

Expert Systems: VP-Expert

Learning Objectives

By the end of this chapter, you should be able to do the following:

- Invoke the VP-Expert program
- Use the VP-Expert menus
- Use the VP-Expert Help facility
- Use the VP-Expert Editor
- Create a knowledge base by entering its rules
- Run a consultation
- Understand backward chaining
- Use variables with multiple values
- Use rules with multiple conditions
- Create a knowledge base from an induction table
- Enhance the appearance of a consultation
- Use all options of the Consult menu

Introduction

An **expert system** is a computer program that contains a collection of facts and a list of rules for making inferences about those facts. The facts and rules usually concern one particular field and are generally contributed by experts in that field. Expert systems use those facts and rules to advise, analyze, categorize, diagnose, explain, identify, interpret, and teach. They attempt to address problems traditionally solved by human experts. A few of the many expert systems now in use are MYCIN, which helps doctors to diagnose infections; PROSPECTOR, which aids geologists in evaluating mineral sites; and TAXADVISOR, which gives estate-planning advice.

Expert systems are among the most useful and marketable products of **artificial intelligence**. This intriguing field of study combines aspects of computer science, mathematics, philosophy, psychology, and linguistics. The main goal of artificial intelligence research is to enable computers to mimic certain aspects of human learning and decision-making.

The expert system examples we've just mentioned are quite specific, and many expert systems run only on minicomputers or mainframes. Special artificial intelligence programming languages, such as LISP and PROLOG, are frequently used to develop proprietary expert systems. There is, however, a relatively new class of software that runs on microcomputers and lets nonprogrammers set up their own expert systems. These programs are called expert system shells.

An **expert system shell** is an application package that contains everything you need to create your own expert systems and is easier to use than a programming language such as LISP or PROLOG. You supply the facts to create the knowledge base and the rules to create the rule base. The expert system shell con-

Handwritten notes in red ink:

- ① Press [H] to me
- ② Add path
- ③ Press [H] to me
- ④ Press [H] to me
- ⑤ Press [H] to me
- ⑥ Press [H] to me
- INPUT CNF VALUES
- HOME
- Widen AT A
- SELECTED ITEM
- FOR HELP: ① WORK ② [F1] ③ [ESC]
- 3
- JUSTICE: YOU CAN NOT THEN IT WORKS UNLESS YOU: ① TRY ② SEE UP
- RESULTS
- AND WORK
- AND
- 150

- **Using Induction** You can have VP-Expert automatically create a complete expert system from a table of facts.
- **Enhancing Consultations** Various commands let you govern the appearance of the screen during a consultation session.
- **Controlling Consultations** The Consult menu has several options that let you control various aspects of consulting a knowledge base.

Getting Started

Although VP-Expert is a powerful tool, it's easy to use. The package has a well-written manual and an excellent built-in help facility. In this guide, we'll be using VP-Expert Version 2.0, but most of what we do will also work with earlier versions. The program comes from Paperback Software on two floppy disks: the Program disk and the Sample Files disk. The three most likely arrangements for students running VP-Expert are

1. on a computer with two floppy drives and the VP-Expert package on the two floppy disks
2. on a computer with a hard disk and at least one floppy disk drive, with the VP-Expert package installed on the hard disk in a subdirectory named VPX or VPEXPRT
3. on a computer connected to a local area network, with the VP-Expert package installed on the network's file server

In each of these cases, the computer may be any IBM-compatible. Because computer systems can be organized in many ways, your instructor might have you follow some directions unique to your particular installation. Once you are running VP-Expert, however, you should be able to work all of the following lessons.

Lesson 1: Running VP-Expert

Like any software package, VP-Expert must be loaded into your computer's memory before you can use it. So, the first thing to do is gain access to and run the VP-Expert program.

Step 1: Boot Up DOS

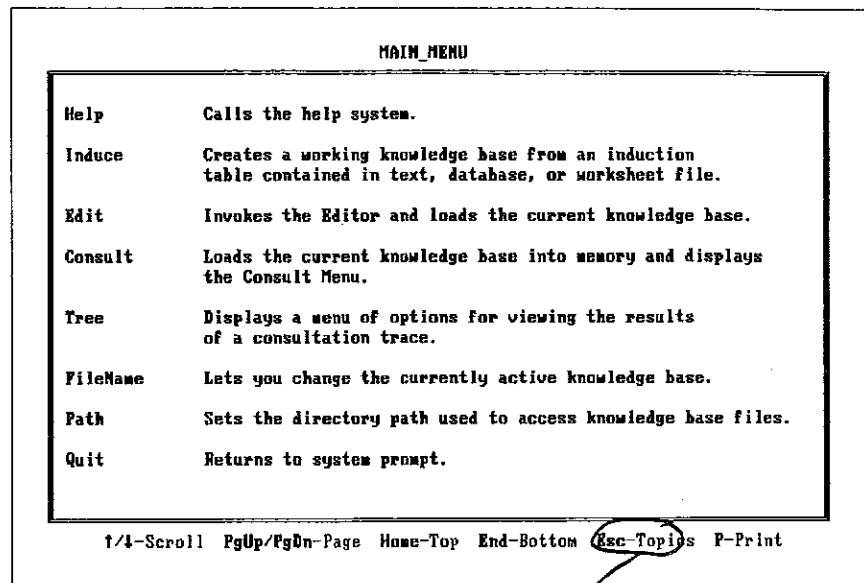
If your computer isn't already turned on and running DOS, you'll need to boot it up. On computer systems with only two floppy drives, put your DOS disk in drive A, close the door or lever if you have one, and turn on the system unit. If your computer has a hard disk drive or is connected to a local area network, just turn it on. Don't forget to turn on your display if it is a color monitor. Finally, enter the date and time (if necessary) to complete the DOS boot-up process as we described in Lesson 1 of Chapter 1.

