CHAPTER 6

TIDA - THE SYSTEM DEVELOPED

6.1 INTRODUCTION

In this chapter a discussion on the details of the TIDA system along with the control mechanism employed by it is presented. The Handbook of A.I. [98] defines the "control structure" of a problem solving system as a component which decides what rule to execute next. A right choice of control strategy will enable the system to perform more rationally. The performance of a problem solving system is observed to be rational if the findings at any stage can help select an appropriate rule in the next stage. To be rational the control strategy adopted should be flexible. This is more so in the legal realms where one can not draw up an abstract plan of things to be done in advance. In its control mechanism Tida employs multiple agendas. The agenda mechanism along with either of the two common control structures i.e., backward chaining and forward chaining, and a monitor program provides the required flexibility to the control structure as well as allows the problem solving system to direct its focus-of-attention. Finally, the details of an interactive session with the TIDA system is also presented.

6.2 DETAILS OF TIDA

In TIDA the domain knowledge has been represented by employing "FORMS and modified production rules" [56] technique of knowledge representation. In its control mechanism TIDA employs multiple agendas along with a MONITOR program.
details pertaining to TIDA's control structure is discussed in section 6.3.2. At present Tide consists of 126 rules, inclusive of the rules having common sense knowledge encoded in them. Inference rules having the domain knowledge encoded in them are in the modified form and have system's object level knowledge drawn from both statues as well as precedents. The system has been implemented in GOLDEN COMMON LISP, a subset of COMMON LISP [99]. Procedures to create FORMs, to retrieve and update information content of FORMs, to selectively load rules as well as FORMs, to record consultation sessions, etc., have been implemented. A procedure called SIFTER assists TIDA in eliciting relevant facts from the textual form input data. A procedure called PASSADE makes TIDA to behave like a pure rule based system whenever the latter enters into a specific context or situation. At present the complete system works with a FORM called CONSULT as its top level FORM which first asks for the general book keeping information like user's name, date of consultation, etc. After a facts situation or case to be analyzed is input, the MONITOR module takes over the control and gets into different contexts by arousing user responses as well as by making certain assumptions depending upon the case or facts situation on hand.

6.3 THE CONTROL MECHANISM

6.3.1 Backward chaining or Forward chaining

Of the two representative knowledge-based systems reviewed in chapter 3, the infectious disease diagnosis system MYCIN employs the backward chaining and the DEC's computer configuration system R1 employs the forward chaining control strategy. In backward chaining initially an hypothesis is formulated and then the effort is to determine the validity of the hypothesis by moving backwards searching for the relevant information or symptoms. However, in the case of forward
chaining, as in RL, the problem solving starts with a given set of requirements (or facts) and moves forward to arrive at a plausible result.

Obviously, in the legal realm initially a set of facts pertaining to a case will be available which need to be analyzed. This situation is analogous to the RL's situation where also a set of facts, in the form of a purchase order, will be available to start with. This suggests that the forward chaining is appropriate for legal reasoning and hence has been adopted. At this point it should be noted that in RL the entire task of configuring the VAX systems has been subdivided into six sub tasks which have definite temporal relationship and the aim is to arrive at one final solution. However this method is not applicable for the analysis of legal problems. The reason is that in the case of legal analysis problems, the order of sub tasks cannot be predetermined but has to be generated dynamically instead. In this application the pre-processed input sentences are explicated as the analysis slowly progresses, reorienting the system's attention as the need arises. One cannot draw up an abstract context plan which specifies what "legal variables" have to be handled at a particular problem solving stage. The process of case analysis in the legal domain requires a "non-deterministic" approach. Floyd [100] summarizes the meaning of "non-deterministic" algorithm as follows:

"It is perhaps desirable to make clear that non-deterministic algorithms are not probabilistic, random or Monto Carlo algorithm. Rather they are convenient representation of systematic search procedures. From one point of view, a non-deterministic algorithm represents a method of thinking of computer programs as being in part governed not by efficient causes but by final causes".

As it is not possible to draw an abstract plan of situations or contexts for analyzing a fact situation off-hand as well as there exists no pre defined goal description, a legal reasoning system should have a mechanism that allows it to explore the solution space rather than a systematic search. This situation is similar to the situation that exists in Lenat's AM system [101]. As in the case of AM program use of AGENDAs offer a solution to maneuver such situations.

