

# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM OF A SECTION 7 (2) OF THE UNITED KINGDOM DATA PROTECTION ACT 1984\*

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## I. INTRODUCTION

The automatic generation of the Turbo Prolog code for a legal expert system is described in this article.<sup>1</sup> The interpretation of a statutory or other legal rule by one expert (or by the consensus of a group of experts) expressed in normalized form is the only input needed by the AUTOPROLOG program (along with Turbo Prolog) to automatically produce a computer program that is an expert system about that legal rule.

The expert system so produced draws inferences about a situation described by a user and supplies explanations of the grounds for those inferences in terms of the provisions of the statute. It also specifies some inferences that cannot be drawn. The user's description of the situation to be analyzed is provided to the program in the form of responses that the user gives to a series of questions that are constructed by the system.

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In illustrating how such an expert system is generated and used, the process for producing a normalized version of Section 7 (2) of the United Kingdom Data Protection Act 1984 is described first. An interpreter's analysis together with the NORMALIZER program is then used to construct a normalized version of Section 7 (2). That normalized version is, in turn used to construct an input file to AUTOPROLOG to produce a legal expert system on Section 7 (2). Finally, the responses of that legal expert system to several situations furnished by a hypothetical user are included to show how the system works.

## II. THE PROCESS OF NORMALIZING A LEGAL RULE

Obtaining the Final Normalized Version of some statutory or other legal rule is a three-step process. First, the analyst makes a Preliminary Analysis of the legal rule to produce constituent sentences of the normalized version and an expression of the logical relationships between those sentences. Second, the results of the Preliminary Analysis are used as input to the NORMALIZER program to make a NORMALIZER Run and obtain a tentative set of outputs in the form of arrow diagrams, outlines, and/or normalized versions. Finally, the analyst examines the results of the NORMALIZER Run to determine their adequacy and makes Repeated Analyses and NORMALIZER Runs until a satisfactory normalized version is obtained. This three-step process is represented in Figure 1.<sup>2</sup>

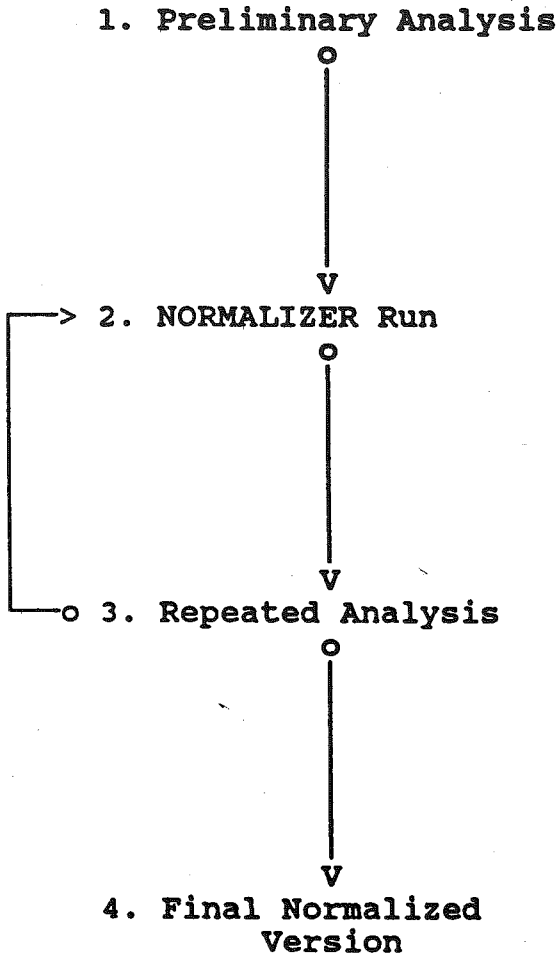
### A. Preliminary Analysis

The analyst begins the Preliminary Analysis by marking the sentences of the Present Version of the legal rule to determine the Marked Version, which, in turn, is used to determine the Present Version Structure (the set of words used to express the logical structure that relates those sentences to each other). This is straightforward and the results will tend to be highly uniform. This

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Figure 1

BRIEF SUMMARY OF PROCESS OF  
NORMALIZING A LEGAL RULE



beginning step and the rest of the Preliminary Analysis is represented in Figure 2.

Then, the analyst uses the Marked Version and the Present Version Structure to formulate Questions designed to determine the most appropriate structural interpretation of the legal rule. In doing this the analyst must be thinking ahead to the Normalized Version. The process at this stage is clearly becoming more artful, and the results produced by different analysts, likely to be more diverse.

Next, the analyst uses those Questions, along with the Marked Version and the Present Version Structure to determine the constituent sentences of the Normalized Version in the form of a Detailed Marked Version of the rule. Usually, this will require modifying the Marked Version by adding and deleting some words and phrases. This modification needs to be done with exquisite care to assure that inadvertent change in meaning does not occur.

At the next stage, some source of legal expertise is required in the process. It might be the analyst, using whatever sources are available, but preferably it is a legal expert in the subject matter of the rule. The analyst, along with the legal expert, uses the Present Version, the Questions, and the Detailed Marked Version to determine the most appropriate Answers to the Questions.

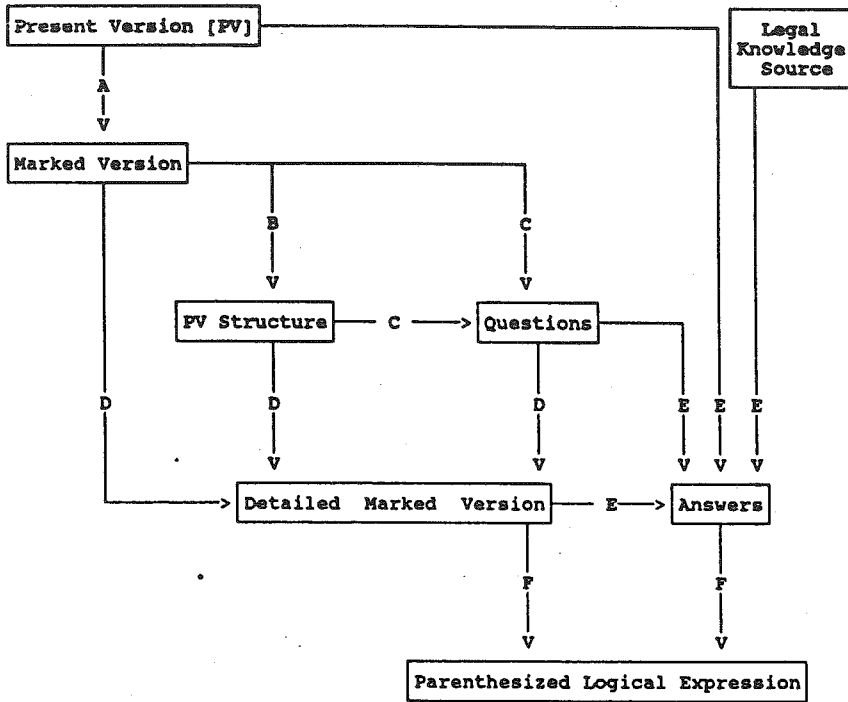
Finally, the analyst uses these Answers, along with the Detailed Marked Version, to determine the Parenthesized Logical Expression and complete the Preliminary Analysis. With the results of the Preliminary Analysis available (the Detailed Marked Version and the Parenthesized Logical Expression), the analyst is ready to make the NORMALIZER Run with the NORMALIZER program to generate the first tentative versions of Arrow Diagrams, Outlines, and Normalized Versions of the legal rule. Alternatively, the analyst can use these same results to generate a legal expert system of that rule by using the AUTOPROLOG system.



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Figure 2

## A. Preliminary Analysis



### ANALYST'S TASKS

- A Generate Marked Version [MV] from Present Version.
- B Generate Present Version Structure [FVS] from MV.
- C Generate Questions [Q] from MV and FVS.
- D Generate Detailed Marked Version [DMV] from MV, FVS, Q and NV.
- E Generate Answers [AN] from FV and Q.
- F Generate Parenthesized Logical Expression [PLE] from DMV and AN.

## **B. The NORMALIZER Run**

The production of Arrow Diagrams, Outlines, and Normalized Versions of the legal rule from the Detailed Marked Version and the Parenthesized Logical Expression is done entirely automatically by the NORMALIZER program. This is represented in Figure 3. These outputs can then be carefully examined by the analyst (and if necessary, the legal expert) to determine what modifications are needed for achieving a satisfactory Final Normalized Version.

## **C. Repeated Analysis**

If the Normalized Version is unsatisfactory in some respect, either the Detailed Marked Version or the Parenthesized Logical Expression (or possibly, both) will need to be modified. The analyst then does a somewhat richer version of the Preliminary Analysis of Step 1, richer in the sense that in determining the Questions to be asked, inputs to the prior NORMALIZER Run and the outputs obtained from that run, along with any modifications made to the Detailed Marked Version or Parenthesized Logical Expression, are considered in formulating the Questions for the Legal Knowledge Source. These additions to the Preliminary Analysis are represented by the pair of feedback loops to the Detailed Marked Version and Questions in Figure 4, where the entire process of Repeated Analysis is represented. This Repeated Analysis is done iteratively until a satisfactory Final Normalized Version is achieved.