Step 2: Change the Disk or Subdirectory

If your computer has only two floppy drives, remove the DOS disk from drive A, replace it with the VP-Expert Program Disk, and insert the Sample Files disk into drive B.

If you are using a hard disk drive or a network, you may need to follow some other directions from your instructor in order to use VP-Expert. For example, if

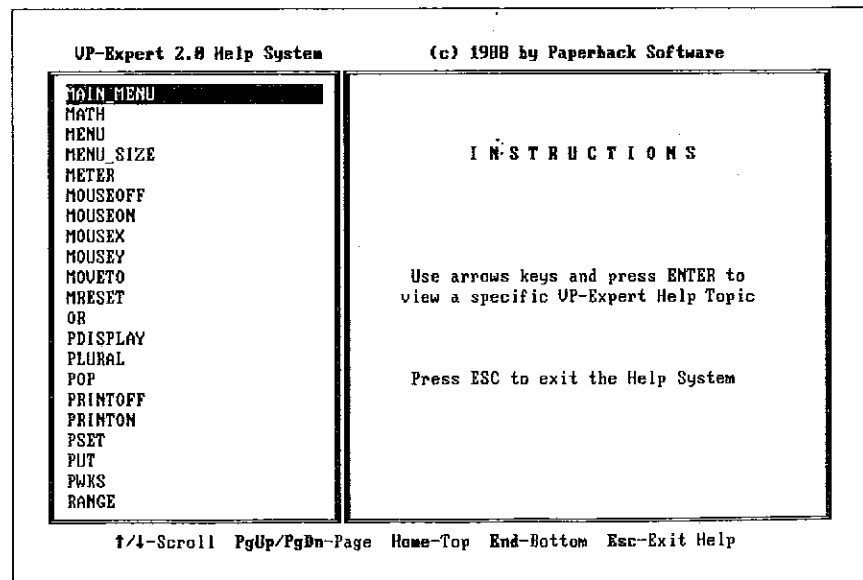
Figure 3.2 VP-Expert Main Menu Help Screen



Step 5: Explore the Help Facility

As Figure 3.2 shows, your screen reveals helpful information about the options in VP-Expert's Main menu. The line of text at the bottom of the screen tells you which keys to press for further help. For example, press **Escape** to see an index of all the topics you can look up. Your screen should look like Figure 3.3. Press **Page Up**, **Page Down**, **Up Arrow**, or **Down Arrow** to see more topics. Find Function Keys in the list of topics, highlight it with an arrow key, and press **Enter**. As Figure 3.4 shows, VP-Expert reveals the purpose of each function key. By providing such information about all commands, the Help facility makes VP-Expert easier to use and can often save you the trouble of referring to the printed manual. Press Escape twice to return to the Main menu.

Figure 3.3 VP-Expert Help Index of Topics



Like a programming language, VP-Expert has specific formatting and punctuation guidelines for the entry of the ACTIONS, rules, and statements that make up a knowledge base file. These procedures, however, are fairly simple and straightforward.

Step 1: Start VP-Expert

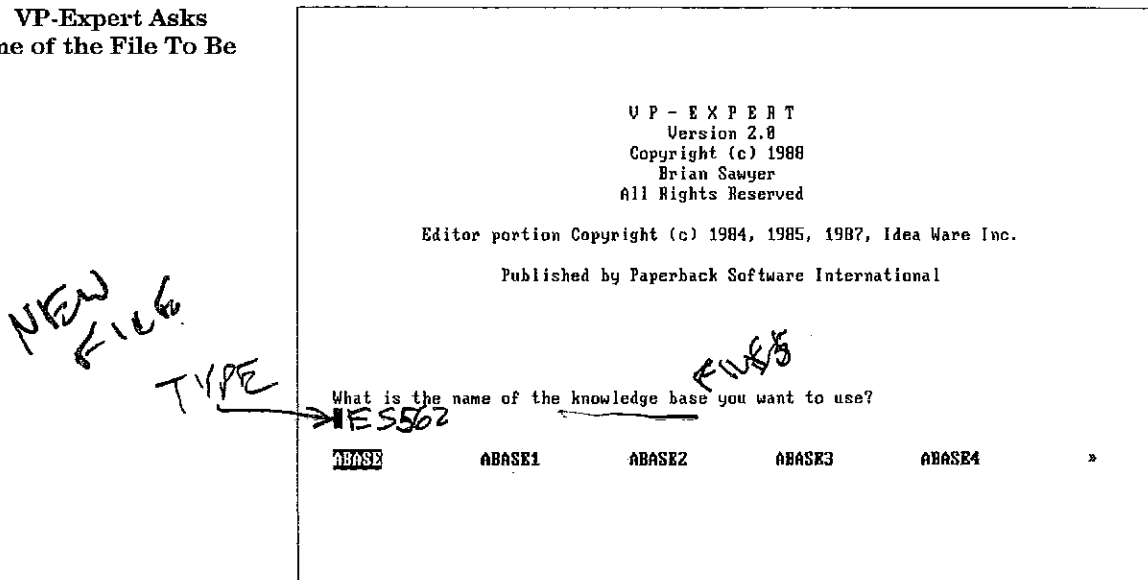
If you are not already running VP-Expert, switch to the proper disk drive and sub-directory, type **vp**x and press **Enter**.

