative individual decision strategies, beginning with POPULAR DECISION.

Popular Decision

The first strategy tried for any decision is POPULAR DECISION.

Test: All stances are on one side of the bill. There is either no opposition or no support for the given measure. The resulting vote is consistent with all constituencies. There are no conflicts.

This strategy is used for the clear cases, not the close calls. Members of Congress report that 80% to 90% of their votes fall in this category (Kingdon 1973). It is important to note that a given bill can result in an easy choice both for or against, depending on the given member.

Below we present two votes on the same bill by different members of Congress. Both votes use POPULAR DECISION, however they arrive at opposite conclusions.

```
> (vote 'gephardt 'clean-water)

* Member:        Richard A. Gephardt
* Bill:          Water Quality Renewal Act
* Amendment to freeze funding for the Clean
* Air Act through 1990.
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Popular decision
All stances are AGN this bill:
(((PRO B GROUP:CONSERVATION-VOTERS CLEAN-AIR)
  (PRO B GROUP:DEMOCRATS AIR-POLLUTION)
  (PRO B GROUP:CONSERVATION-VOTERS CLEAN-WATER)
  (PRO B GROUP:DEMOCRATS CLEAN-WATER)))
There are no reasons to vote FOR this bill.
Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

Richard A. Gephardt is opposed to bill HR-8, the Water Quality Renewal Act. He believes this bill not to be in the best interests of the people. He feels strongly in favor of the policy of increased funding for air pollution control. Gephardt is committed to the program of increased funding for water pollution control.

VOTE's natural language generation facility produces the English rationale.

Congressman Gephardt finds it easy to oppose HR-8. We see below that Representative Gingrich has no problems supporting the bill. We note that the reasons for opposing the bill are not merely the opposite of the stances in support of the bill.

```
> (vote 'gingrich 'clean-water)

* Member:        Newt Gingrich
* Bill:          Water Quality Renewal Act
* Amendment to freeze funding for the Clean
* Air Act through 1990.
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Popular decision
All stances are FOR this bill:
(((PRO B GROUP:CHAMBER-COMMERCE DEREGULATION)
  (PRO B BILL:S-557 DEREGULATION)
  (PRO B MEMBER:MEMBER.3055 DEREGULATION)
  (PRO B MEMBER:MEMBER.3055 FREE-ENTERPRISE)
  (PRO B GROUP:REPUBLICANS DEREGULATION)
  (PRO C BILL:HR-5210 DEREGULATION)))
There are no reasons to vote AGN this bill.
Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

Newt Gingrich votes for bill HR-8, the Water Quality Renewal Act. He believes this bill to be in the best interests of the people. He feels strongly in favor of limiting federal regulation of industry and society. Gingrich is committed to free enterprise and capitalism.

The explanation associated with POPULAR DECISION is not very involved given that the member's constituencies should agree with the vote in the first place. That is, a member has to pay more attention to an explanation when he knows that people will disagree with his vote. Other decision strategies must deal with the disaffected constituencies and the resulting downsides of decisions.

Not Constitutional

One of the few strategies that is clearly specific to the Congressional voting domain is the NOT CONSTITUTIONAL strategy. Decisions dictated by this strategy have a clear explanation. However, members may often find it convenient to vote in favor of a bill they deem unconstitutional, knowing that they can get symbolic milage from a measure that will be thrown out in court.

Test: There is a consensus opposing the measure. One issue among the opposing stances is the Constitution. The member votes against a measure that would be struck down by the Supreme Court.

