1991

Automatic Generation of a Legal Expert System

Layman E. Allen
University of Michigan Law School

Charles S. Saxon
Eastern Michigan University

Available at: https://repository.law.umich.edu/book_chapters/99

Follow this and additional works at: https://repository.law.umich.edu/book_chapters

Part of the Computer Law Commons, Legal Writing and Research Commons, and the Science and Technology Law Commons

Publication Information & Recommended Citation

This Book Chapter is brought to you for free and open access by the Faculty Scholarship at University of Michigan Law School Scholarship Repository. It has been accepted for inclusion in Book Chapters by an authorized administrator of University of Michigan Law School Scholarship Repository. For more information, please contact mlaw.repository@umich.edu.
INTRODUCTION

The use of the AUTOPROLOG system to generate automatically a legal expert system is described in this chapter. 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 system (which includes Turbo Prolog, the AUTOPRO program, and some data files) to produce automatically a computer program that is an expert system for that legal rule. The process for producing a legal expert system for Section 213.1 of the Model Penal Code, which deals with rape and related offenses, by using the AUTOPROLOG system is described and the resulting legal expert system is illustrated.

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.

In illustrating how such an expert system is generated and used, the process for producing a normalized version of Section 213.1 of the Model Penal Code is described first. An interpreter's analysis together with the NORMALIZER program is then used to construct a normalized version of Section 213.1. That normalized version is, in turn used to construct an input file to AUTOPROLOG.
to produce a legal expert system on Section 213.1. Finally, the responses of that legal expert system to several situations furnished by a hypothetical user are included to show how the system works. In this case, the interpretation being used is that of David L. Chambers of the University of Michigan Law School, who originally suggested Section 213.1 as a candidate to embody in a legal expert system.

The AUTOPROLOG system automatically generates expert systems from normalized legal rules. It is the first system to generate automatically legal expert systems in this way, and it may well be 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.

**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 16.1.²

**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 beginning step and the rest of the preliminary analysis are represented in figure 16.2.

The analyst then 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 are 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. The person pursuing this process 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.

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 expres-
Figure 16.2
Preliminary Analysis

The normalization process is done entirely automatically by the NORMALIZER program. This is represented in figure 16.3. The analyst, and if possible the legal expert, can then carefully examine the outputs to determine what modifications are needed for achieving a satisfactory final normalized version.

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 16.4, 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 16.5.

NORMALIZING SECTION 213.1 OF THE MODEL PENAL CODE

The three-step process of normalizing a legal rule described above can be used as a guide in normalizing Section 213.1 of the Model Penal Code.

Preliminary Analysis of Section 213.1

The sentences in the present version of Section 213.1 of the Model Penal Code are indicated by square brackets and labeled by letters to produce the marked version and present version structure shown in table 16.2.

Having the present version (table 16.1) and the marked version (table 16.2) 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 213.1 consists of a set of results, each of which are logically related to a set of conditions. Some combination of its related set of conditions must be fulfilled before a given result
Table 16.1
Section 213.1 of the Model Penal Code, Present Version

(1) Rape. A male who has sexual intercourse with a female not his wife is guilty of rape if:
   (a) he compels her to submit by force or by threat of imminent death, serious bodily injury, extreme pain or kidnapping, to be inflicted on anyone; or
   (b) he has substantially impaired her power to appraise or control her conduct by administering or employing without her knowledge drugs, intoxicants or other means for the purpose of preventing resistance; or
   (c) the female is unconscious; or
   (d) the female is less than 10 years old.

Rape is a felony of the second degree unless (i) in the course thereof the actor inflicts serious bodily injury upon anyone, or (ii) the victim was not a voluntary social companion of the actor upon the occasion of the crime and had not previously permitted him sexual liberties, in which cases the offense is a felony of the first degree.

(2) Gross Sexual Imposition. A male who has sexual intercourse with a female not his wife commits a felony of the third degree if:
   (a) he compels her to submit by any threat that would prevent resistance by a woman of ordinary resolution; or
   (b) he knows that she suffers from a mental disease or defect which renders her incapable of appraising the nature of her conduct; or
   (c) he knows that she is unaware that a sexual act is being committed upon her or that she submits because she mistakenly supposes that he is her husband.

occurs by virtue of the legal rule. In most statutes the expression of the logical relationships among the various parts of the legal rule state is highly ambiguous. Section 213.1 is unusual in this regard. By our current reading, Section 213.1 contains only one structural ambiguity.