Step 2: Execute the Edit Option

Press **e** to invoke the Edit option from the Main menu. As Figure 3.5 shows, VP-Expert will ask you for the name of the knowledge base you want to use. The horizontal list across the bottom of the screen gives the names of knowledge base files already on your disk. Paperback Software provides several knowledge base files that are discussed as examples in the VP-Expert manual.

EDIT
↓

Figure 3.5 VP-Expert Asks for the Name of the File To Be Edited



Step 3: Enter a New File Name

We want to create a new knowledge base file, so instead of selecting an existing name, type **stains** and press **Enter**. VP-Expert will present the blank editing screen shown in Figure 3.6.

Table 3.1 Cursor Movement Keys

Keypress	Cursor Movement
Up Arrow	Up one line
Down Arrow	Down one line
Left Arrow	Left one character
Right Arrow	Right one character
Ctrl-Left Arrow	Left one word
Ctrl-Right Arrow	Right one word
Home	Beginning of line
End	End of line
Tab	Forward one tab stop
Shift-Tab	Back one tab stop
~ Page Up	Previous screen
^ Page Down	Next screen
^ Ctrl-Page Up	Beginning of file
^ Ctrl-Page Down	End of file

Table 3.2 Commonly-Used Commands

Keypress	Command
F1	Invokes the Help facility
F10	Prints the file PRINT
Alt-F4	Inserts another file at the cursor location
Alt-F5	Saves the file to the disk without leaving the Editor SAVE
Alt-F6	Saves the file and leaves the Editor
Alt-F8	Leaves the Editor without saving the file
Ctrl-F3	Marks the beginning of a block
Ctrl-F4	Marks the end of a block
Ctrl-F5	Unmarks a marked block
Ctrl-F6	Moves a marked block to the current cursor location
Ctrl-F7	Copies a marked block to the current cursor location
Ctrl-F8	Deletes the marked block (the cursor must be inside the block)
Ctrl-F10	Restores the most recently deleted word, line, or block.

Lesson 3: Creating a Simple Knowledge Base

Our first knowledge base will be short and simple. It will give advice about removing three types of stains. We will expand on this modest knowledge base in later lessons as we explore more complex features of VP-Expert.

We will use the VP-Expert Editor to create our knowledge base. We've already chosen STAINS as the name of the file in Step 3 of the previous lesson. When you save the file at the end of this lesson, VP-Expert will automatically add the extension .KBS to STAINS, identifying the file as a knowledge base.

Step 1: Enter the ACTIONS Block

The first element in a knowledge base is the ACTIONS block. This consists of the keyword ACTIONS followed by one or more clauses and a semicolon. A keyword

RULE

VP-Expert rules have four essential parts.

- The rule name
- The rule premise
- The rule conclusion
- A semicolon at the end of the rule

Each rule must begin with the keyword RULE followed by a space and a name between 1 and 40 characters long. Numbers are often used for rule names, especially in knowledge bases with many rules. For instance, the name of the rule you just entered is simply 1. In addition to letters and numbers, the following characters are also allowed in rule names:

_ \$ % ^ |

The rule premise begins with the keyword IF. Up to twenty conditions can be stated in the premise. A **condition** compares the contents of a variable to a value. In our rule premise, there is only one condition, *stain = catsup*. *Stain* is the variable, *catsup* is the value, and *=* is the **relational operator**, which is a symbol specifying the type of comparison to be performed. VP-Expert allows the following relational operators:

= equal
 < less than
 <= less than or equal
 > greater than
 >= greater than or equal
 <> not equal

A **logical operator**, either AND or OR, can be used to combine two conditions. For example, *if stain = catsup AND fabric <> cotton*. We will see more examples of how logical operators can be used in a later lesson.

The rule conclusion begins with the keyword THEN and must be followed by at least one equation assigning a value to a variable. In our rule, for example, the conclusion is *solvent = dry_cleaning_fluid*. *Solvent* is the variable to which the value *dry_cleaning_fluid* will be assigned if the rule premise is true.

Note the use of underscore characters in value and variable names. Since blanks cannot be used within names, underscores are used to make multiword names more readable.

Finally, each rule must end with a semicolon. Now, press **Enter** and enter the other two rules of our knowledge base:

```
RULE 2
IF stain = coffee
THEN solvent = cool_water;

RULE 3
IF stain = fingernail_polish
THEN solvent = acetone;
```

Your screen should look like Figure 3.8.

The ASK statement presents a question to the user, whose response will be assigned to the specified variable. In this case, the variable is *stain*. The CHOICES statement works together with the ASK statement. It presents a list of values as a menu. Instead of having to type an answer to the question presented by the ASK statement, the user simply selects an answer from the menu presented by the CHOICES statement. The selected value will then be assigned to the specified variable, which, in this case, is *stain*.

now
Step 4: ~~Save~~ the File

Our simple knowledge base is complete. It must now be saved in the file STAINS.KBS before you can use it. Press ~~Alt-F6~~. VP-Expert will ask:

Save as "stains.kbs" (Y or N)?

Type *y* for yes. VP-Expert will save the file STAINS.KBS on your disk and return to the Main menu.

Lesson 4: Running a Consultation

Once a knowledge base has been set up, a user can consult it to help answer a question.

Step 1: Select the Consult Option

To use the simple expert system we have created, type *c* to execute the Consult option from the Main menu. *MAIN MENU*

Step 2: Enter or Select the Knowledge Base Name

After you invoke the Consult command, VP-Expert will ask

What is the name of the knowledge base you want to use?