6.3.2 The AGENDA mechanism

As expressed by Elaine Rich in [102], an AGENDA is a list of tasks a system could perform. Associated with each task there will be usually two things: a list of reasons why the task is being proposed (often called justification) and a rating representing the over all weight of evidence suggesting that the task would be useful. One of the advantageous traits of the agenda mechanism is that though there exist many tasks on it no task need have any knowledge of how the other tasks work or what knowledge they contain. Another advantage of the agenda scheme is that it forces key steps in the interpretation process to be defined as solitary tasks, resulting in a highly-modular and cleanly structured system. Isolating key steps in the interpretation process, in turn, makes it easier to explain what the system is doing at any time.

6.3.2.1 TIDA's AGENDAS

The TIDA system employs two agendas. One of the agendas is known as the task agenda, referred to as the t-agenda, and the other agenda is known as the situation or context agenda, referred to as the s-agenda. The t-agenda is a list the members of which are also lists i.e., sub lists, containing tasks to be performed. The s-agenda is a list the members of which are atomic or symbol names, each one
referring to a context or a situation. Tasks are added to the t-agenda, in the form of a list, from concept or object service slots and as a result of change in the system's attention towards that concept. Contexts or situations are added to the s-agenda, in the form of a symbolic name, from a concept's NAME slot whenever the system's focus-of-attention shifts. Figure 6.1 shows the contents of both the agendas at a particular time point during the analysis of the case that is discussed in the following sections. In figure 6.1 square brackets have been employed to indicate a group of tasks corresponding to a specific context. Both situations as well the tasks are picked up from their respective agendas for execution in a Last-in First-out (LIFO) order. The agendas operate as stacks in which situations are added to the s-stack from top and tasks are added to the top of the top most sub list on the t-task. The names of the service slots represent tasks and whenever a concept or object is selected all its service slots are added to the t-agenda as a group, thus preserving the order in which they have been specified and are expected to be executed. This is important because

```
( [ (FIND-FACT 'SERVICE) (USERULES '(RL051 RL052)) ]
 [ (USERULES '(RL085 RL086)) ]
NIL
[ (UTILIZE 'PRINT-SUMMARY) ]
)  
```

`Task-agenda`

```
( 25B 25FFF1 25FFF CONSULT )
```

`Situation-agenda`

---

Figure 6.1 The TIDA agendas.
Please type in the CASE DETAILS sentence by sentence.

B. Ravichandran was appointed by the American International Banking Corporation on 4th November 1974 as a temporary clerk.

He was illegally absent from the service from 10th December 1974 to 18th January 1975 and from 2nd May 1975 to 25th June 1975.

He was retrenched from the service on 31st October 1975.

Now, the dispute is regarding the eligibility for the retrenchment compensation.

The names and dates processed sentences are....

NAME-1 WAS APPOINTED BY THE NAME-2 ON DATE-1 AS A TEMPORARY CLERK.
HE WAS ILLEGALLY ABSENT FROM THE SERVICE FROM DATE-2 TO DATE-3 AND FROM DATE-4 TO DATE-5.
HE WAS RETRENCHED FROM THE SERVICE ON DATE-6.
NOW THE DISPUTE IS REGARDING THE ELIGIBILITY FOR THE RETRENCHMENT COMPENSATION.

The time period processed sentences are....

NAME-1 WAS APPOINTED BY THE NAME-2 ON DATE-1 AS A TEMPORARY CLERK.
HE WAS RETRENCHED FROM THE SERVICE ON DATE-6.
NOW THE DISPUTE IS REGARDING THE ELIGIBILITY FOR THE RETRENCHMENT COMPENSATION.
The noun phrases processed sentences are....

NP-1 WAS APPOINTED BY NP-2 ON NP-3 AS NP-4 CLERK.
NP-5 WAS ILLEGALLY ABSENT FROM NP-6 PRD-1 AND PRD-2.
NP-7 WAS RETRENCHED FROM NP-8 ON NP-9.
NOW NP-10 IS REGARDING NP-11 FOR NP-12.