The bill prohibiting desecration of the American flag provides a good example of this strategy.

```
> (vote 'schroeder 'hr-2978)

* Member:        Patricia Scott Schroeder
* Bill:          Flag Desecration
* Bans the desecration of the American flag.
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Not constitutional
Found a consensus AGN this bill.
Most important stances are all AGN this bill:
Group: (AGN (PRO A GROUP:ACLU CONSTITUTION))
Record:(AGN (PRO B BILL:HR-5345 CONSTITUTION))
Norm:  (AGN (PRO B ISSUE:SELF CONSTITUTION))
Constitutional grounds for opposing this bill:
      (((PRO A GROUP:ACLU CONSTITUTION)
        (PRO B BILL:HR-5345 CONSTITUTION)
        (PRO B GROUP:COUNTRY CONSTITUTION)))
Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

Patricia Scott Schroeder votes against bill HR-2978, the flag desecration bill. She believes that provisions of this bill are not constitutional. She is unwavering in her support of the United States Constitution and the Bill of Rights. However, Schroeder sees that members of the Democratic party object to the right of burning the American flag in protest.

Clearly, many members were willing to vote in favor of this bill, as it passed by a 10 to 1 margin. However, the resulting law was subsequently appealed, and declared unconstitutional by the Supreme Court.

Balance the Books

BALANCE THE BOOKS relies on the fact that over time, a member's record can be used to support most any position. This strategy suggests that the downside of a vote can be mediated through reference to previous votes in support of the relevant issues.

Test: There is a majority opinion on this bill. The member's record has positions that fall on both sides of the bill. The member may offset the current vote with past or future votes.

```
> (vote 'boggs 'hr-3)

* Member:          Corinne Claiborne Lindy Boggs
* Bill:            Child Care
* Provide greater funding for child care.
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Balance the books
Found a simple majority FOR this bill.
There are 7 FOR stances:
    (((PRO B GROUP:AFLCIO-COPE CHILD-CARE)
     (PRO B GROUP:AFLCIO-COPE LABOR)
     (PRO B GROUP:ADA LABOR)
     (PRO B GROUP:DEMOCRATS LABOR)
     (PRO B GROUP:DEMOCRATS CHILD-CARE)
     (PRO C BILL:HR-1234 LABOR)
     (PRO C GROUP:COUNTRY CHILD-CARE)))
There is only 1 AGN stance:
    (PRO B BILL:HR-3299 FISCAL-RESPONSIBILITY)
The record supports positions on both sides:
FOR:(PRO C BILL:HR-1234 LABOR)
AGN:(PRO B BILL:HR-3299 FISCAL-RESPONSIBILITY)
Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

Corinne Claiborne Lindy Boggs is in favor of bill HR-3, the child care bill. She believes that the people who disagree with this vote may find reassurance in the record. She is eager to support the proposal of increased funding for child care. Boggs strongly supports the legitimate concerns of decent working people. However, Boggs believes that her voting record shows support for fiscal responsibility.

In this case, Congresswoman Boggs is already on the record as supporting fiscal responsibility. Therefore, she can state that her vote on this bill does not necessarily imply that she opposes fiscal responsibility.

Shifting Alliances

SHIFTING ALLIANCES is a complex strategy. The member is faced with a dilemma. There are constituencies on both sides of the bill with equally compelling stances. In order to break the tie, the member looks beyond the present case to find another issue that divides these two groups, to see if he has a position on that other issue that would tend to make him politically or philosophically closer to one of the groups.

Test: The member has no credo stance on this bill. There are constituencies on opposite sides of the issues. One of the constituencies is in conflict with the member on another issue, or one of the constituencies is in agreement with the member on another issue. Then, the member sides with the constituency that is ideologically closer. The member may lower the importance of the other relationship.

```
> (vote 'morrison 'hjr-350)

* Member:          Bruce A. Morrison
* Bill:            Flag Burning Amendment
* Constitutional amendment to ban flag burning
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Shifting alliances
Conflict with FOR groups:
 (CON C MEMBER:MEMBER.872 DEATH-PENALTY)
There is no credo stance involved in this vote.
There are groups on either side of this bill:
FOR:(CON C GROUP:DEMOCRATS FLAG-BURNING)
AGN:(PRO A GROUP:ACLU CONSTITUTION)
The member has belief conflicts with the
FOR group (noted above),
so the decision is with the AGN group.

Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

Bruce A. Morrison votes against bill HJR-350, the Flag Burning Constitutional Amendment. He believes that sincere people have honest differences of opinion on this bill. He is deeply committed to the principle of the United States Constitution and the Bill of Rights. Even so, Morrison knows that members of the Democratic party are against the right of burning the American flag in protest.

In this case, the groups are the Democrats on one side and the ACLU on the other. Morrison decides that since he disagrees with the Democrats on the issue of the death penalty, he will side with the ACLU on this matter. Another pragmatic strategy would be to vote with the Democrats on this bill, assuming that the member would be able to assuage the ACLU on a later death penalty vote.

Deeper Analysis

DEEPER ANALYSIS is a "think harder" strategy. None of the other strategies have worked, for whatever reason. The agent now tries to come up with more stances on both sides of the bill to resolve the question.

Test: This is an indirect strategy. First expand the bill stances through inference, then run through the

preceding decision strategies again. If that fails, then try a deeper level of inference. Inferencing is triggered by the level of importance of the stances. Process stops at the D level.

The DEEPER ANALYSIS strategy depends on inferences made from the core bill stances. Typically, DEEPER ANALYSIS is invoked if none of the bill consequence stances match any of the member's preference stances. That is, the member has no position on any of the relevant issues. Associated with each issue is a set of pro and con consequence stances. These are stances that might be used to justify a pro or con stance on that issue. For example, the issue of trade tariffs and restrictions has the following pro and con stances.