Type *stains* and press **Enter**. VP-Expert will load the file STAINS.KBS from disk into memory. Note that you also could have loaded the file by using the Left or Right Arrow key to highlight STAINS and then pressing Enter. Your screen should now look like Figure 3.10. *NOW USE STAINS*

Step 3: Execute the Go Command

Figure 3.10 shows three windows and the Consult menu. The top box is the consult window, which displays the questions, choices, and output of a consultation session. This is the window normally seen by the expert system's end user.

The lower left box is the rules window, which allows you to observe the activity of the VP-Expert inference engine as it works its way through the knowledge base.

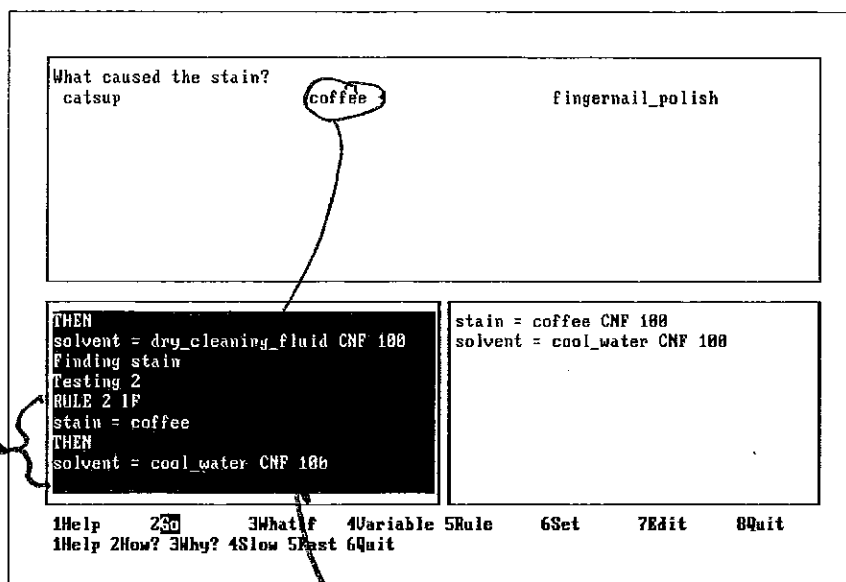
The lower right box is the values window, which displays the intermediate and final values of the variables derived during the consultation. The rules window and values window are used primarily by the person creating the expert system. They allow the creator to observe and trace the logic of the system as it advises the user.

first rule, but discovers that it must first determine the stain. So, the system is waiting for you to pick a stain. Press **Right Arrow** to highlight coffee and press **Enter**. VP-Expert will place an arrow beside the coffee option to indicate that this is the stain you have chosen. Press **Enter** to finalize your selection.

Step 5: Observe the Results

VP-Expert processes the rules of the STAINS knowledge base until it finds the answer. As Figure 3.12 shows, the results appear in the values window. If the stain is coffee, the solvent should be cool water.

Figure 3.12 Getting an Answer from the Expert System



The abbreviation CNF 100, which appears beside each variable assignment in the values window, represents the confidence factor. This is a number that indicates the degree of certainty that a conclusion is valid. A confidence factor of 0 would indicate no confidence, while a factor of 100 would indicate absolute confidence. Confidence factors can be included in the rules of a knowledge base by its creator. They can also be entered by the end user when answering questions during a consultation. Confidence factors are a subjective way to assign varying levels of certainty to assertions. If no confidence factor is explicitly specified, then 100 is assumed. For example, when you picked coffee as the stain, a confidence factor of 100 was assumed because you didn't specify otherwise. Nor was a confidence factor specified when Rule 2 was entered into the knowledge base. Consequently, a confidence factor of 100 is assigned to the conclusion that cool water is the best solvent to remove a coffee stain. Whether this is actually true depends on the expertise of the person who created the knowledge base.

Step 6: Quit the Consultation

If you have other questions, you can consult the expert system again by executing the Go command. When you are finished, simply type q to quit the consultation and return to the VP-Expert Main menu.

MULTIPLE QUESTIONS

Figure 3.13 A Knowledge Base to Demonstrate Backward Chaining

```

Editing: New File chaining.kbs

ACTIONS
  FIND technique:
  ↓
RULE 1
IF stain = set
THEN technique = soak:
  ↓
RULE 2
IF spot = dry
THEN stain = set:
  ↓
RULE 3
IF substance = crusty
THEN spot = dry:
  ↓
ASK substance : "Describe the substance.":
  ↓
CHOICES substance : wet, crusty, powdery:
  ↓
+
Insert On Document Off Boldface Off Underline Off
1Help 2Reform 3TabSet 4Margins5Center 6 7Bold 8Ulin 9Documnt10Print
    
```

Figure 3.14 A Value Has Been Assigned to the Goal Variable

Describe the substance. wet crusty ↓ powdery	
<pre> stain = set CNF 100 Finding spot Testing 3 RULE 3 IF substance = crusty THEN spot = dry CNF 100 Finding substance </pre>	<pre> substance = crusty CNF 100 spot = dry CNF 100 stain = set CNF 100 technique = soak CNF 100 </pre>
1Help 2Go 3WhatIf 4Variable 5Rule 6Set 7Edit 8Quit 1Help 2How? 3Why? 4Slow 5Fast 6Quit	

Step 3: Observe the Values Window

The values window in the lower right corner of the screen shows how VP-Expert solved the problem of which cleaning technique to use. The first rule tries to assign a value to technique, the goal variable. But a value for technique cannot be found until a value for stain is found. A value for stain cannot be found until a value for spot is found. A value for spot cannot be found until a value for substance is found. A value for substance, however, can be obtained from the user. Once the value for substance is known to be crusty, the inference engine can retrace its steps and assign *dry* to *spot*, *set* to *stain*, and *soak* to *technique*. So, back-