NINE SOURCES OF STRUCTURAL AMBIGUITY

There are at least nine sources of structural ambiguity in the natural prose used to express legal rules; these are summarized in table 16.3. There are four sources of expressed and unexpressed grouping and other structural ambiguity between sentences, four corresponding sources of expressed and unexpressed grouping and other structural ambiguity within sentences, and a fifth source of within-sentence structural ambiguity resulting from grammatical structure.

The only question about the logical structure of Section 213.1 involves the second between-sentence type of structural ambiguity—unexpressed relationships between one of the section’s results and some of the conditions that can, perhaps, be implied from the content of that result and those conditions. The
Table 16.2
Section 213.1 of the Model Penal Code, Marked Version

(1) Rape. (a: a male who has sexual intercourse with a female not his wife is guilty of rape) if:
   (a) (b: he compels her to submit by force or by threat of imminent death, serious bodily injury, extreme pain or kidnapping, to be inflicted on anyone); or
   (b) (c: he has substantially impaired her power to appraise or control her conduct by administering or employing without her knowledge drugs, intoxicants or other means for the purpose of preventing resistance); or
   (c) (d: the female is unconscious); or
   (d) (e: the female is less than 10 years old).

   (f: rape is a felony of the second degree) unless (i) (g: in the course thereof the actor inflicts serious bodily injury upon anyone), or (ii) (h: the victim was not a voluntary social companion of the actor upon the occasion of the crime and had not previously permitted him sexual liberties), in which cases (i: the offense is a felony of the first degree).

(2) Gross Sexual Imposition. (j: a male who has sexual intercourse with a female not his wife commits a felony of the third degree) if:
   (a) (k: he compels her to submit by any threat that would prevent resistance by a woman of ordinary resolution); or
   (b) (l: he knows that she suffers from a mental disease or defect which renders her incapable of appraising the nature of her conduct); or
   (c) (m: he knows that she is unaware that a sexual act is being committed upon her or that she submits because she mistakenly supposes that he is her husband).

BETWEEN-SENTENCE LOGICAL STRUCTURE OF MARKED VERSION

(1) a if: (a) b; or (b) c; or (c) d; or (d) e. f unless (i) g, or (ii) h, in which cases i.

(2) j if: (a) k; or (b) l; or (c) m.

question has to do with whether rape and gross sexual imposition are independent crimes according to Section 213.1 that can be committed by a male by virtue of the same set of acts. There is nothing explicitly stated in Section 213.1 that requires nonfulfillment of the conditions requisite for rape before a male can be held guilty of committing gross sexual imposition, but it certainly is imaginable that it is more appropriate to so interpret Section 213.1. The argument for treating gross sexual imposition and rape as mutually exclusive is that the very same section does exactly that for two other crimes dealt with in the section. Rape of the first degree is clearly and explicitly made mutually exclusive from rape of the second degree. So why should gross sexual imposition be regarded as appropriate to treat differently? The answer is that Section 213.1 explicitly provides for rape-1 and rape-2 to be treated as mutually exclusive, and nothing is said about making gross sexual imposition mutually exclusive from rape.
Table 16.3
Nine Sources of Structural Ambiguity