A consolidated summary of the entire process of Normalizing a legal rule is represented in Figure 5.

Figure 3

B. NORMALIZER Run

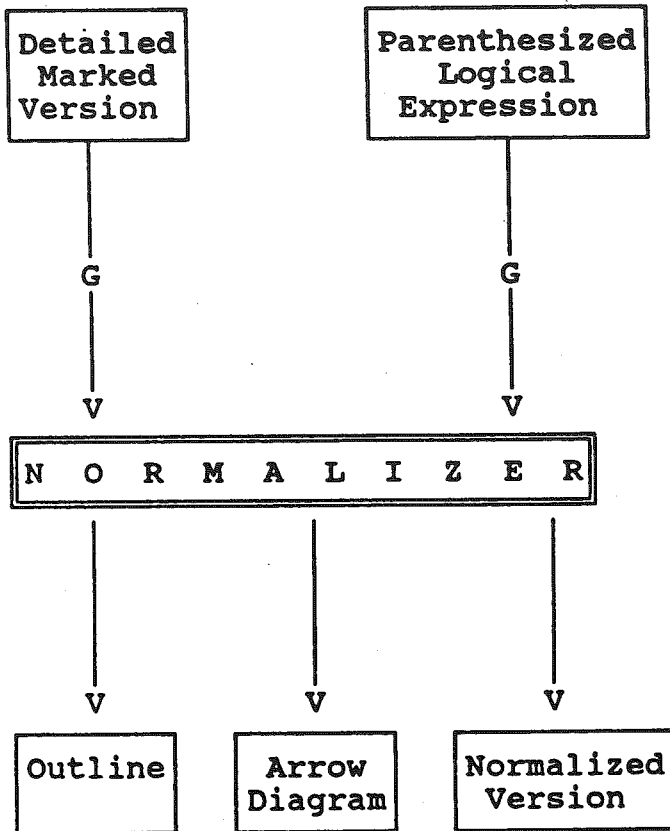
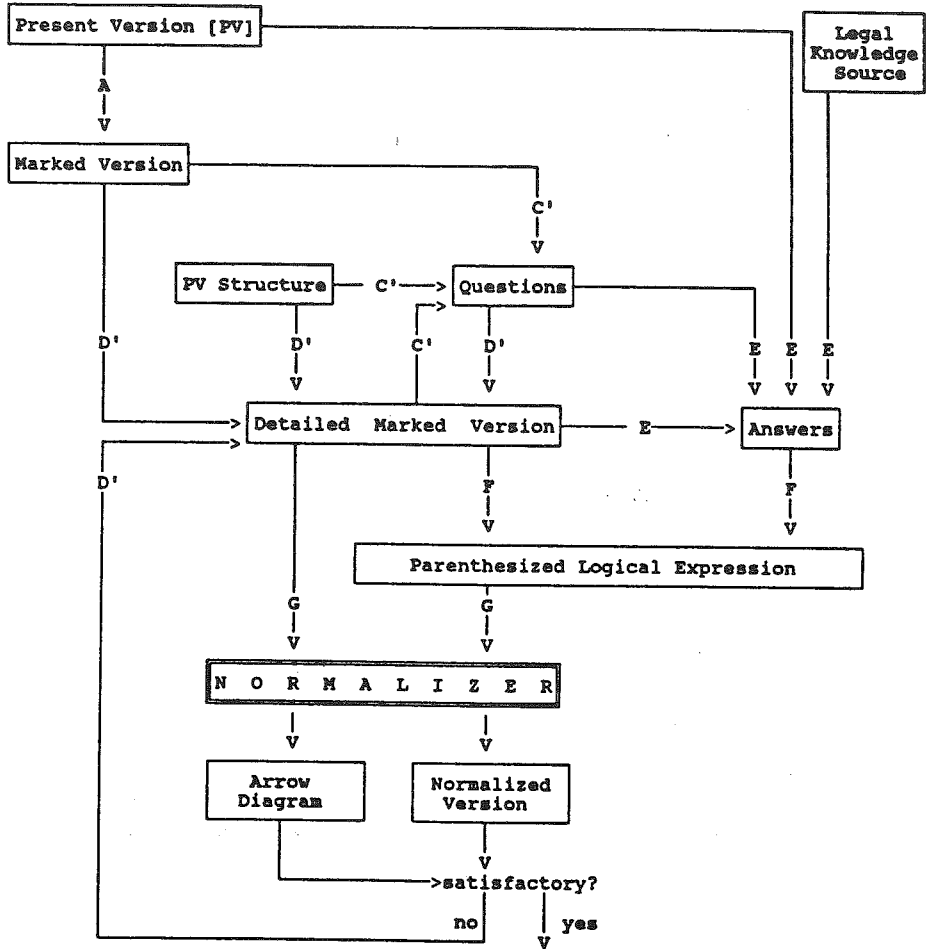


Figure 4  
C. Repeated Analysis



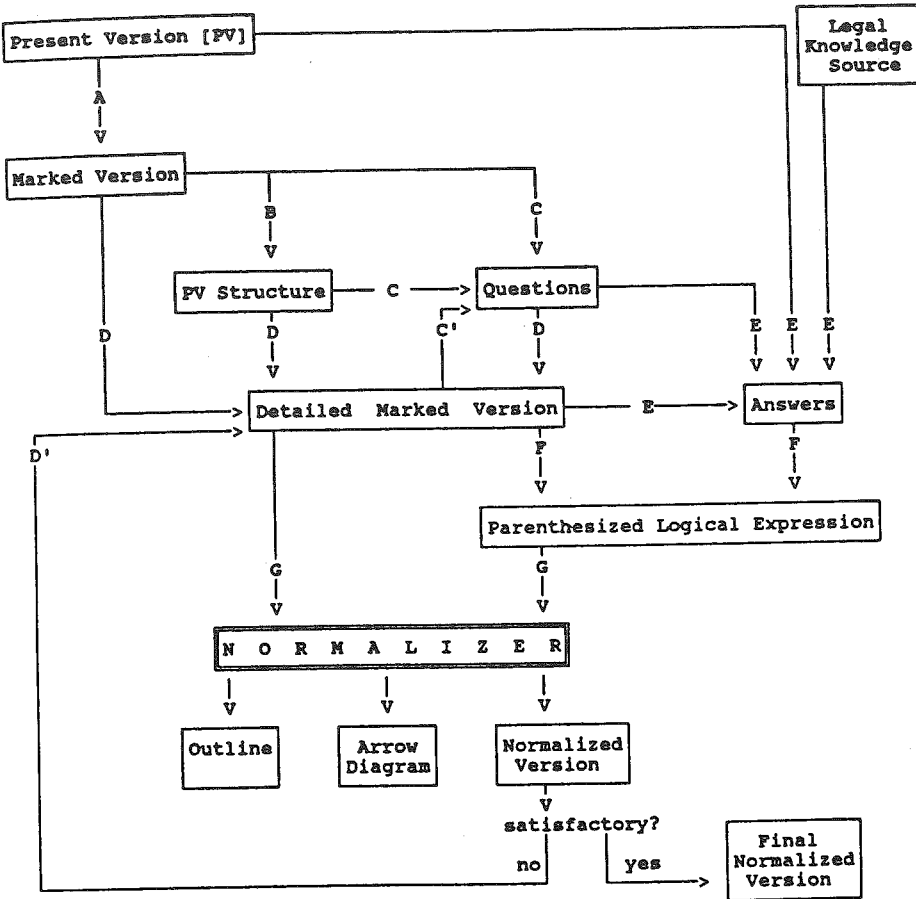
ANALYST'S TASKS

- D' Generate Detailed Marked Version [DMV] from MV, PVS, Q and NV.
- C' Generate Questions [Q] from MV, PVS, and DMV.
- E Generate Answers [AN] from PV and Q.
- F Generate Parenthesized Logical Expression [PLE] from DMV and AN.
- G Input DMV and PLE into NORMALIZER to get Normalized Version [NV].

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Figure 5

SUMMARY OF PROCESS OF NORMALIZING A LEGAL RULE



**ANALYST'S TASKS**

- A Generate Marked Version [MV] from Present Version.
- B Generate Present Version Structure [PVS] from MV.
- C Generate Questions [Q] from MV and PVS.
- C' Generate Questions [Q] from MV, PVS, and DMV.
- D Generate Detailed Marked Version [DMV] from MV, PVS, Q and NV.
- D' Generate Detailed Marked Version [DMV] from MV, PVS, Q and NV.
- E Generate Answers [AN] from FV and Q.
- F Generate Parenthesized Logical Expression [PLE] from DMV and AN.
- G Input DMV and PLE into NORMALIZER and generate Normalized Version [NV].

### **III. NORMALIZING SECTION 7 (2), UNITED KINGDOM DATA PROTECTION ACT 1984**

The three-step process of normalizing a legal rule described above can be used as a guide in normalizing Section 7 (2) of the United Kingdom Data Protection Act 1984.

#### **A. Preliminary Analysis of Section 7 (2)**

The sentences in the Present Version of the Data Protection Act 1984 are indicated by square brackets and labeled by letters to produce the Marked Version and Present Version Structure shown below.