```
PRO Stances:
((PRO B ISSUE:TRADE-TARIFFS JOB-PROTECTION))
CON Stances:
((PRO B ISSUE:TRADE-TARIFFS TRADE)
 (PRO B ISSUE:TRADE-TARIFFS FREE-MARKET)
 (PRO B ISSUE:TRADE-TARIFFS FOREIGN)
 (PRO A ISSUE:TRADE-TARIFFS FREE-TRADE))
```

VOTE expresses these positions in English as follows.

> *Support of trade tariffs and restrictions is important for efforts to protect domestic jobs. Opposition to protectionism is always part of free trade among countries. It upholds stimulating foreign trade and investment, free enterprise and capitalism, and this nation's foreign policy.*

The method of generating new stances is based on the importance of the initial stances, and is analogous to spreading activation models of memory. The DEEPER ANALYSIS algorithm proceeds as follows.

1. Expand all A consequence stances both FOR and AGN the bill, and then reprocess the decision.

2. If no decision results from step 1, expand all A or B stances (including those derived from step 1) and reprocess the decision.

3. If no decision results from step 2, expand all A, B, or C stances (including those derived from steps 1 and 2), and reprocess the decision. At this stage, all remaining consequence stances will be expanded, regardless of level.

The point of this strategy is to consider the more important consequences first, and to give them greater influence on the decision making process. Our view of cognitive resources suggests that importance provides us with a principled means for organizing and searching memory. DEEPER ANALYSIS is one method of implementing an importance-based search.

In the following example of DEEPER ANALYSIS, an A level analysis results in a SIMPLE MAJORITY decision against the bill.

```
> (vote 'foley 'hr-1154)
```

```
* Member: Thomas S. Foley
* Bill:   Textile and Apparel Trade Act
* Passage, over Reagan's September 28 veto,
* of the bill to limit imports of textiles,
* apparel, and footwear.
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Deeper analysis...
results in new bill stances at level A...
New AGN stances:
 (PRO A ISSUE:TRADE-TARIFFS FREE-TRADE)
* Re-Analyzing alternative positions
— OMITTING INTERMEDIATE OUTPUT —
Decision strategy: Simple Majority
Found a simple majority AGN this bill.
There are 2 AGN stances:
 ((PRO B BILL:HR-1234 FREE-TRADE)
  (CON C BILL:HR-1234 TRADE-TARIFFS))
There is only 1 FOR stance:
 ((PRO B GROUP:COPE TRADE-TARIFFS))
Adding current vote to DECISION database
— OMITTING INTERMEDIATE OUTPUT —
```

> *Thomas S. Foley is opposed to bill HR-1154, the Textile and Apparel Trade Act / Veto Override. Upon reflection, he believes that the majority of people oppose this bill. He is eager to support free trade among countries. Foley cares about free trade. Still, Foley knows that the Committee on Political Education of the AFL-CIO is eager to support the policy of trade tariffs and restrictions.*

Foley required a one-step, A level analysis. He ended up voting against the bill using a SIMPLE MAJORITY strategy.

Conclusion

We have discussed the role of decision strategies in the VOTE program. VOTE is a robust demonstratation of the computational feasibility of our model of decision making. In contrast to prescriptive decision analysis, VOTE provides a descriptive framework for examining decision making as a process. The VOTE model does not assume that there is one right or best result, but rather that the final decision depends on a range of goal-based cognitive processes. VOTE makes explicit many of the underlying issues of reasoning about goals, consequences, and explanations in decision making.

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