The problem-type is (RETRENCHMENT COMPENSATION).

[Here the goal or problem type has been identified. Depending upon the problem type an empty PROBLEM FORM, shown below, is built by using both CIVs and CDVs.]

Do you like to have a look at the PROBLEM FORM details ?

> yes

<table>
<thead>
<tr>
<th>NAME</th>
<th>DISPUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>*REGARDING</td>
<td>VALUE (RETRENCHMENT COMPENSATION)</td>
</tr>
<tr>
<td>RETRENCHMENT-DATE</td>
<td>VALUE NIX</td>
</tr>
<tr>
<td>NOTICE-GIVEN</td>
<td>VALUE NIX</td>
</tr>
<tr>
<td>EMPLOYEE</td>
<td>VALUE NIX</td>
</tr>
<tr>
<td>EMPLOYER</td>
<td>VALUE NIX</td>
</tr>
<tr>
<td>ENTRY-DATE</td>
<td>VALUE NIX</td>
</tr>
</tbody>
</table>

[In LISP implementations the use of NILs as property values cause ambiguity. As such NIXs have been used to mean "there is no value".]

Do you like to have a look at the DISPUTE details ?

> yes

[The slot names of the PROBLEM FORM are also procedure names. For example, the slot name entry-date also represents the procedure entry-date, the execution of which results in a value for the slot entry-date. After building an initial PROBLEM FORM the system collects all its slot names of which the property VALUE is NIX and executes them by treating them as procedures, thus filling the FORM. In case a NIX cannot be filled up by the system, it queries the user and gets one.]
[After filling the selected PROBLEM FORM facts are built and put on to the facts-file. The facts present on the facts-file, now, are (1) "The dispute is regarding the retrenchment compensation" and (2) "The notice was not given".

The system then passes through all the rules associated with the current context i.e., CONSULT. Here the system satisfies the rule RL009 and results in the selection of a new context, section 25FFF.

Whenever the system draws a conclusion it pauses, allowing the user to query the system how it concluded or to ask it to continue with the analysis.]

Rule RL009 is satisfied.

CONCLUSION: USE SECTION 25FFF.

> ?

Type in CONTINUE : for continuing the analysis.

HOW : to ask how the preceding conclusion was drawn.

> continue

[To work in the context 25FFF the system primarily needs the WORK-NATURE i.e., whether the establishment is engaged in building construction activity or not. Whenever such important facts are being extracted or built the system asks the user "Should I continue ?" to keep the user informed of what is going on.

In the present case the establishment being a banking...
corporation, the system, using its common sense knowledge, concludes that (3) "The nature of work is not building construction" and (4) "The employees work above the ground level".

Whenever such inferences are not possible the system proposes a suitable fact and asks the user whether he can assume that fact or its complement. At such points the user can ask the system why it needs the proposed fact. Also, if he is not sure of a definite answer because of the open texturdness of the legal concept, can type in a DONOTKNOW. Responding to a system's query with a DONOTKNOW results in the assumption of both the complementary facts one by one in turn and the generation of multiple results which will be conditional in nature. (For more details on DONOTKNOW see appendix 2.)

In the present analysis, at this point, there will be four facts on the facts-file. The system now passes through all the rules associated with the context 25FFF. Rule RL026 is satisfied and the system gets in to another new context 25FFF1]

No value for WORK-NATURE is available. Should I continue?

> yes

[A NO response here makes the system to ask the user to supply a value (i.e., fact) for the WORK-NATURE.]

Rule RL026 is satisfied.

CONCLUSION: USE SECTION 25FFF1.

> continue

No value for PCS is available. Should I continue?

> yes

[To work in the context 25FFF1 the system primarily needs PCS (the period of continuous service). This shifts the systems attention to another new context section 25B. Getting into a new context that is a section (as opposed to a part of a section) results in gathering of the new context's CDVs and appending them to the PROBLEM FORM, thus expanding the form. Execution of certain procedures like process-interrupt-information also expand the problem. Earlier, section 25PP and part 25PP1 were selected as new contexts as a result of certain facts on the facts-file satisfying certain rules. However, section
25B is activated by the context 25FFF1 directly and as such does not appear as a CONCLUSION.