#### **UNITED KINGDOM DATA PROTECTION BILL 1984**

##### **PRESENT VERSION**

Section 7. Acceptance and refusal of applications.

(2) The Registrar shall not refuse an application made in accordance with section 6 above unless --

(a) he considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate; or

(b) he is satisfied that the applicant is likely to contravene any of the data protection principles; or

(c) he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles.

#### **UNITED KINGDOM DATA PROTECTION BILL 1984**

##### **MARKED VERSION**

Section 7. Acceptance and refusal of applications.

(2) [a: the Registrar shall not refuse an application made in accordance with section 6 above] unless --

(a) [b: he considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate]; or

- (b) [c: he is satisfied that the applicant is likely to contravene any of the data protection principles];  
or
- (c) [d: he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles].

UNITED KINGDOM DATA PROTECTION BILL 1984  
PRESENT VERSION STRUCTURE

- a unless --
  - (a) b; or
  - (b) c; or
  - (c) d.

Having the Marked Version and the Present Version Structure available, the analyst next turns to formulating questions about how the logical structure is most appropriately interpreted. In doing so, he or she must pay meticulous attention to both the natural language words that are used in the Marked Version to express the content of the legal rule as well as those used to express the logical structure. The language used to express the between-sentence logical structure is emphasized in the Present Version Structure, but it is the Marked Version that must be examined for possible questions about within-sentence logical structure.

The legal rule expressed by the present language of Section 7 (2) consists of a result (or results) that is/are logically related to a set of conditions, some combination of which must be fulfilled before that result or results occur. The explicitly expressed result of Section 7 (2) is contained in its consequent, sentence-a.

[a: the Registrar shall not refuse an application made  
in accordance with section 6 above]

However, imbedded along with the result in sentence-a is a condition, and the only way that we can ask questions about the ambiguity of that condition's logical relationship to the result and express the different structural interpretations automatically, using the NORMALIZER program, is to modify

sentence-a and label the modified sentences that express the result and the imbedded condition.

[a1: the Registrar shall not refuse {an}<that>  
application>]

[a2: <an application is> made in accordance with  
section 6 above]

Deletions are indicated by enclosing the deleted part in curly braces { }.  
Additions are indicated by enclosing the added part in corner brackets < >.

The first question deals with the within-sentence grammatical structure of the Present Version of Section 7 (2) and the logical relationship between the condition and the result which it is appropriate to interpret that structure as expressing.

#### Q1. INTERPRETATION OF THE RELATIONSHIP OF THE IMBEDDED CONDITION TO THE RESULT

Which of the following is the most appropriate interpretation of the sentence:

the Registrar shall not refuse an application made in  
accordance with section 6 above

A or B or C?

Indicate your choice by circling the letter of the "missing part" of the following:

IF an application is made in accordance with section 6 above,  
THEN the Registrar shall not refuse that application

A) (just a period to end the statement; there is no  
"missing part")

B) BUT OTHERWISE, the Registrar may refuse that  
application.



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- C) **BUT OTHERWISE**, the Registrar shall refuse that application.

This expresses the question in a form that can be used to try to elicit the opinion of an expert (or group of experts) on this rule.

The second question deals with logical structure that is expressed by within-sentence language.

### Q2. INTERPRETATION OF "SHALL NOT"

Which of the following is the most appropriate interpretation of the sentence:

the Registrar shall not refuse that application

A or B or C?

- A) the Registrar **MUST NOT** refuse that application
- B) the Registrar does **NOT** have the **LEGAL POWER** to refuse that application
- C) the Registrar does **NOT** have the **LEGAL POWER** to refuse that application and **MUST NOT** engage in action that would exercise that **LEGAL POWER**, were he to have that **LEGAL POWER**

Thus, the logical structure explored by the first two questions is involved with within-sentence considerations: within-sentence grammatical structure by the first question and within-sentence language by the second one. The third question, on the other hand, deals with the logical relationship expressed by between-sentence structural language, namely the word "unless".

### Q3. INTERPRETATION OF "UNLESS"

Which of the following is the most appropriate interpretation of the overall statement in which the term "unless" connects the sentence:

the Registrar shall not refuse an application made in accordance with section 6 above

to the set of sentences:

- (a) he considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate; or
- (b) he is satisfied that the applicant is likely to contravene any of the data protection principles; or
- (c) he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles

A or B or C or D?

Indicate your choice by circling the letter of the "missing part" of the following:

IF

1. IT IS NOT SO THAT the Registrar considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate, AND
2. IT IS NOT SO THAT he is satisfied that the applicant is likely to contravene one or more of the data protection principles, AND
3. IT IS NOT SO THAT he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles.

THEN

4. he shall not refuse an application made in accordance with section 6 above
- A) . (just a period to end the statement; there is no "missing part")
- B) BUT OTHERWISE
5. IT IS NOT SO THAT he shall not refuse an application made in accordance with section 6 above.
- C) BUT OTHERWISE
5. he may refuse an application made in accordance with section 6 above.

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## D) BUT OTHERWISE

5. he shall refuse an application made in accordance with section 6 above.

With these 3 questions and the 3 alternative answers to Question 1, the 3 alternatives to Question 2, and the 4 to Question 3, there are a total of  $3 \times 3 \times 4 = 36$  different structural interpretations of Section 7 (2).

### THE 36 POSSIBLE STRUCTURAL INTERPRETATIONS

```

O1 A B C
O2 A B C
O3 A B C D

A ..... B ..... C ..... O1                O2
:         :         :         :         :
AAA AAB AAC AAD   BAA BAB BACBAD   CAA CAB CAC CAD   A
ABA ABB ABC ABD   BBA BBB BCBBD    CBA CBB CBC CBD   B
ACA ACB ACC ACD   BCA BCE BCCBCD    CCA CCB CCC CCD   C
:         :         :         :         :
A...B...C...D...O3
    
```

Although for purposes of showing how normalizing the different structural interpretations of a legal rule is related to the automatic generation of a legal expert system for that rule, only 36 alternative interpretations of Section 7 (2) are being considered here, there are many more such interpretations from the "shall not" interpretation and from the "shall" and "may" interpretations that arise from the interaction of the responses to Question 2 and Question 3.<sup>3</sup>

Having the first tentative version of the questions formulated, the analyst is ready to consider what changes, if any, are appropriate to make in the Marked Version to obtain the Detailed Marked Version that will indicate the constituent sentences of the Normalized Version. At this stage, by examining the Marked Version and the Present Version Structure the only changes that seem to be needed are the deletions from and additions to sentence-a to convert it into sentence-a1 and sentence-a2. When the analyst sees the output from the first NORMALIZER Run, it may become apparent that other changes are appropriate.

UNITED KINGDOM DATA PROTECTION BILL 1984  
DETAILED MARKED VERSION

Section 7. Acceptance and refusal of applications.

- (2) [a1: the Registrar shall not refuse <that application>]  
[a2: <an application is> made in accordance with section  
6 above] unless --
- (a) [b: he considers that the particulars proposed for  
registration or, as the case may be, the particulars  
that would result from the proposed alteration, will  
not give sufficient information as to the matters to  
which they relate]; or
  - (b) [c: he is satisfied that the applicant is likely to  
contravene any of the data protection principles]; or
  - (c) [d: he considers that the information available to  
him is insufficient to satisfy him that the applicant  
is unlikely to contravene any of those principles].

DETAILED MARKED VERSION STRUCTURE

- a1 if a2 unless --
- (a) b; or
  - (b) c; or
  - (c) d.

In constructing the Detailed Marked Version the analyst should also examine the Questions, as well as the Marked Version and the Present Version Structure. In this case when the analyst does so, it is apparent that in order to represent all of the various alternative interpretations of the logical structure presented in the Questions, it is necessary to add some additional sentences to those already in the tentative Detailed Marked Version. Each of the sentences added below correspond to one of the alternatives posed in the three Questions asked about how it is most appropriate to interpret the logical structure of Section 7 (2).

ADDITIONAL SENTENCES NEEDED FOR THE  
DETAILED MARKED VERSION

- [ona1: the Registrar **MUST NOT** refuse that application]  
[ona2: the Registrar does **NOT** have the **LEGAL POWER** to refuse

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that application]

[oa3: the Registrar does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER]

[oa1: the Registrar MUST refuse that application]

[oa2: the Registrar has the LEGAL POWER to refuse that application]

[oa3: the Registrar has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER]

[pa1: the Registrar MAY refuse that application]

[pa2: the Registrar has the LEGAL POWER to refuse that application]

[pa3: the Registrar has the LEGAL POWER to refuse that application and MAY engage in action that will exercise that LEGAL POWER]

The completion of the Detailed Marked Version provides the analyst with the first part of the input needed to make a NORMALIZER Run. To get the second part of the input needed (the Parenthesized Logical Expression) the analyst must get Answers to the three Questions about how it is most appropriate to interpret the logical structure of Section 7 (2). These Answers should reflect the best legal expertise that is available to the analyst. Along with the Detailed Marked Version, these Answers will determine the Parenthesized Logical Expression that produces the most appropriate interpretation.