Figure 3.15 A New Rule and a PLURAL Statement Have Been Added

```

Editing: Old File stains.kbs

THEN solvent = dry_cleaning_fluid;
↓
RULE 2
IF stain = coffee
THEN solvent = cool_water;
↓
RULE 3
IF stain = fingernail_polish
THEN solvent = acetone;
↓
RULE 4
IF stain = cream
THEN solvent = dry_cleaning_fluid;
↓
ASK stain : "What caused the stain?";
CHOICES stain : catsup, coffee, cream, fingernail_polish;
PLURAL: stain, solvent;
■
+   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲   ▲
Insert On Document Off Boldface Off Underline Off
1 Help 2 Before 3 TabSet 4 Margins 5 Center 6 7 Bold 8 Uline 9 Count 10 Print

```

MULTIPLE VALUE
VARIABLES

Step 3: Consult the STAINS Knowledge Base

Press **c** to select the Consult option from the Main menu and then press **g** to select the Go option from the Consult menu. The STAINS knowledge base will present four options for the cause of the stain. Press **Right Arrow** to highlight coffee, then press **Enter**. Press **Right Arrow** again to highlight cream, and press **Enter**. You have selected both coffee and cream as the stain. Press **End** to finalize your selections. VP-Expert will process the rules given your selections for the stain and present the results in the values window in the lower right corner of the screen (see Figure 3.16). As you can see, if the stain is made up of both coffee and cream, the knowledge base suggests two solvents: cool water and dry cleaning fluid. When you are finished examining the values window, type **q** to select the Quit option and return to the Main menu.

ENTER
ENTER
END

Lesson 7: Using Rules with Multiple Conditions

EX #4

The rules we have used so far have been quite simple. A value is assigned to a variable if one particular condition is true. More complex rules can be constructed, however. For example, many stubborn stains cannot be removed completely after the first treatment with a solvent. The second treatment may require soaking in another solvent. Furthermore, different solvents may be required for washable and nonwashable fabrics. Taking these factors into account requires using rules with multiple conditions.

Step 1: Load the STAINS File into the Editor

Let's make our STAINS knowledge base more complex to demonstrate how rules can have multiple conditions.

First, retrieve the STAINS.KBS file from your disk and load it into the VP-Expert Editor. From the Main menu, type **f** to select the FileName option. Then type **stains** and press **Enter**. Type **e** to invoke the Edit option.

- Q ASK stain : "What caused the stain?";
CHOICES stain : catsup, coffee, cream, fingernail_polish;
- Q ASK treatment : "Which treatment is this?";
CHOICES treatment : first, second, third;
- Q ASK fabric : "In which type of fabric is the stain?";
CHOICES fabric : washable, nonwashable;

PLURAL: stain, solvent;

Check your work carefully for typographical errors. When you are sure the file is correct, press Alt-F6 and type y to save it in STAINS.KBS. VP-Expert will return to the Main menu.

Before we actually try our new knowledge base, let's discuss what we have done. Examine Rule 1. This rule says that the first treatment for catsup or cream, regardless of the fabric, is dry cleaning fluid. The logical operators OR and AND have been used to make a premise with multiple conditions. If two conditions are combined with OR, then the premise is true if either condition is true. If two conditions are combined with AND, then the premise is true only if both conditions are true. When both AND and OR are used in a rule, OR takes precedence over AND. In other words, the conditions combined with the OR are evaluated first.

Now examine Rules 4 and 5. These rules describe the second treatment for a coffee stain, which may be applied if the stain cannot be successfully removed with cool water. If the stain is in a washable fabric, the second treatment involves soaking the fabric in a mixture of detergent and vinegar. If the stain is in a non-washable fabric, the second treatment involves soaking the fabric in a mixture of wet spotter and vinegar. Incidentally, a wet spotter is a special solution made up of one part liquid detergent, one part glycerin, and eight parts water.

The new ASK and CHOICES statements let the user specify which treatment (first, second, or third) and fabric (washable or nonwashable) are to be considered. Note that the fabric question will be asked only if necessary—in this case, only if the stain is coffee and the treatment is second.

Note also that this knowledge base is not complete. If it were actually going to be used by clients as a finished product, second and third treatments for washable and nonwashable fabrics would have to be specified in rules for all possible stains.

Step 3: Consult the STAINS Knowledge Base

Press c to select the Consult option from the Main menu and then press g to select the Go option from the Consult menu. The knowledge base will ask for the stain. Highlight coffee, press Enter, and then press End. Next the knowledge base will ask for the treatment. Select second. Finally, the knowledge base will ask for the type of fabric. Select washable. Observe the values window in the lower right corner of your screen (see Figure 3.17). It indicates that the solvent should be detergent with vinegar. (VP-Expert cuts off part of the name to fit it in the window.)