<table>
<thead>
<tr>
<th>NINE SOURCES OF STRUCTURAL AMBIGUITY</th>
<th>BETWEEN-SENSE STRUCUTRAL AMBIGUITY</th>
<th>WITHIN-SENTENCE STRUCTURAL AMBIGUITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Expressed Structural Terms</td>
<td>Expressed Structural Terms</td>
<td>Unexpressed Structural Relationships</td>
</tr>
<tr>
<td>2 Unexpressed Structural Relationships</td>
<td>between parts of sentences, but</td>
<td>between parts of sentences, but</td>
</tr>
<tr>
<td></td>
<td>implied from content of those</td>
<td>implied from content of those</td>
</tr>
<tr>
<td></td>
<td>results and conditions</td>
<td>results and conditions</td>
</tr>
<tr>
<td>3 Unexpressed Grouping Relationships</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>among conditions or among</td>
<td></td>
</tr>
<tr>
<td></td>
<td>results</td>
<td></td>
</tr>
<tr>
<td>4 Expressed Grouping Relationships</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>among conditions or among</td>
<td></td>
</tr>
<tr>
<td></td>
<td>results by</td>
<td></td>
</tr>
<tr>
<td></td>
<td>punctuation (or possibly by</td>
<td></td>
</tr>
<tr>
<td></td>
<td>indentation) that are in conflict</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with relationships implied from</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the content of those conditions or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>results</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Grammatical Structure</td>
<td></td>
</tr>
</tbody>
</table>

Although only these two alternative interpretations of Section 213.1 are being considered here 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, there are frequently many more interpretations from ambiguities that arise from expressed and unexpressed structural relationships.

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 (table 16.2) to obtain the detailed marked version (table 16.4) that will indicate the constituent sentences of the normalized version. Additions to the marked version will be indicated by enclosing the added parts in corner brackets (< >). Deletions will be indicated by enclosing the deleted parts in curly braces { }. Changes in capitalization will be made without indicating the added and deleted letters. The changes made to obtain the detailed marked version were: (1) to simplify some sentences; (2) to export some conditions out of sentences that express results; and (3) to achieve grammatical correctness and clear references in the resulting normalized version.

The completion of the detailed marked version (table 16.4) 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 an answer to the question about how it is most appropriate to interpret the logical structure of Section 213.1. The answers to any questions asked about the logical structure of a legal rule 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 structural interpretation. When the analyst sees the output
Table 16.4
Section 213.1 of the Model Penal Code, Detailed Marked Version

(1) Rape. [a1: a male (who) has sexual intercourse with a female not his wife] [a2: <he> is guilty of rape] if:
   (a) [b: he compels her to submit by force or by threat of imminent death, serious bodily injury, extreme pain or kidnapping, to be inflicted on anyone]; or
   (b) [c: he has substantially impaired her power to appraise or control her conduct by administering or employing without her knowledge drugs, intoxicants or other means for the purpose of preventing resistance]; or
   (c) [d: the female is unconscious]; or
   (d) [e: the female is less than 10 years old].

   [f1: <the> rape is a felony of the second degree] unless (i)
   [g: in the course thereof the actor inflicts serious bodily injury upon anyone],
   or (ii) [h1: the victim was not a voluntary social companion of the actor upon the occasion of the crime] and [h2: <the victim> had not previously permitted him sexual liberties], in which cases [i1: the (offense) <rape> is a felony of the first degree].

(2) Gross Sexual Imposition. [j1: a male (who) has sexual intercourse with a female not his wife] [j2: <he> commits <gross sexual imposition>] [j3: <the offense is> a felony of the third degree] if:
   (a) [k: he compels her to submit by any threat that would prevent resistance by a woman of ordinary resolution]; or
   (b) [l: he knows that she suffers from a mental disease or defect which renders her incapable of appraising the nature of her conduct]; or
   (c) [m1: he knows that she is unaware that a sexual act is being committed upon her] or [m2: <he knows> that she submits because she mistakenly supposes that he is her husband].

from the first NORMALIZER run, it may become apparent that there are some other changes that need to be made in the detailed marked version.

There are only five defined between-sentence terms used to express logical structure in the clear normalized form in which interpretations of Section 213.1 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:

&., l., ~., >., and BO

Each of the expressions below, x and y, is a parenthesized logical expression for one of the two structural interpretations of Section 213.1. 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.

FORM

\[ x = a_1 > (blc dle > (a_2 & (gl(h_1 \& h_2) > i1BOf1))) BO (~a_2&(klllm1lm2 > j2&j3BO~j2)) BO~a_2&~j2 \]
\[ y = a_1 > (blc dle > (a_2 & (gl(h_1 \& h_2) > i1BOf1))) BO~a_2)&(klllm1lm2 > j2&j3BO~j2) BO~a_2&~j2 \]

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. The set of commands below specify:(1) that the arrow diagrams, outlines, and normalizations for each of the two interpretations are to be displayed on the screen; and (2) that each of these six outputs are to be stored in the file 'RAPE-CLR.ANV'.