For example the Answers A, C, and B to Questions Q1, Q2, and Q3 will determine Interpretation ACB. Similarly, Answers B, C, and C will determine Interpretation BCC, and other sets of answers will determine the other 34 interpretations.

There are only five defined between-sentence terms used to express logical structure in the Clear Normalized Form in which interpretations of Section 7 (2) will be expressed here. Those terms are:

AND, OR, NOT, IF..THEN, and BUT OTHERWISE

The symbols used to express these defined terms in the Parenthesized Logical Expression are, respectively:

&, |, ~, >, and BO

Each of the expressions below, aaa through ccd (with selected omissions), is a Parenthesized Logical Expression for one of the 36 structural interpretations of Section 7 (2). In the input file to the NORMALIZER program, the Detailed Marked Version appears in a section labeled DATA, and the Parenthesized Logical Expressions appear in a section labeled FORM.

```
aaa = ~b1&~c1&~d > (a2 > ona1)
aab = ~b1&~c1&~d > (a2 > ona1) BO ~(a2 > ona1)
aac = ~b1&~c1&~d > (a2 > ona1) BO (a2 > pa1)
aad = ~b1&~c1&~d > (a2 > ona1) BO (a2 > oa1)

aba = ~b1&~c1&~d > (a2 > ona2)
:
abd = ~b1&~c1&~d > (a2 > ona2) BO (a2 > oa2)

aca = ~b1&~c1&~d > (a2 > ona3)
:
acd = ~b1&~c1&~d > (a2 > ona3) BO (a2 > oa3)

baa = ~b1&~c1&~d > (a2 > ona1 BO pa1)
:
ccd = ~b1 & ~c1 & ~d & a2 > ona3 BO oa3
```

In the FORM section the analyst will also specify which of the various kinds of output of these interpretations are desired:

- the ARROW command for Arrow Diagrams
- the OUTLINE command for Outlines
- the NORM command for Normalized Versions

and a FileName.Ext where these outputs are to be stored. Requested below are (a) the Arrow Diagrams for the selected group of the 36 possible interpretations, (b) the Outline for Interpretation CCD, and (c) the Normalized Versions for Interpretation AAA (the interpretation that says the least) and Interpretation CCD (the one that says the most). It is also specified that each of these outputs are to be stored in the file UK-DPA.ANV.

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```
ARROW aaa 'UK-DPA.ANV'  
NORM aaa 'UK-DPA.ANV'  
ARROW aab 'UK-DPA.ANV'  
ARROW aac 'UK-DPA.ANV'  
ARROW aad 'UK-DPA.ANV'  
  
ARROW aba 'UK-DPA.ANV'  
:  
ARROW abd 'UK-DPA.ANV'  
  
ARROW aca 'UK-DPA.ANV'  
:  
ARROW acd 'UK-DPA.ANV'  
  
ARROW baa 'UK-DPA.ANV'  
:  
ARROW ccd 'UK-DPA.ANV'  
OUTLINE ccd 'UK-DPA.ANV'  
NORM ccd 'UK-DPA.ANV'
```

This completes the Preliminary Analysis, and the analyst is ready to make the first NORMALIZER Run.

## B. NORMALIZER Run of Section 7 (2)

With the Detailed Marked Version above in the DATA section and the Parenthesized Logical Expressions and output commands in the FORM section of the file used as input to the NORMALIZER program, the following Arrow Diagrams, Outline, and Normalized Versions are produced and stored in the UK-DPA.ANV file. (Captions have been added.)

SOME OUTPUTS OF NORMALIZER: SECTION 7 (2)  
ARROW DIAGRAMS, OUTLINES AND NORMALIZED VERSIONS

ARROW DIAGRAM OF INTERPRETATION AAA

>Nb—Nc—Nd—> >a2—> ona1

CLEAR NORMALIZED VERSION OF INTERPRETATION AAA

IF

1. IT IS NOT SO THAT

he considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate, AND

2. IT IS NOT SO THAT

he is satisfied that the applicant is likely to contravene any of the data protection principles, AND

3. IT IS NOT SO THAT

he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles,

THEN

4. IF

A. an application is made in accordance with section 6 above,

THEN

B. the Registrar MUST NOT refuse that application.

>Nb—Nc—Nd—>	>-a2—>	ona1	AAB
	o └>	N>-a2—>	ona1
>Nb—Nc—Nd—>	>-a2—>	ona1	AAC
	o └>	>-a2—>	pa1
>Nb—Nc—Nd—>	>-a2—>	ona1	AAD
	o └>	>-a2—>	oa1
>Nb—Nc—Nd—>	>-a2—>	ona2	ABA
:			:
>Nb—Nc—Nd—>	>-a2—>	ona2	ABD
	o └>	>-a2—>	oa2





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that would result from the proposed alteration,  
will not give sufficient information as to the  
matters to which they relate, AND

2. IT IS NOT SO THAT

he is satisfied that the applicant is likely to  
contravene any of the data protection principles,  
AND

3. IT IS NOT SO THAT

he considers that the information available to him  
is insufficient to satisfy him that the applicant  
is unlikely to contravene any of those principles,

THEN

4. the Registrar does NOT have the LEGAL POWER to  
refuse that application and MUST NOT engage in  
action that would exercise that LEGAL POWER, were he  
to have that LEGAL POWER,

BUT OTHERWISE,

5. the Registrar has the LEGAL POWER to refuse that  
application and MUST engage in action that will  
exercise that LEGAL POWER, AND

2. IF

A. an application is made which is not in accordance with  
section 6 above,

THEN

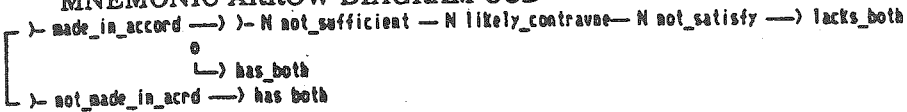
B. the Registrar has the LEGAL POWER to refuse that  
application and MUST engage in action that will  
exercise that LEGAL POWER.

With these outputs from the first NORMALIZER Run available for careful  
examination, the analyst is ready for the third step namely, Repeated Analysis.

### C. Repeated Analysis of Section 7 (2)

At this stage the analyst would also have available all 36 Mnemonic  
Arrow Diagrams like the one for Interpretation CCD below (which would have  
been generated by a process similar to the one exemplified above, except that  
the analyst has substituted mnemonic abbreviations for the short letter names  
in the Detailed Marked Version and the Parenthesized Logical Expression).

**MNEMONIC ARROW DIAGRAM CCD**



The analyst should carefully examine the Mnemonic Arrow Diagrams that include an indication of the substantive content of the 36 alternative interpretations to be sure that the content and logical structure of each of these interpretations is not unreasonable. This can more easily be done from the Mnemonic Arrow Diagrams that include content than from the short Arrow Diagrams that express only the bare logical structure. The Short Arrow Diagrams are handier to use when the analyst is interested only in matters of logical structure, for example, in exploring the logical equivalence of two interpretations or in transforming one interpretation into a logically equivalent, but perhaps simpler, one. But an analyst must be careful to supplement the using of Short Arrow Diagrams for purposes of such logical analysis with a careful examination of the full set of Mnemonic Arrow Diagrams to see if there are any of these that are identical with each other, because some such identities show up in the Mnemonic Arrow Diagrams that do not show up in the Short Arrow Diagrams.

The Detailed Marked Versions with mnemonic names for the sentences (rather than short letter names) that produce the Mnemonic Arrow Diagrams are also much more appropriate as input for the AUTOPROLOG system that produces expert systems than Detailed Marked Versions with letter names.

The careful analysis of the Arrow Diagrams may also reveal some equivalencies among the interpretations. In the case of these 36 alternative interpretations of Section 7 (2), it seems clear that each of these Short Arrow Diagrams is different from every other one. However, when the 36 Mnemonic Arrow Diagrams are examined carefully, it turns out that three pairs of them are identical with each other: ABC with ABD, BBC with BBD, and CBC with CBD. So, there are really only 33 different structural interpretations of Section 7 (2), rather than the 36 that there seemed to be at the outset.

The analyst should also carefully examine one or more of the Normalized Versions to detect awkward or otherwise inappropriate wording that needs to be changed by modifying the parts of the Detailed Marked Version which specify the constituent sentences of the Normalized Version. In the Normalized Version of Interpretation CCD of Section 7 (2) it is apparent that pronoun reference of sentences 1, 5, and 6 need to be switched. This is achieved by modifying the Detailed Marked Version as shown below (in which "he" is changed to "the Registrar" in sentence b, and "the Registrar" is changed to "he" in sentences ona3 and oa3, and for purposes of other interpretations, "the Registrar" is changed to "he" also in a1, ona1, ona2, oa1, oa2, pa1, pa2, and pa3).

{ } indicates deletions  
< > indicates additions

UNITED KINGDOM DATA PROTECTION BILL 1984  
DETAILED MARKED VERSION.2

Section 7. Acceptance and refusal of applications.

- (2) [a1: {the Registrar}<he> shall not refuse <that application>]  
[a2: <an application is> made in accordance with section 6 above] unless
- (a) [b: he considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate]; or
  - (b) [c: he is satisfied that the applicant is likely to contravene any of the data protection principles]; or
  - (c) [d: he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles].

ADDITIONAL SENTENCES NEEDED FOR  
DETAILED MARKED VERSION.2

[ona1: {the Registrar}<he> MUST NOT refuse that application]

## AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

[ona2: {the Registrar}<he> does NOT have the LEGAL POWER to refuse that application]  
[ona3: {the Registrar}<he> does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER]

[oa1: {the Registrar}<he> MUST refuse that application]  
[oa2: {the Registrar}<he> has the LEGAL POWER to refuse that application]  
[oa3: {the Registrar}<he> has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER]

[pa1: {the Registrar}<he> MAY refuse that application]  
[pa2: {the Registrar}<he> has the LEGAL POWER to refuse that application] [pa3: {the Registrar}<he> has the LEGAL POWER to refuse that application and MAY engage in action that will exercise that LEGAL POWER]

In continuing the Repeated Analysis the analyst may be led by the Arrow Diagram, Outline, or Normalized Version outputs of the first NORMALIZER Run to make changes in the Questions asked because of changes that have been made in the Detailed Marked Version. These changes in the Questions, in turn, might lead to changes in the Answers given, and they, in turn to changes in the Parenthesized Logical Expression. In this case involving Section 7 (2) no such additional changes seem needed, and so the next NORMALIZER Run can be made with just the modifications in the Detailed Marked Version that have been described.

### B.2 Second NORMALIZER Run of Section 7 (2)

In the second NORMALIZER Run the Arrow Diagram and outputs for Interpretations AAA and CCD of Section 7 (2) are the same, but the Normalized Versions are different. They read as follows:

#### NORMALIZED VERSION OF INTERPRETATION AAA

IF

1. IT IS NOT SO THAT

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the Registrar considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate, AND

2. IT IS NOT SO THAT

he is satisfied that the applicant is likely to contravene any of the data protection principles, AND

3. IT IS NOT SO THAT

he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles,

THEN

4. IF

A. an application is made in accordance with section 6 above,

THEN

B. he MUST NOT refuse that application.

NORMALIZED VERSION OF INTERPRETATION CCD

IF

1. IT IS NOT SO THAT

the Registrar considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate, AND

2. IT IS NOT SO THAT

he is satisfied that the applicant is likely to contravene any of the data protection principles, AND

3. IT IS NOT SO THAT

he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles, AND

4. an application is made in accordance with section 6 above,

THEN

5. he does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER,

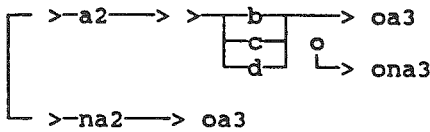
BUT OTHERWISE,

6. the Registrar has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER.

**C.2 Second Repeated Analysis of Section 7 (2)**

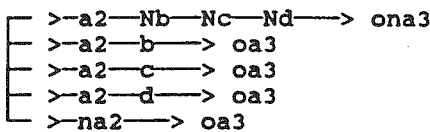
If the Legal Knowledge Source had determined that the Answers to the the Questions were CCD so that the best expertise available had resulted in Interpretation CCD as the most appropriate way to structurally interpret Section 7 (2), then the analyst might recognize that there is an equivalent interpretation which eliminates the negatives from the conditions specified by sentences namely, Interpretation CCD.2.

ARROW DIAGRAM OF INTERPRETATION CCD.2



Interpretations CCD and CCD.2 can be shown to be equivalent by transforming them into Elementary Normalized Form. They both transform into exactly the same set of elementary norms shown in the following Elementary Normalized Form Arrow Diagram CCD.elem.

ELEMENTARY ARROW DIAGRAM OF ALTERNATIVES CCD AND CCD.2



This simplification of Interpretation CCD by transforming it into and equivalent interpretation that is without the negatives in its conditions is a move that is not available for Interpretation AAA and 8 other of the interpretations. There is no equivalent simpler interpretation that is without the negatives in its conditions for these 9 interpretations (AAA, ABA, ACA, BAA, BBA, BCA, CAA, CBA, and CCA). For another 9 interpretations (those ending in B, i.e., ..B), there is a simpler equivalent interpretation for each of

them that is without the negations in the conditions, but they introduce an ordering arrangement that is unsatisfactory. For the NORMALIZER Program to automatically produce the Arrow Diagrams and other outputs that minimize the occurrences of negations in the expression of the conditions, in 17 other of the interpretations as well as in Interpretation CCD (in the 18 interpretations that end in C and D, i.e., ..C and ..D), the Parenthesized Logical Expressions in the FORM section of the input file to NORMALIZER needs to be changed to the following:

```

aaa = ~b&~c&~d > (a2 > ona1)
aab = ~b&~c&~d > (a2 > ona1) BO ~(a2 > ona1)
aac = b|c|d > (a2 > pa1) BO (a2 > ona1)
aad = b|c|d > (a2 > oa1) BO (a2 > ona1)

```

```

aba = ~b&~c&~d > (a2 > ona2)
:
abd = b|c|d > (a2 > oa2) BO (a2 > ona2)

```

```

aca = ~b&~c&~d > (a2 > ona3)
:
acd = b|c|d > (a2 > oa3) BO (a2 > ona3)

```

```

baa = ~b&~c&~d > (a2 > ona1) & (na2 > pa1)
:
ccd = (a2 > (b|c|d > oa3 BO ona3))) & (na2 > oa3)

```

```

ARROW aaa 'UK-DPA.ANV'
NORM aaa 'UK-DPA.ANV'
ARROW aab 'UK-DPA.ANV'
ARROW aac 'UK-DPA.ANV'
ARROW aad 'UK-DPA.ANV'

```

```

ARROW aba 'UK-DPA.ANV'
:
ARROW abd 'UK-DPA.ANV'

```

```

ARROW aca 'UK-DPA.ANV'
:
ARROW acd 'UK-DPA.ANV'

```

```

ARROW baa 'UK-DPA.ANV'
:
ARROW ccd 'UK-DPA.ANV'
OUTLINE ccd 'UK-DPA.ANV'

```



# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

## NORM ccd 'UK-DPA.ANV'

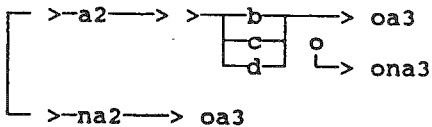
After making the required changes in the ..C and ..D interpretations of the input file, the analyst is ready for a third NORMALIZER Run.

### B.3 Third NORMALIZER Run of Section 7 (2)

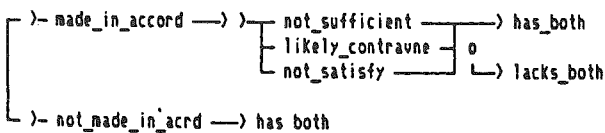
When the outputs from the third run of NORMALIZER for Section 7 (2) are subjected to the third Repeated Analysis, let us assume that they are found to be satisfactory. One of the 36 alternative interpretations constructed will be the appropriate one to represent in a legal expert system on Section 7 (2) that can be automatically constructed by the AUTOPROLOG system from the same sort of input file that is used to produce the normalized version of that interpretation by NORMALIZER.

For the sake of illustrating the relationship between the various forms of normalized inputs and outputs and their corresponding legal expert systems, let us assume that the selected most appropriate interpretation of Section 7 (2) is the one that (in some sense) says the most Interpretation CCD. The 2 Arrow Diagrams, the two corresponding Outlines, and Normalized Version of this Interpretation CCD are presented below.

#### CLEAR SHORT ARROW DIAGRAM OF CCD



#### CLEAR MNEMONIC ARROW DIAGRAM OF CCD



CLEAR SHORT OUTLINE OF CCD

1. IF  
A. a2,  
THEN  
B. IF  
1) b, OR  
2) c, OR  
3) d,  
THEN  
4. oa3,  
BUT OTHERWISE,  
5. ona3, AND
2. IF  
A. na2,  
THEN  
B. oa3.

CLEAR MNEMONIC OUTLINE OF CCD

1. IF  
A. made in accord,  
THEN  
B. IF  
1) not sufficient, OR  
2) likely contravne, OR  
3) not satisfy,  
THEN  
4. has both,  
BUT OTHERWISE,  
5. lacks both, AND
2. IF  
A. not made in acrd.  
THEN  
B. has both.

CLEAR NORMALIZED VERSION OF CCD

1. IF  
A. an application is made in accordance with section 6  
above,  
THEN  
B. IF  
1) he considers that the particulars proposed for  
registration or, as the case may be, the particulars  
that would result from the proposed alteration, will  
not give sufficient information as to the matters to

## AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

- which they relate, OR
- 2) he is satisfied that the applicant is likely to contravene any of the data protection principles, OR
  - 3) he considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles,
- THEN
4. the Registrar has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER,
- BUT OTHERWISE,
5. the Registrar does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER, AND
2. IF
- A. an application is made which is not in accordance with section 6 above,
- THEN
- B. the Registrar has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER.

## IV. AUTOMATIC GENERATION OF LEGAL EXPERT SYSTEMS

At present only one of the 36 alternative structural interpretations of Section 7 (2) can be embodied in the legal expert system to be created by the AUTOPROLOG system. The one selected as appropriate after viewing the 36 MNEMONIC ARROW DIAGRAMS of Section 7 (2) shown in Appendix A is Interpretation CCD.

### A. AUTOPROLOG on Normalized Version of Section 7 (2)

To generate the legal expert system for Section 7 (2) an input file to the AUTOPROLOG system must be constructed. This file will consist of three parts: (a) a title, (b) the logical structure of Interpretation CCD of Section 7 (2) that was specified to construct the Mnemonic Arrow Diagram of that interpretation, and (c) the constituent sentences of the Normalized Version of

Section 7 (2) that were specified in its Detailed Marked Version. This input file, which is called SECTION7.INP here, is reproduced below.

SECTION7.INP

UNITED KINGDOM DATA PROTECTION ACT, SECTION 7 (2)

Interpretation by John Q. Expert

World University Law School

(made\_in\_accord  
> (not\_sufficient | likely\_contravne | not\_satisfy  
> has\_both  
BO lacks\_both))  
&  
(not\_made\_in\_acrd > has\_both)

UNITED KINGDOM DATA PROTECTION BILL 1984  
DETAILED MARKED VERSION

Section 7. Acceptance and refusal of applications.

(2) [shall\_not\_refuse: the Registrar shall not refuse <that application>] [made\_in\_accord: <an application is> made in accordance with section 6 above] unless --

(a) [not\_sufficient: the Registrar considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate]; or

(b) [likely\_contravne: the Registrar is satisfied that the applicant is likely to contravene any of the data protection principles]; or

(c) [not\_satisfy: the Registrar considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles].

ADDITIONAL SENTENCES NEEDED FOR THE  
DETAILED MARKED VERSION

[not\_made\_in\_acrd: <an application is> made which is not in accordance with section 6 above] unless --