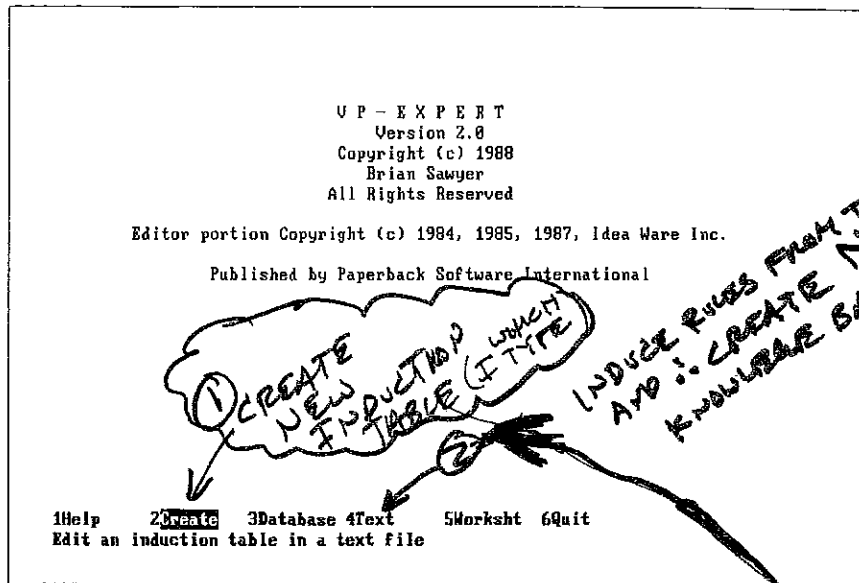
Press g to run the consultation again, but this time choose the second treatment with a nonwashable fabric for a coffee stain. Note how VP-Expert displays the rules as it processes them in the rules window in the lower left corner of the screen.

Press g to run the consultation one more time. Choose the first treatment for a coffee stain and see how the knowledge base does not ask for the type of fabric because this information is not necessary for determining the first treatment for a coffee stain. When you are finished examining the values window, type q to select the Quit option and return to the Main menu.

★
ONLY ASK IF NEEDED
(ie: SOL NOT YET FOUND)
(ie: RULE 1,2,3 FAIL!)

TYPE
2MSIPME

Figure 3.18 The Induce Menu



Step 2: Enter the Induction Table

Each column in an induction table lists the values of a particular variable. The first row of the table lists the names of the variables. Each subsequent row in the table corresponds to a rule. An * (asterisk) in the table indicates that the value of the corresponding variable doesn't matter in that rule. Type the lines on the next page, pressing **Enter** at the end of each one. You can use the **Tab** key to line up the columns.

Check your table and correct any typographical errors you might have made. When you are sure the table is correct, press Alt-F6 and then type y to save the table in the file STAINS.TBL. VP-Expert will return to the Induce menu.

Step 3: Induce the Rules

From the Induce menu, type t to select the Text option. This option tells VP-Expert to induce rules from the induction table to automatically create a knowledge base file. The program will ask you for the name of the examples file. Highlight STAINS and press **Enter**. Then VP-Expert will ask you for the name of the rules file to create and it will suggest STAINS.KBS. Press **Enter** to choose STAINS.KBS as the name of your knowledge base file. Using this name will overwrite your previous version of STAINS.KBS. It is all right to overwrite the old STAINS.KBS because the new STAINS.KBS created from the induction table is more comprehensive and complete. VP-Expert will take a minute to generate the knowledge base file and will then return to the Induce menu. Type **q** to return to the Main menu.

★ REPAIR
INDUCTION
TABLE
CREATED
BY
RULES

Figure 3.19 The List of Stains from the Induction Table

What is the value of Stain?		
Asphalt	Beer	Butter
Catsup	Coffee	Cream
Egg_white	Egg_yolk	Fingernail_polish

<pre> Finding Solvent Testing 0 RULE 0 IF Stain = Asphalt AND Treatment = First THEN Solvent = Dry_cleaning_fluid CNF 100 Finding Stain </pre>	
--	--

↑ ↓ → ← Enter to select END to complete /Q to Quit ? for Unknown

Figure 3.20 The Solvent To Use in the Second Treatment

Catsup	Coffee	Cream
Egg_white ←	Egg_yolk	Fingernail_polish

What is the value of Treatment?		
First	Second ←	Third

What is the value of Fabric?	
Washable ←	Nonwashable

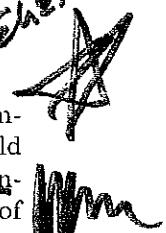
<pre> RULE 21 IF Stain = Egg_white AND Treatment = Second AND Fabric = Washable THEN Solvent = Detergent_with_ammonia CNF 100 0 Finding Fabric </pre>	<pre> Stain = Egg_white CNF 100 Treatment = Second CNF 100 Fabric = Washable CNF 100 Solvent = Detergent_with_ammon CNF 100 0 </pre>
---	--

1Help 2Go 3WhatIf 4Variable 5Rule 6Set 7Edit 8Quit
1Help 2How? 3Why? 4Slow 5Fast 6Quit

Lesson 9: Enhancing the Appearance of the Consultation

The STAINS knowledge base you have created from the induction table is a complete, working expert system. Although it includes only a few stains, you should understand how it can be made much more comprehensive by expanding the induction table and then regenerating the knowledge base file. The appearance of the consultation, however, leaves much to be desired. It provides no conclusion message in the consultation window and it asks only generic questions of the form, "What is the value of (variable name)?" Fortunately, VP-Expert lets you easily enhance the output of a knowledge base.

EXPAND &
REGENERATE



DISPLAY

It would be better, however, to report the conclusion more clearly in the consult window. The DISPLAY clause can be used in the ACTIONS block or in rules to reveal the results of a consultation. For example, you could add the following DISPLAY clause to Rule 0:

```
RULE 0
IF Stain=Asphalt AND
Treatment=First
THEN Solvent=Dry_cleaning_fluid
DISPLAY "Use dry cleaning fluid.";
```

If Rule 0 were true, then the message, "Use dry cleaning fluid," would be displayed in the consult window.

A similar DISPLAY clause at the end of each rule would present a conclusion for every possible result of the consultation. An easier way to present a conclusion for each rule is to put a single DISPLAY clause in the ACTIONS block. By adding a DISPLAY clause to the ACTIONS block, you can tell VP-Expert to report the value of the goal variable after it has been found.