In the present case getting into new context section 25B results in the subjoining of APTCAT (appointment category) and BREAK-IN-SERVICE slots to the PROBLEM FORM. NIXs, if any, will be taken care off as mentioned earlier.]

PROBLEM FORM expanded. Do you like to see it ?

> yes

<table>
<thead>
<tr>
<th>NAME</th>
<th>DISPUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>*REGARDING</td>
<td>VALUE (RETRENCHMENT COMPENSATION)</td>
</tr>
<tr>
<td>RETRENCHMENT-DATE</td>
<td>VALUE 31/10/75</td>
</tr>
<tr>
<td>NOTICE-GIVEN</td>
<td>VALUE NO</td>
</tr>
<tr>
<td>EMPLOYEE</td>
<td>VALUE (B RAVICHANDRAN)</td>
</tr>
<tr>
<td>EMPLOYER</td>
<td>VALUE (AMERICAN INTERNATIONAL BANKING CORPORATION)</td>
</tr>
<tr>
<td>ENTRY-DATE</td>
<td>VALUE 4/11/74</td>
</tr>
<tr>
<td>APTCAT</td>
<td>VALUE TEMPORARY</td>
</tr>
<tr>
<td>BREAK-IN-SERVICE</td>
<td>VALUE YES</td>
</tr>
</tbody>
</table>

No value for SERVICE is available. Should I continue ?

> yes

[Though the current context 25B primarily needs both SERVICE and WORK-LEVEL informations to carry on with the analysis, it is querying only regarding SERVICE as the fact pertaining to the WORK-LEVEL already exists on the facts-file. Execution of the procedure SERVICE adds the fact (5) "the service is interrupted" on to the facts-file. The system now passes through all the rules associated with the context 25B. Rule RL052 is satisfied and the system gets into another new context 25B2.]
Rule RL052 is satisfied.


> continue

[Here the PROBLEM FORM is expanded as a result of the execution of the procedure PROCESS-INTERRUPT-INFO.]

PROBLEM FORM expanded. Do you like to see it?

> yes

<table>
<thead>
<tr>
<th>NAME</th>
<th>DISPUTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>*REGARDING</td>
<td>VALUE (RETRENCHMENT COMPENSATION)</td>
</tr>
<tr>
<td>RETRENCHMENT-DATE</td>
<td>VALUE 31/10/75</td>
</tr>
<tr>
<td>NOTICE-GIVEN</td>
<td>VALUE NO</td>
</tr>
<tr>
<td>EMPLOYEE</td>
<td>VALUE (B RAVICHANDRAN)</td>
</tr>
<tr>
<td>EMPLOYER</td>
<td>VALUE (AMERICAN INTERNATIONAL BANKING CORPORATION)</td>
</tr>
<tr>
<td>ENTRY-DATE</td>
<td>VALUE 4/11/74</td>
</tr>
<tr>
<td>APTCAT</td>
<td>VALUE TEMPORARY</td>
</tr>
<tr>
<td>BREAK-IN-SERVICE</td>
<td>VALUE YES</td>
</tr>
<tr>
<td>NO-OF-ABSENTS</td>
<td>VALUE 2</td>
</tr>
</tbody>
</table>

Do you like to have a look at the absent details?

> yes

<table>
<thead>
<tr>
<th>NAME</th>
<th>ABSENT-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEG-DATE</td>
<td>VALUE 10/12/74</td>
</tr>
<tr>
<td>END-DATE</td>
<td>VALUE 18/1/75</td>
</tr>
<tr>
<td>DURATION</td>
<td>VALUE 39</td>
</tr>
<tr>
<td>LEGAL</td>
<td>VALUE NO</td>
</tr>
</tbody>
</table>
The total number of days worked is 268.

[As the service was interrupted the number of days worked during 12 calendar months preceding the event retrenchment is computed.

PCS-1 is a procedure that actually computes the total number of days worked. In the present case, the total number of days worked is 268. At this point another fact (6) "The number of days worked is greater than 239" is put on to the facts-file. With six facts on the facts-file the system, now, passes through all the rules associated with the context 25B2. Rule RL065 is satisfied as a result of which another fact (7) "The period of continuous service is greater than one year" is put on to the facts-file.]