[lacks\_both: the Registrar does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER]

[has\_both: the Registrar has the LEGAL POWER to refuse

## AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

that application and MUST engage in action that will exercise that LEGAL POWER]

The analyst can then use SECTION7.INP as an input file to the AUTOPROLOG program, which will produce as output a Turbo Prolog program in a file that is entitled SECTION7.PRO. When this program is compiled with Turbo Prolog, a legal expert system is generated in a file called SECTION7.EXE. Anybody who wishes to consult this legal expert system can issue the command SECTION7 to run the program.

### B. Sample Consultations with SECTION7

The legal expert system for Interpretation CCD of Section 7 (2) of the United Kingdom Data Protection Act 1984 has been produced automatically as described above. When a user consults it, SECTION7 generates questions to which the user responds to describe the situation that he or she is seeking advice about. These questions are based on the constituent sentences of the Normalized Version of Interpretation CCD of Section 7 (2). Each of these questions at present must be answered YES, NO, or UNKNOWN. As soon as the user has provided enough information about the situation for SECTION7 to draw an inference, the system will do so and notify the user as the interrogation proceeds. When the user has provided all of the information from which inferences can be drawn by SECTION7, it will terminate the interview and provide a summary of the situation described by the user's responses to the questions asked. SECTION7 will also provide a summary of all of the inferences that can be drawn in the situation described and the reasons why such inferences can be drawn. In addition, SECTION7 will indicate which of the possible results of the application of Section 7 (2) cannot be inferred in the situation described. This process can be repeated as often as the user wishes to test various hypothetical variations of the situation being analysed. An audit trail of each of the "runs" of SECTION7 is recorded in a file called SECTION7.TRA. A pair of runs of SECTION7 is presented below.

Layman E. ALLEN and Charles S. SAXON

LEGAL EXPERT SYSTEMS GENERATED FROM  
INTERPRETATIONS OF LEGAL RULES BY LEGAL EXPERTS

Generated with the AUTOPROLOG Program  
by Layman E. Allen and Charles S. Saxon

The version of the AUTOPROLOG Program that was used to generate this Legal Expert System was developed by Allen and Saxon on a research grant from the National Center for Automated Information Research (NCAIR).

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Trace of run done on 3/18/1988 at 0:32:50

UNITED KINGDOM DATA PROTECTION ACT, SECTION 7 (2)  
Interpretation by John O. Expert  
World University Law School

Answer the questions below on the basis of the situation that you are analyzing. Please enter Y (for YES), N (for NO) or U (for UNKNOWN).

Each of the sentences that states a question below will be preceded by an abbreviation of that sentence. Each abbreviation will contain an underline (that is, '\_'). Sentences that state inferred results are abbreviated similarly.

For example:

ABBREVIATION                      SENTENCE

result\_is\_harsh                      The result in this case is harsh upon the defendant.

made\_in\_accord?

In the situation that you are analyzing is it the case that an application is made in accordance with section 6 above?  
<Pick: (Y)es or (N)o or (U)known>                      y

not\_sufficient?

In the situation that you are analyzing is it the case that the Registrar considers that the particulars proposed for registration or, as the case may be, the particulars that would result from the proposed alteration, will not give sufficient information as to the matters to which they relate?  
<Pick: (Y)es or (N)o or (U)known>                      n

likely\_contravne?

In the situation that you are analyzing is it the case that the Registrar is satisfied that the applicant is likely to contravene any of the data protection principles?  
<Pick: (Y)es or (N)o or (U)known>                      n

not\_satisfy?

In the situation that you are analyzing is it the case that the Registrar considers that the information available to him is insufficient to satisfy him that the applicant is unlikely to contravene any of those principles?  
<Pick: (Y)es or (N)o or (U)known>                      n

INFERRED RESULT

lacks\_both

the Registrar does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER

# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

not\_made\_in\_acrd?

In the situation that you are analyzing is it the case that an application is made which is not in accordance with section 6 above?

<Pick: (Y)es or (N)o or (U)nknown> n

Based on the Interpretation by John Q. Expert of this provision and your responses given below to the questions asked:

QUESTIONS	RESPONSES
made_in_accord ?	y
not_sufficient ?	n
likely_contravne ?	n
not_satisfy ?	n
not_made_in_acrd ?	n

the following results can be inferred for the reasons given:

RESULT  
REASON(S)

The result -- lacks\_both --  
can be inferred for the following reason(s):  
made\_in\_accord,  
NOT not\_sufficient,  
NOT likely\_contravne, and  
NOT not\_satisfy

On the basis of the same interpretation and the same responses none of the following results can be inferred:

RESULT(S) THAT CANNOT BE INFERRED

has\_both