Move the cursor to the semicolon after the word *solvent* in the ACTIONS block. Make sure Insert mode is turned on and press Ctrl-Enter. Type the following DISPLAY clause beneath the FIND clause:

```
DISPLAY "Use {#Solvent} to remove the stain."
```

Your screen should look like Figure 3.22. Note that the semicolon must now be after the last quotation mark of the DISPLAY statement. The variable name Solvent in curly brackets tells VP-Expert to display the value of Solvent in the sentence at the end of the consultation. The # character, which is optional, tells VP-Expert to present the confidence factor along with the value of Solvent.

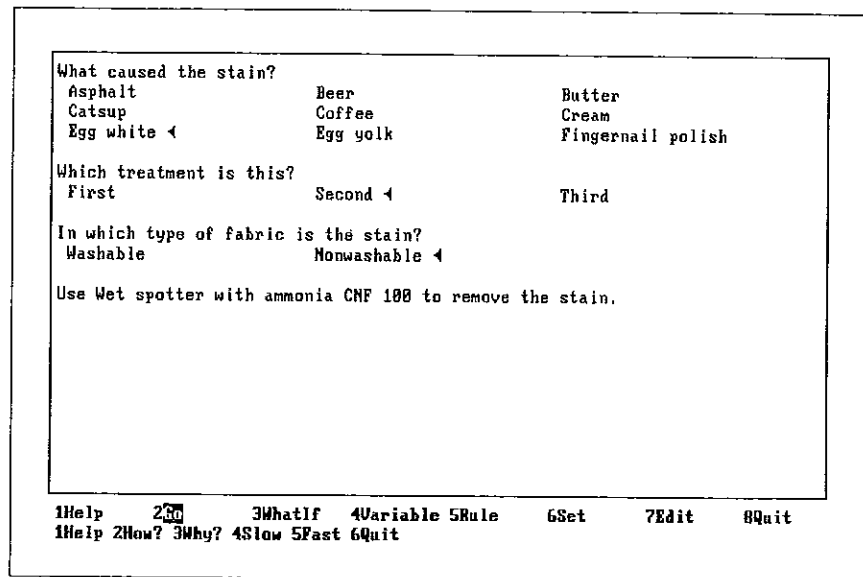
Figure 3.22 A DISPLAY Clause Has Been Added to the ACTIONS Block

```
Editing: Old File stains.kbs

ACTIONS<
  FIND Solvent<
  DISPLAY "Use {#Solvent} to remove the stain."
<
RULE 0<
IF Stain=Asphalt AND<
Treatment=First<
THEN Solvent=Dry_cleaning_fluid:<
<
RULE 1<
IF Stain=Asphalt AND<
Treatment=Second<
THEN Solvent=Dry_spotter:<
<
RULE 2<
IF Stain=Asphalt AND<
Treatment=Third<

+ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲ ▲
Insert On Document Off Boldface OFF Underline OFF
1Help 2Reform 3TabSet 4Margins5Center 6 7Bold 8Ulin 9Decum10Print
```

Figure 3.23 The RUNTIME Consultation Session



Lesson 10: Exploring the Consult Menu Options

We have used the Consult menu several times in this chapter. Let's discuss its options in more detail.

Step 1: Select the Consult Option

You should be at the VP-Expert Main menu. If STAINS.KBS is not already selected as your knowledge base file, use the FileName option to select it. Then press **c** to execute the Consult option from the VP-Expert Main menu. After the STAINS knowledge base file is loaded, the Consult menu will appear at the bottom of your screen (see Figure 3.23). Eight options are available: Help, Go, WhatIf, Variable, Rule, Set, Edit, and Quit.

Step 2: Try the Help Option

Help is the first option in the Consult menu. It is just like the Help option in all of the other menus, except that it goes directly to the help page on the Consult menu. Type **h** to invoke the Help facility from the Consult menu. As you can see from Figure 3.24, VP-Expert will present information about the options of the Consult menu. Press **Escape** twice to return to the Consult menu.

Step 3: Try the Go Option

When you select the Consult option from the Main menu, VP-Expert automatically highlights the Go option. You have already used the Go option several times to start a consultation. Notice the additional options that appear below the Go option. These are commands you can use while running a consultation. Type **g** or press **Enter** to choose the Go option. Type **/** (forward slash) to activate the Go menu. Six options are available: Help, How, Why, Slow, Fast, and Quit.

demonstrate these options, let's make a small modification to our STAINS knowledge base.

Type /q to return to the VP-Expert Main menu. Type e to invoke the Editor and load the STAINS.KBS file. Modify Rule 0 as follows:

```

RULE 0
IF Stain=Asphalt AND
   Treatment=First
THEN Solvent=Dry_cleaning_fluid
  BECAUSE "You must specify the substance that caused
  the stain, which treatment, and, in some cases, the
  type of fabric. STAINS can then determine the
  solvent that will dissolve the stain."

```

INSERT
THIS

MOVE
SEMICOLON

The BECAUSE keyword is used to specify text that will be displayed on the screen during a consultation when the user selects Why from the Go menu. The BECAUSE text must be enclosed in quotes and appear at the end of the rule before the final semicolon. If your BECAUSE text takes up more than one line, leave a space at the end of each line before you press Enter or Ctrl-Enter. Ideally, you should use BECAUSE at the end of every rule. To save time and typing, however, we will just demonstrate the use of BECAUSE in Rule 0.

Press Alt-F6 and type y to save the modified STAINS.KBS file. Type c from the Main menu to select the Consult option and then type g to select the Go option from the Consult menu. Highlight Asphalt, press Enter, and press End to specify the stain.