ARROW x
ARROW y
OUTLINE x
OUTLINE y
NORM x
NORM y
ARROW x 'RAPE-CLR.ANV'
OUTLINE x 'RAPE-CLR.ANV'
NORM x 'RAPE-CLR.ANV'
ARROW y 'RAPE-CLR.ANV'
OUTLINE y 'RAPE-CLR.ANV'
NORM y 'RAPE-CLR.ANV'

This completes the preliminary analysis, and the analyst is ready to make the first NORMALIZER run.

NORMALIZER Run of Section 213.1

With the detailed marked version (table 16.4) in the DATA section and the parenthesized logical expressions and output commands in the FORM section
Figure 16.6
Clear Outline of Interpretation X

IF
1. a1,
THEN
2. IF
   A) b, OR
   B) c. OR
   C) d. OR
   D) e,
   THEN
   E. a2, AND
F. IF
   1) g, OR
   2) A. h1, AND
      B. h2,
      THEN
   3. i1,
      BUT OTHERWISE.
   4. f1.
   BUT OTHERWISE.
G. IT IS NOT SO THAT
   a2, AND
H. IF
   1) k. OR
   2) l, OR
   3) m1. OR
   4) m2,
   THEN
   5. j2, AND
   6. j3,
   BUT OTHERWISE.
   7. IT IS NOT SO THAT
      j2,
      BUT OTHERWISE.
   3. IT IS NOT SO THAT
      a2, AND
   4. IT IS NOT SO THAT
      j2.

of the file used as input to the NORMALIZER program, the outlines, arrow diagrams, and normalized versions illustrated in figures 16.6 through 16.11 are produced and stored in the file RAPE-LIB.ANV.

With these outputs from the first NORMALIZER run available for careful examination, the analyst is ready for the third step: repeated analysis.

Repeated Analysis of Section 213.1

At this stage the analyst would also have available both mnemonic arrow diagrams like the one for interpretation Y in figures 16.12 and 16.13 (which would have been generated by a process similar to the one exemplified above,
except that the analyst would substitute mnemonic abbreviations for the short letter names in the detailed marked version and the parenthesized logical expression. For legal rules with many alternative structural interpretations, mnemonic arrow diagrams are the most convenient form in which to represent such interpretations for purposes of examining them and carefully comparing them with each other. It is not uncommon for some legal rules to have thirty-six, forty-eight, or sometimes even hundreds of different structural interpretations.

The analyst should carefully examine the mnemonic arrow diagrams, which include an indication of the substantive content of the 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 more handy to use when the analyst is interested only, for example, in matters of logical structure, 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 using short arrow diagrams for purposes of such logical analysis with a careful examination of the full set of mnemonic arrow diagrams to see if any of these are identical with each other. Some such identities show up in the mnemonic arrow diagrams that are not so easily detected in the short arrow diagrams.

The detailed marked versions with mnemonic names for the sentences, which are used to produce the mnemonic arrow diagrams, are also more appropriate than detailed marked versions with short letter names as input for the AUTOPROLOG system that produces expert systems.

Careful analysis of the arrow diagrams may also reveal some equivalencies among the interpretations. In the case of these alternative interpretations of
Figure 16.8
Clear Normalized Version of Interpretation X