The summary of a second run of SECTION7 below illustrates that if the user enters a contradictory description of the situation, this legal expert system will generate contradictory inferences, alerting the user that something is amiss in the description of the situation.

Based on the Interpretation by John Q. Expert of this provision and your responses given below to the questions asked:

QUESTIONS	RESPONSES
made_in_accord ?	y
not_sufficient ?	n
likely_contravne ?	n
not_satisfy ?	n
not_made_in_acrd ?	y

the following results can be inferred for the reasons given:

RESULT  
REASON(S)

The result -- lacks\_both --  
can be inferred for the following reason(s):  
made\_in\_accord,  
NOT not\_sufficient,  
NOT likely\_contravne, and  
NOT not\_satisfy

The result -- has\_both --  
can be inferred for the following reason(s):  
not\_made\_in\_acrd

On the basis of the same interpretation and the same responses  
none of the following results can be inferred:

RESULT(S) THAT CANNOT BE INFERRED

The fact that nothing is listed under RESULT(S) THAT CANNOT BE INFERRED is to be interpreted as indicating that there are no possible results of the application of Section 7 (2) that cannot be inferred in this situation. And the abbreviations under RESULT(S) in the part that shows what can be inferred indicate that in the contradictory situation described the Registrar both

- (1) has the LEGAL POWER to refuse that application and MUST engage in action that will exercise that LEGAL POWER, and
- (2) the Registrar does NOT have the LEGAL POWER to refuse that application and MUST NOT engage in action that would exercise that LEGAL POWER, were he to have that LEGAL POWER.

Legal expert systems like SECTION7, generated automatically from normalized interpretations of legal rules, permit users to see the effects of application of those interpretations to actual as well as hypothetical situations. This capability is likely to be fruitful in a variety of settings throughout the legal process. We intend to explore in some detail its potentialities for improving the original drafting of statutes and other legal rules.

### C. Future Extensions of AUTOPROLOG

In its present form AUTOPROLOG automatically generates a legal expert system for only a single rule. For practical use, this will need to be generalized for use with sets of rules that are interrelated with each other. AUTOPROLOG will need to be generalized in a way that facilitates the incremental development of sets of rules in both breadth and depth.

The current version of AUTOPROLOG generates an expert system that is only one level deep; there are no interpretations of either the content or the



## AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

structure of the conditions or results of the rule that defines the expert system. The only responses that a user can give to the questions asked by the system now are: YES, NO, and UNKNOWN. There is currently no assistance provided by the expert system to help the user determine the appropriate response for the problem being analyzed. The wealth of expert advice available in most areas of law needs to be made available in depth in a way that does not overwhelm the user -- in a way that enables the user to obtain all (but only) the assistance needed.

Future versions of AUTOPROLOG under development will aim to generalize the system to handle sets of interrelated rules, provide assistance to a user to help determine the appropriate response to a question, and enable users to describe the various aspects of the situation in probabilistic terms. When they can allow probabilistic input, the legal expert systems automatically generated by the AUTOPROLOG system will provide inferences in probabilistic terms.

### V. CONCLUSION

The AUTOPROLOG system automatically generates expert systems from normalized legal rules. It is the first system to automatically generate legal expert systems in this way, and it may well be the the first system to automatically generate them in any way. The potential impact upon legal thought of such facility in automatically constructing inference systems is bounded only by the current lack of widespread understanding among legal scholars and practitioners in law of the fruitful intercourse possible between computer technology and legal systems. But the blowing in the wind that can be sensed is not just the edge of technology cutting ... .

-- Notes --

1. The research and development of AUTOPROLOG has been supported in part by a grant from the National Center for Automated Information Retrieval (NCAIR). Copies of the software are available to legal expert system developers for the cost of reproducing, packaging, and shipping by writing to the authors at the University of Michigan Law School, Ann Arbor, MI 48109-1215.

2. For a more detailed account of the process of normalization and the features of the NORMALIZER program, see Layman E. Allen and Charles S. Saxon, Computer Aided Normalizing and Unpacking: Some Interesting Machine-Processable Transformations of Legal Rules, pp. 495-572 in COMPUTING POWER AND LEGAL REASONING (Edited by Charles Walter) West Publishing Company, 1985.

3. See Layman E. Allen and Charles S. Saxon, One Use of Computerized Instructional Gaming in Legal Education: To Better Understand the Rich Logical Structure of Legal Rules and Improve Legal Writing, 8 UNIVERSITY OF MICHIGAN JOURNAL OF LAW REFORM 386, 390-396 (1985).

# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

## Appendix A

### MNEMONIC ARROW DIAGRAMS FOR THE 3 ALTERNATIVE INTERPRETATIONS OF SECTION 7 (2)

AAA