Rule RL065 is satisfied.

CONCLUSION: THE PERIOD OF CONTINUOUS SERVICE IS GREATER THAN ONE YEAR.

> continue

[With seven facts on the facts-file the system once again passes through all the rules associated with the context 25B2 and finds no more rule getting satisfied. As such it attempts to pick up the next task in the current context and finds no task in it. The system, therefore, shifts back its attention to the earlier context i.e., 25B and attempts to execute the tasks that may be present in that context. However, in context 25B also there remains no more task to be taken care of and the system once again shifts back its attention to yet another earlier context, i.e., 25EFF1. Here, it finds a task. Execution of this task makes the system to pass through all the rules associated with the context]
25FFF1. Rule RL085 is satisfied as a result of which the fact (8) "The workman is eligible for compensation" is put on to the facts-file.

Rule RL085 is satisfied.

CONCLUSION: THE WORKMAN IS ELIGIBLE FOR COMPENSATION.

> continue

[With eight facts on the facts-file the system once again passes through all the rules associated with the context 25FFF1 and finds no more rule getting satisfied. Attempt to pick next task in the context 25FFF1 finds no more task and hence shifts its attention to an earlier context i.e., 25FFF. As seen from the agenda details there exists no task to be executed in this context. Hence the system once again shifts its attention to an earlier context i.e., CONSULT. In this context exists a task: PRINT-SUMMARY, the execution of which prints out the "facts of the case" as well as the summary of the consultation.]

The facts considered in the current run are...

(1) The dispute is regarding the retrenchment compensation.
(2) The notice was not given.
(3) The nature of work is not building construction.
(4) The employee works above the ground level.
(5) The service is interrupted.
(6) The number of days worked is greater than 239.
(7) The period of continuous service is greater than one year.
(8) The workman is eligible for the retrenchment compensation.
Summary of the consultation . . .

As per THE ID ACT
Since THE DISPUTE IS REGARDING RETRENCHMENT COMPENSATION
USE SECTION 25FFF.

Since THE ESTABLISHMENT IS A BANK/COLLEGE/SCHOOL
THE NATURE OF WORK IS NOT BUILDING CONSTRUCTION.

and
THE EMPLOYEE WORKS ABOVE THE GROUND LEVEL.

As per SECTION 25FFF
Since THE NATURE OF WORK IS NOT BUILDING CONSTRUCTION
USE SECTION 25FFF1.

As per SECTION 25B
Since THE SERVICE IS INTERRUPTED

As per SECTION 25B PART 2, LLJ(II)-306-1970
Since THE SERVICE IS INTERRUPTED
THE NUMBER OF DAYS DURING THE PRECEDING 12 CALENDAR MONTHS IS CALCULATED.

As per SECTION 25B PART 2, LLJ(I)-386-1981
Since THE NUMBER OF DAYS IN A PERIOD OF 12 CALENDAR MONTHS IS BEING CALCULATED
THE WORKMAN NEED NOT BE IN THE EMPLOYMENT THROUGHOUT THAT PERIOD.

As per SECTION 25B
Since THE ABSENCE WAS ILLEGAL
THE ABSENT DAYS ARE EXCLUDED FROM THE CONTINUOUS SERVICE CALCULATIONS.
As per SECTION 25B PART 1
Since THE NUMBER OF DAYS WORKED IS GREATER THAN 239
and THE WORKMAN WORKS ABOVE THE GROUND LEVEL
THE PERIOD OF CONTINUOUS SERVICE IS GREATER THAN ONE YEAR.

As per SECTION 25FFF
Since THE PERIOD OF CONTINUOUS SERVICE IS GREATER THAN ONE YEAR
and THE NOTICE WAS NOT GIVEN
THE WORKMAN IS ELIGIBLE FOR COMPENSATION.

Summary printing completed . . .

[After printing the summary of a complete run the system looks at the stack *all-facts-file* to examine whether it has any information stacked on it as a result of some DONOTKNOW response during the course of the just concluded as well as previous analysis. If present, the system informs the same to the user and allows him to generate additional answers, if required.]