IF
1. a male has sexual intercourse with a female not his wife,
THEN
2. IF
   A) he compels her to submit by force or by threat of imminent
dearth, serious bodily injury, extreme pain or kidnapping,
to be inflicted on anyone, OR
   B) he has substantially impaired her power to appraise or
control her conduct by administering or employing without
her knowledge drugs, intoxicants or other means for the
purpose of preventing resistance, OR
   C) the female is unconscious, OR
   D) the female is less than 10 years old,
THEN
E. he is guilty of rape, AND
F. IF
   1) in the course thereof the actor inflicts serious bodily
injury upon anyone, OR
   2) A. the victim was not a voluntary social companion of
the actor upon the occasion of the crime, AND
      B. the victim had not previously permitted him sexual
liberties,
THEN
3. the rape is a felony of the first degree,
BUT OTHERWISE.
4. the rape is a felony of the second degree.
BUT OTHERWISE.
G. IT IS NOT SO THAT
   he is guilty of rape, AND
H. IF
   1) he compels her to submit by any threat that would
prevent resistance by a woman of ordinary resolution, OR
   2) he knows that she suffers from a mental disease or
defect which renders her incapable of appraising the
nature of her conduct, OR
   3) he knows that she is unaware that a sexual act is being
committed upon her, OR
   4) he knows that she submits because she mistakenly
supposes that he is her husband.
THEN
5. he commits gross sexual imposition, AND
6. the offense is a felony of the third degree.
BUT OTHERWISE.
7. IT IS NOT SO THAT
   he commits gross sexual imposition.
BUT OTHERWISE.
3. IT IS NOT SO THAT
   he is guilty of rape, AND
4. IT IS NOT SO THAT
   he commits gross sexual imposition.
Section 213.1, it is clear that the two short arrow diagrams are different from each other.

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 specifies the constituent sentences of the normalized version.

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, might lead to changes in the parenthesized logical expression. In this particular case, the outputs for Section 213.1 do not suggest any changes that need to be made to clean up any awkward wording, imprecise references, or grammatical flaws.

After it has been cleared up, analysts should always submit the interpretation that is determined by an expert's pattern of answers to the series of questions formulated back to the expert to doublecheck whether that interpretation is, indeed, that expert's choice as the most appropriate interpretation. In this case, the recheck with the expert, David Chambers, made it clear that he regarded interpretation Y as the most appropriate for Section 213.1.

Ordinarily there will need to be multiple NORMALIZER runs to clean up the initial interpretation and to complete the doublecheck with the expert. However, in the case of Section 213.1 there is no need for further NORMALIZER runs because there does not appear to be any need for clean up and the logical structure of Section 213.1 is relatively unambiguous so that the expert's ultimate choice coincides with the interpretation determined by his or her answer to the only question asked about the logical structure.

**AUTOMATIC GENERATION OF LEGAL EXPERT SYSTEMS**

At present only one of the alternative structural interpretations of Section 213.1 can be embodied in the legal expert system to be created by the AUTOPROLOG system. After viewing all of the mnemonic arrow diagrams of the provision being interpreted in consultation with the expert whose opinion is being represented, the appropriate interpretation for embodiment in the legal expert system is selected. In this case, Chambers indicated interpretation Y as his selection.
Clear Normalized Version of Interpretation Y

IF
1. a male has sexual intercourse with a female not his wife,
THEN
2. IF
   A) he compels her to submit by force or by threat of imminent
death, serious bodily injury, extreme pain or kidnapping,
to be inflicted on anyone, OR
   B) he has substantially impaired her power to appraise or
control her conduct by administering or employing without
her knowledge drugs, intoxicants or other means for the
purpose of preventing resistance, OR
   C) the female is unconscious, OR
   D) the female is less than 10 years old,
THEN
   E. he is guilty of rape, AND
   F. IF
      1) in the course thereof the actor inflicts serious bodily
         injury upon anyone, OR
      2) A. the victim was not a voluntary social companion of
         the actor upon the occasion of the crime, AND
         B. the victim had not previously permitted him sexual
         liberties,
THEN
      3. the rape is a felony of the first degree.
      BUT OTHERWISE,
      4. the rape is a felony of the second degree.
      BUT OTHERWISE,
   G. IT IS NOT SO THAT
      he is guilty of rape, AND

3. IF
   A) he compels her to submit by any threat that would prevent
resistance by a woman of ordinary resolution, OR
   B) he knows that she suffers from a mental disease or defect
which renders her incapable of appraising the nature of her
conduct, OR
   C) he knows that she is unaware that a sexual act is being
committed upon her, OR
   D) he knows that she submits because she mistakenly supposes
that he is her husband,
THEN
   E. he commits gross sexual imposition. AND
   F. the offense is a felony of the third degree.
   BUT OTHERWISE,
   G. IT IS NOT SO THAT
      he commits gross sexual imposition.
   BUT OTHERWISE,
4. IT IS NOT SO THAT
   he is guilty of rape. AND
5. IT IS NOT SO THAT
   he commits gross sexual imposition.
Figure 16.12
Clear Mnemonic Arrow Diagram of Interpretation Y