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) must\_not\_refuse

AAB

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) must\_not\_refuse

o  
L) N)-made\_in\_accord- ) must\_not\_refuse

AAC

)-not\_sufficient- )-made\_in\_accord- ) may\_refuse

-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) must\_not\_refuse

AAD

)-not\_sufficient- )-made\_in\_accord- ) must\_refuse

-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) must\_not\_refuse

ABA

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) no\_legal\_power

ABB

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) no\_legal\_power

o  
L) N)-made\_in\_accord- ) no\_legal\_power

ABC

)-not\_sufficient- )-made\_in\_accord- ) has\_legal\_power

-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) no\_legal\_power

ABD

)-not\_sufficient- )-made\_in\_accord- ) has\_legal\_power

-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) no\_legal\_power

ACA

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) lacks\_both

ACB

)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) lacks\_both

o  
L) N)-made\_in\_accord- ) lacks\_both

ACC

)-not\_sufficient- )-made\_in\_accord- ) power\_and\_may\_ex

-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) lacks\_both

ACD

)-not\_sufficient- )-made\_in\_accord- ) has\_both

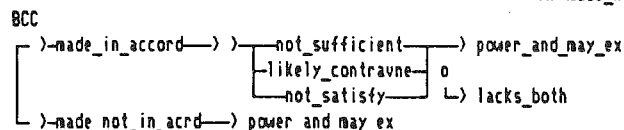
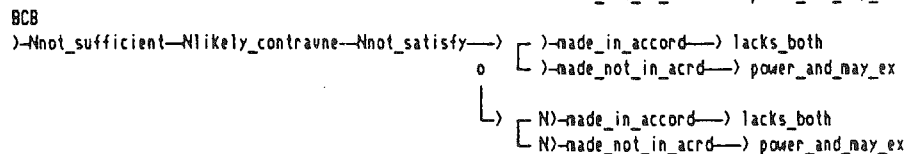
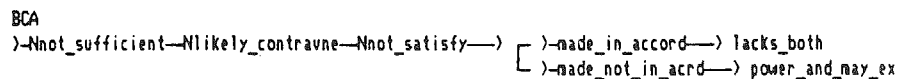
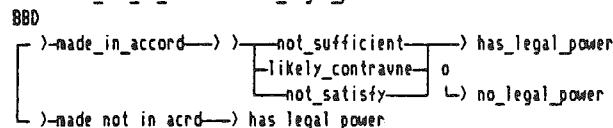
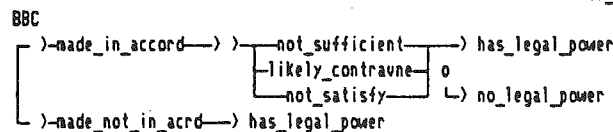
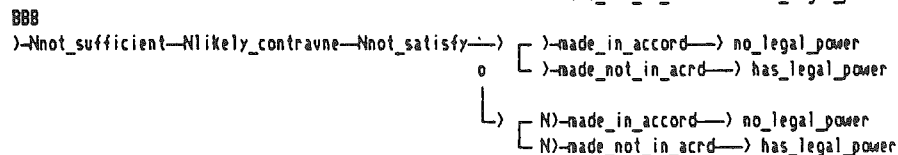
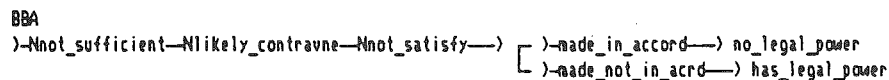
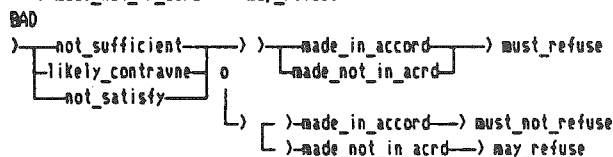
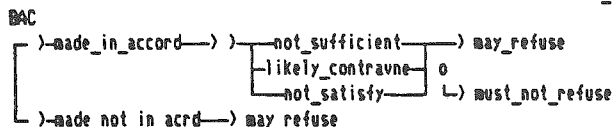
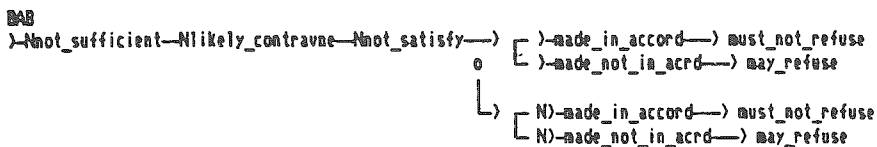
-likely\_contravne- o  
-not\_satisfy- L) )-made\_in\_accord- ) lacks\_both

BAA

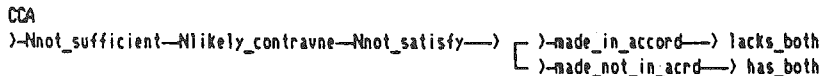
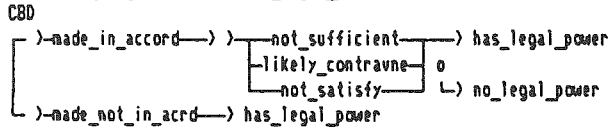
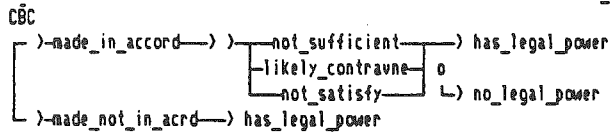
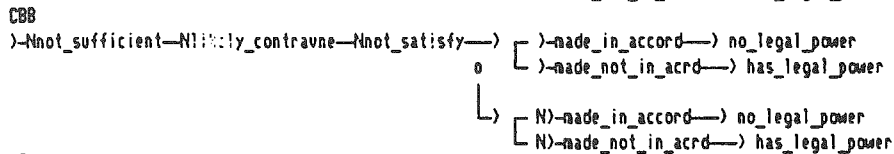
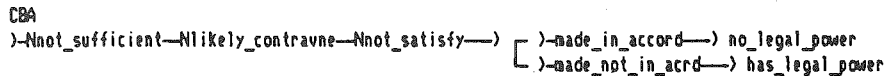
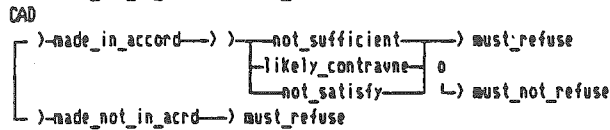
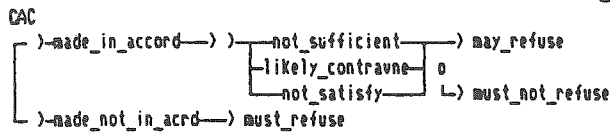
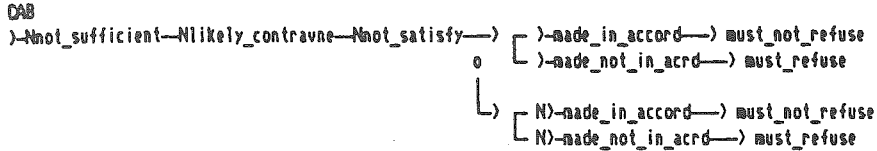
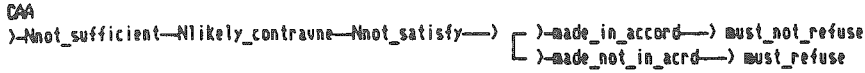
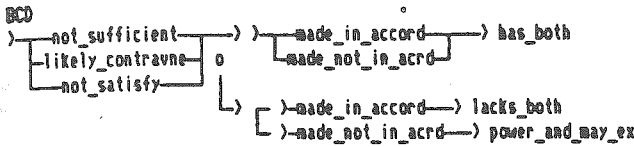
)-Nnot\_sufficient-Nlikely\_contravne-Nnot\_satisfy- )-made\_in\_accord- ) must\_not\_refuse

[ )-made\_not\_in\_acrd- ) may\_refuse

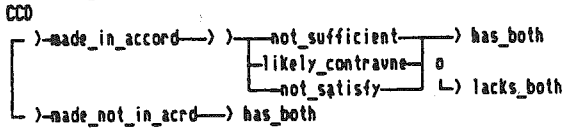
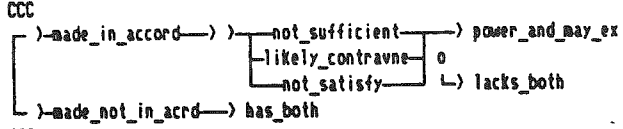
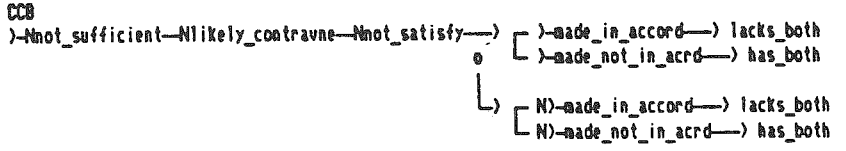
Layman E. ALLEN and Charles S. SAXON



# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM



Layman E. ALLEN and Charles S. SAXON



AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM

Appendix B

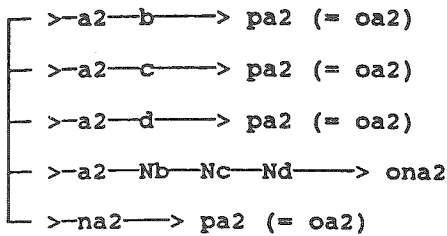
SHORT ARROW DIAGRAMS FOR THE 36  
ALTERNATIVE INTERPRETATIONS OF SECTION 7 (2)

$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona1$	AAA
$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona1$	AAB
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> N \>a2 \longrightarrow$	$ona1$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$pa1$	AAC
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona1$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$oa1$	AAD
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona1$	
$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona2$	ABA
$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona2$	ABB
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> N \>a2 \longrightarrow$	$ona2$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$pa2$	ABC
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona2$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$oa2$	ABD
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona2$	
$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona3$	ACA
$\>Nb-Nc-Nd \longrightarrow \>a2 \longrightarrow$	$ona3$	ACB
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> N \>a2 \longrightarrow$	$ona3$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$pa3$	ACC
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona3$	
$\begin{matrix} \text{b} \\ \text{c} \\ \text{d} \end{matrix} \longrightarrow \>a2 \longrightarrow$	$oa3$	ACD
$\quad \quad \quad \begin{matrix} \circ \\ \text{L} \end{matrix} \> \>a2 \longrightarrow$	$ona3$	
$\>Nb-Nc-Nd \longrightarrow \begin{matrix} \text{ } \\ \text{ } \\ \text{ } \end{matrix} \>a2 \longrightarrow$	$ona1$	BAA
$\quad \quad \quad \begin{matrix} \text{ } \\ \text{ } \\ \text{ } \end{matrix} \>na2 \longrightarrow$	$pa1$	





# AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM



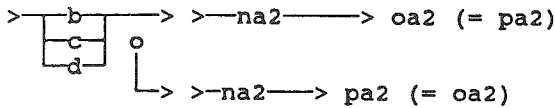
In Interpretation BBC the fifth of these elementary legal rules is expressed simply by

$$>-na2 \longrightarrow pa2 (= oa2)$$

that is

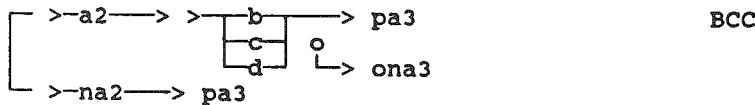
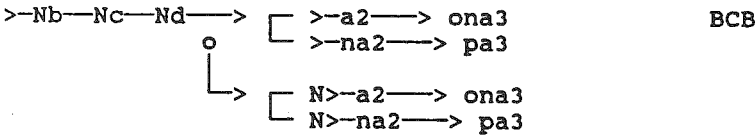
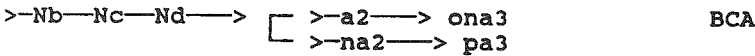
IF na2, THEN pa2 (which is equivalent to oa2)

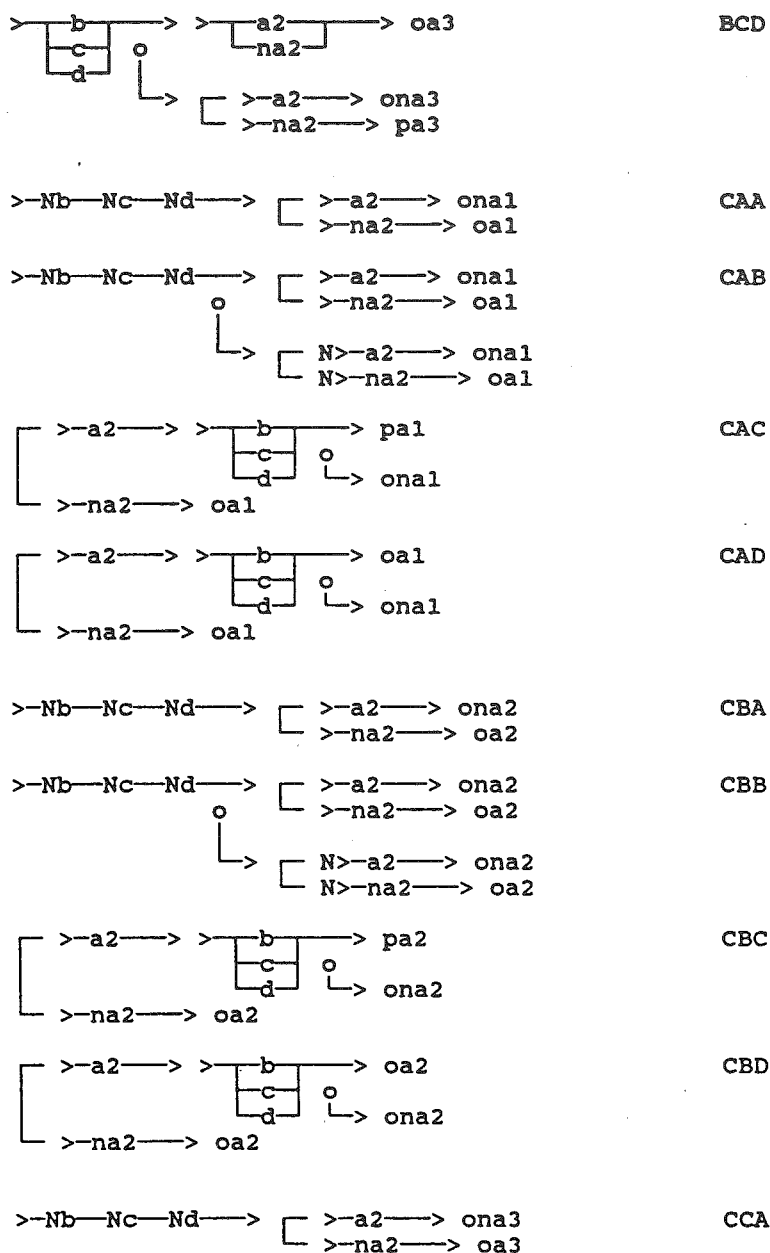
while in Interpretation BBD this fifth elementary legal rule is expressed in the following more complicated manner



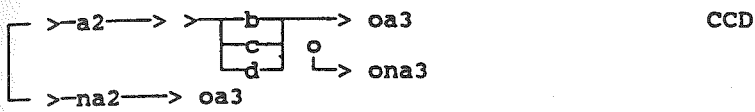
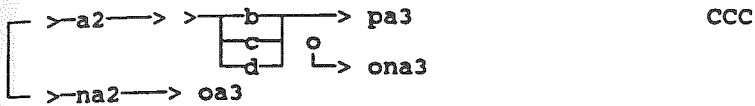
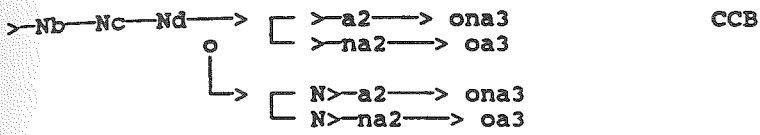
that is

IF b OR c OR d, THEN IF na2 THEN oa2  
 (where oa2 is equivalent to pa2),  
 BUT OTHERWISE, IF na2 THEN pa2  
 (where pa2 is equivalent to oa2).





AUTOMATIC GENERATION OF A LEGAL EXPERT SYSTEM



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