> has_intercourse >

- compels_by_force
  - impaired_power
  - is_unconscious
  - is_less_than_10
    > guilty_of_rape
      > inflicts_injury
        > NOT_victim_companion
        > NOT_previous_sex
          > degree1_felony
    > NOT_guilty_of_rape

- compels_by_threat
  - mental_disease
  - she_is_unaware
  - supposes_husband
    > NOT_guilty_of_rape
    > NOT_sexual_imposition

> sexual_imposition
  > degree1_felony

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_imposition

> NOT_guilty_of_rapesexual_imposition

> NOT_guilty_of_rape
  > NOT_sexual_implementation
Figure 16.13
Clear Mnemonic Outline of Interpretation Y

IF
1. has intercourse.
THEN
2. IF
   A) compels by force, OR
   B) impaired power, OR
   C) is unconscious, OR
   D) is less than 10,
   THEN
   E. guilty of rape, AND
   F. IF
      1) inflicts injury, OR
      2) A. IT IS NOT SO THAT
          victim companion, AND
          B. IT IS NOT SO THAT
          previous sex,
      THEN
      3. degree1 felony,
      BUT OTHERWISE,
      4. degree2 felony,
      BUT OTHERWISE,
      G. IT IS NOT SO THAT
          guilty of rape, AND
3. IF
   A) compels by threat, OR
   B) mental disease, OR
   C) she is unaware, OR
   D) supposes husband,
   THEN
   E. sexual imposition, AND
   F. degree3 felony,
   BUT OTHERWISE,
   G. IT IS NOT SO THAT
       sexual imposition,
   BUT OTHERWISE,
   4. IT IS NOT SO THAT
       guilty of rape, AND
5. IT IS NOT SO THAT
   sexual imposition.

AUTOPROLOG on Normalized Version of Section 213.1

To generate the legal expert system for Section 213.1 an input file to the AUTOPROLOG system must be constructed. This file will consist of three parts: (1) the title; (2) the logical structure of interpretation Y of Section 213.1 that was specified to construct the mnemonic arrow diagram of that interpretation; and (3) the constituent sentences of the normalized version of Section 213.1 that were specified in its detailed marked version (possibly with some changes to make references of pronouns more clear when appearing in isolated questions).
Figure 16.14
Model Penal Code Section 213.1, Rape and Related Offenses

\[
\text{has intercourse} > \begin{align*}
&\text{compels by force} | \text{impaired power} | \text{is unconscious} | \text{is less than 10} \\
&\text{guilty of rape} &
\end{align*}
\]

This input file, which is called SEC213-3.INP here, is reproduced in figures 16.14 and 16.15.

The analyst can then use SEC213-3.INP as an input file to the AUTOPROLOG program, which will produce as output a Turbo Prolog program in a file that is entitled SEC213-3.PRO. When this program is compiled with Turbo Prolog 2.0, a legal expert system is generated in a file called SEC213-3.EXE. Anybody who wishes to consult this legal expert system can issue the command SEC213-3 to run the program.

Sample Consultations with SEC213-3

The legal expert system for interpretation Y of Section 213.1 of the Model Penal Code has been produced automatically as described above. When a user consults it, the command SEC213-3 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 Y of Section 213.1. 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 SEC213-3 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 SEC213-3, it will terminate the interview and provide a summary of the situation described by the user’s responses to the questions asked. SEC213-3 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, SEC213-3 will indicate which of the possible results of the application of Section 213.1 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 analyzed. An audit trail of each of the runs of SEC213-3 is recorded in a file called SEC213-3.TRA. Three runs of SEC213-3 are presented in figure 16.16. The first two runs are done completely, and the third one is abbreviated.
(1) Rape. [has intercourse: a male {who} has sexual intercourse with a female not his wife] [guilty_of_rape: the} is guilty of rape] if:
   (a) [compels_by_force: he compels her to submit by force or by threat of imminent death, serious bodily injury, extreme pain or kidnapping, to be inflicted on anyone]; or
   (b) [impaired_power: he has substantially impaired her power to appraise or control her conduct by administering or employing without her knowledge drugs, intoxicants or other means for the purpose of preventing resistance]; or
   (c) [is unconscious: the female is unconscious]; or
   (d) [is less than 10: the female is less than 10 years old].

   (degree2_felony: <the> rape is a felony of the second degree) unless
   (i) [inflicts_injury: in the course thereof the actor inflicts serious bodily injury upon anyone], or (ii) [vixryn_companion: the victim was a voluntary social companion of the actor upon the occasion of the crime] and
   [previous_sex: <the victim> had previously permitted him sexual liberties], in which cases [degree1_felony: the (offense) <rape> is a felony of the first degree].

(2) Gross Sexual Imposition. [j1: a male {who} has sexual intercourse with a female not his wife] [sexual_imposition: the} commits <gross sexual imposition>] [degree3_felony: <the offense is> a felony of the third degree] if:
   (a) [compel_by_threat: he compels her to submit by any threat that would prevent resistance by a woman of ordinary resolution]; or
   (b) [mental_disease: he knows that she suffers from a mental disease or defect which renders her incapable of appraising the nature of her conduct]; or
   (c) [she_is_unaware: he knows that she is unaware that a sexual act is being committed upon her] or [supposes_husband: he knows that she submits because she mistakenly supposes that he is her husband].

EXPERT SYSTEMS GENERATED FROM STRUCTURAL INTERPRETATIONS OF LEGAL RULES

This legal expert system was produced by the AUTOPROLOG program developed by Layman E. Allen and Charles S. Saxon with the aid of a research grant from the National Center for Automated Information Research (NCAIR). The AUTOPRO system has been developed to demonstrate the potential of expert systems as a tool to assist law teachers and other legal professionals. It is important that users of expert systems produced by AUTOPRO understand that the legal expertise they contain has been furnished by the legal experts who developed those systems. It is the intention of the authors of AUTOPRO that it be used only by qualified legal experts to produce legal expert systems embodying their expertise and that the systems they produce be used only by law students, attorneys, and other appropriately qualified persons. No report, reasons, or conclusions produced by AUTOPRO-generated expert systems should be relied upon
Figure 16.16
Model Penal Code Section 213.1, Rape and Related Offenses: Three Runs

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.

**FIRST SITUATION**

has_intercourse?

In the situation that you are analyzing, is it the case that a male has sexual intercourse with a female not his wife?

Pick: (Y)es or (N)o or (U)nknown

**INFERRED RESULT**

NOT guilty_of_rape

IT IS NOT SO THAT he is guilty of rape

**INFERRED RESULT**

NOT sexual_imposition

IT IS NOT SO THAT he commits gross sexual imposition

Based on the interpretation of Professor David L. Chambers of this provision and your responses given below to the questions asked:

**QUESTIONS**  **RESPONSES**

has_intercourse?  n

the following results can be inferred for the reasons given:

**RESULT**

**REASON(S)**

The result _NOT guilty_of_rape_ can be inferred for the following reason(s):

NOT has_intercourse

The result _NOT sexual_imposition_ can be inferred for the following reason(s):

NOT has_intercourse

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**

guilty_of_rape
degree1_felony
sexual_imposition
degree3_felony
degree2_felony
SECOND SITUATION

Based on the interpretation of Professor David L. Chambers of this provision and your responses given below to the questions asked:

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>has_intercourse ?</td>
<td>y</td>
</tr>
<tr>
<td>compels_by_force ?</td>
<td>y</td>
</tr>
<tr>
<td>inflicts_injury ?</td>
<td>y</td>
</tr>
<tr>
<td>victim_companion ?</td>
<td>y</td>
</tr>
<tr>
<td>is_unconscious ?</td>
<td>y</td>
</tr>
<tr>
<td>compels_by_threat ?</td>
<td>n</td>
</tr>
<tr>
<td>mental_disease ?</td>
<td>n</td>
</tr>
<tr>
<td>suportes_husband ?</td>
<td>n</td>
</tr>
<tr>
<td>impaired_power ?</td>
<td>n</td>
</tr>
<tr>
<td>she_is_unaware ?</td>
<td>n</td>
</tr>
<tr>
<td>is_less_than_10 ?</td>
<td>n</td>
</tr>
</tbody>
</table>

The following results can be inferred for the reasons given:

RESULT

REASON(S)

The result guilty_ofrape can be inferred for the following reason(s):

- has_intercourse, and
- compels_by_force

The result degree_1_felony can be inferred for the following reason(s):

- has_intercourse, and
- compels_by_force, and
- inflicts_injury

The result guilty_ofrape can be inferred for the following reason(s):

- has_intercourse, and
- is_unconscious

The result degree_1_felony can be inferred for the following reason(s):

- has_intercourse, and
- is_unconscious, and
- inflicts_injury

The result NOT sexual_imposition can be inferred for the following reason(s):

- has_intercourse, and
- NOT compels_by_threat, and
- NOT mental_disease, and
- NOT she_is_unaware, and
- NOT suportes_husband

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

- sexual_imposition
- degree_2_felony
- degree_3_felony
- NOT guilty_ofrape
THIRD SITUATION

Based on the Interpretation of Professor David L. Chambers of this provision and your responses given below to the questions asked:

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>nas_intercourse?</td>
<td>y</td>
</tr>
<tr>
<td>compels_by_force?</td>
<td>n</td>
</tr>
<tr>
<td>is_unconscious?</td>
<td>y</td>
</tr>
<tr>
<td>compels_by_threat?</td>
<td>n</td>
</tr>
<tr>
<td>inflicts_injury?</td>
<td>n</td>
</tr>
<tr>
<td>vintry_companion?</td>
<td>y</td>
</tr>
<tr>
<td>mental_disease?</td>
<td>y</td>
</tr>
<tr>
<td>subposes_husband?</td>
<td>y</td>
</tr>
<tr>
<td>previous_sex?</td>
<td>n</td>
</tr>
<tr>
<td>impaired_power?</td>
<td>n</td>
</tr>
<tr>
<td>sne_is_unaware?</td>
<td>n</td>
</tr>
<tr>
<td>is_less_than_10?</td>
<td>n</td>
</tr>
</tbody>
</table>

The following results can be inferred for the reasons given:

RESULT

REASON(S)

The result -- guilty_of_rape -- can be inferred for the following reason(s):
- nas_intercourse, and
- is_unconscious

The result -- sexual_imposition -- can be inferred for the following reason(s):
- nas_intercourse, and
- mental_disease

The result -- degree3_felony -- can be inferred for the following reason(s):
- nas_intercourse, and
- mental_disease

The result -- sexual_imposition -- can be inferred for the following reason(s):
- nas_intercourse, and
- subposes_husband

The result -- degree3_felony -- can be inferred for the following reason(s):
- nas_intercourse, and
- subposes_husband

The result -- degree2_felony -- can be inferred for the following reason(s):
- nas_intercourse,
- is_unconscious,
- NOT inflicts_injury, and
- vintry_companion

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

degree1_felony
NOT guilty_of_rape
NOT sexual_imposition
by any users as authoritative without consulting an attorney competent to evaluate the legal effects of the information furnished.

Law school faculty members who are cooperating in the making of these legal expert systems are being compensated for their efforts only by payments directly from individual users. Each individual lawyer who wishes to use this legal expert system is entitled to lifetime use of it by payment of $100 to the law teacher whose expertise is represented in the interpretation presented here. Participating teachers are providing their services on the faith that lawyers who use the legal expert systems will feel honorbound to forward the modest fee requested. Payments are to be sent to the address of the interpreter listed in note 1.

Legal expert systems like SEC213–3, generated automatically from normalized interpretations of legal rules, permit users to see the effects of application of those interpretations to actual and hypothetical situations. This capability is likely to be fruitful in a variety of settings throughout the legal process. We as developers of the system intend to explore in some detail its potentialities for improving the original drafting of statutes and other legal rules.

FUTURE EXTENSIONS OF THE AUTOPROLOG SYSTEM

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 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.

NOTES

1. The research and development of the AUTOPROLOG system 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 of this chapter at the University of Michigan Law School, Ann Arbor, MI 48109-1215.