Now let's try the How option. Type / to activate the Go menu. Highlight the How option and press Enter. VP-Expert will ask what variable you are asking about and present a menu of variable names. Highlight Stain and press Enter. As Figure 3.26 shows, VP-Expert tells you that the value of the variable Stain was set by you, the user. Press any key to continue.

How

Figure 3.26 The How Option

What caused the stain?

Asphalt 1	Beer	Butter
Catsup	Coffee	Cream
Egg white	Egg yolk	Fingernail polish

Which treatment is this?

1 First	Second	Third
----------------	--------	-------

I HOW I

Stain was set because:
You said so.
(Press Any Key to Continue)

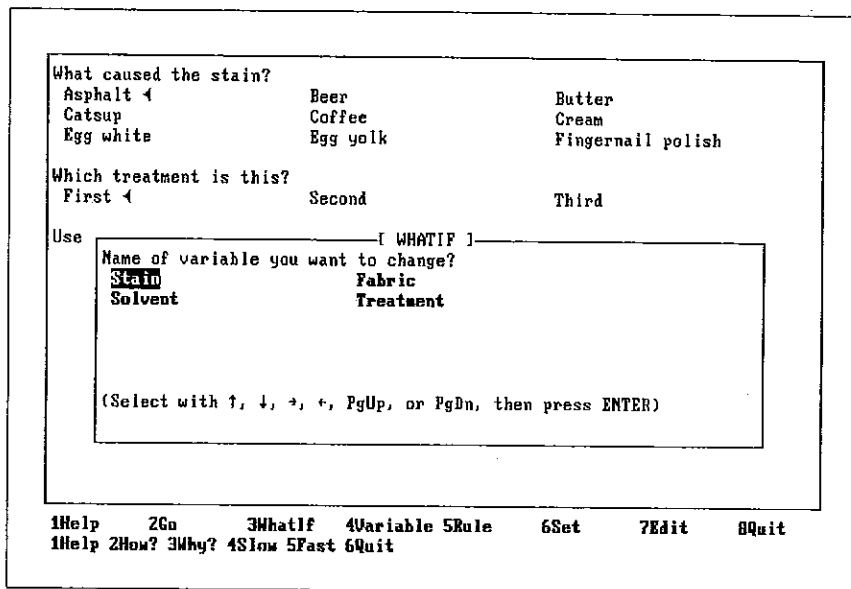
1Help 2**How?** 3Why? 4Slow 5Fast 6Quit

Ask how a conclusion was reached

TO
MAIN
MENU
(NOT CONSULT
MENU
SELECT
OR)

shows, VP-Expert asks you to select the variable you want to change. Highlight Treatment and press Enter. The program will then ask you to choose the treatment. This time, highlight Second, press Enter, and then press End. Now the knowledge base suggests dry spotter to remove the stain.

Figure 3.28 The WhatIf Option



Step 9: Try the Variable Option

The Variable option allows you to examine the values that were assigned to variables in the previous consultation. Type **v** to select the Variable option from the Consult menu. VP-Expert presents a menu of variables in this knowledge base. Highlight **Stain** and press **Enter**. The program clears the consult window and then reports that the value of Stain is Asphalt. It also displays the confidence factor, CNF 100.

Step 10: Examine the Rule Option

The Rule option of the Consult menu allows you to see a rule from the current knowledge base, but only if the knowledge base does not contain the RUNTIME statement. Since our STAINS knowledge base contains the RUNTIME statement, the Rule option will not work. In a non-RUNTIME knowledge base, however, selecting the Rule option presents a menu of rule names. To see a rule, you highlight its name and press the Enter key.

Step 11: Try the Set Option

The Set option of the Consult menu presents a menu of options that control certain aspects of the next consultation session you run. Type **s** to activate the Set menu. Six options are available: **Help, Trace, Slow, Fast, Windows, and Quit**.

The Help option displays more information about the Set menu. The Slow and Fast options are just like those in the Go menu: they control the speed of text

GRAPHICS

If your computer is equipped with a graphics adapter and monitor, type **g** for Graphics. Press the **Space Bar** to zoom in and see a graphic view of the path taken by the inference engine. You can use the arrow keys to reveal different parts of the tree. When you are finished viewing the graphic tree, press **Escape** to return to the Tree menu. From the Tree menu, type **q** to return to the VP-Expert Main menu.

Step 13: Try the Edit Option

Type **c** from the Main menu to execute the Consult option again. Now type **e** from the Consult menu to go directly to the Editor and load the STAINS.KBS file. Having the Edit option in the Consult menu as well as the Main menu makes it easy to view, modify, or correct the knowledge base file while you try consultations. Being able to rapidly switch between the Editor and a consultation is especially convenient during the development of a new knowledge base because you can immediately test your work. Press **Alt-F8** and then type **y** to exit the editor and return to the Consult menu.

Step 14: Try the Quit Option

Although you've already used the Quit option from the Consult menu several times, try it again. Type **q** to return to the VP-Expert Main menu. We are finished with the lessons in this chapter, so type **q** again to return to DOS.

Conclusion

In this chapter, we've covered the basics of using VP-Expert to set up a simple expert system. You should now know enough about the program to create complete, working knowledge bases. Admittedly, we have not discussed many advanced capabilities of this versatile software package. For example, VP-Expert can work directly with spreadsheet packages such as VP-Planner Plus and Lotus 1-2-3, and with data base management packages such as VP-Info and dBASE III PLUS. VP-Expert can also call upon DOS commands, batch files, and other programs from within a knowledge base. Several statements are included in VP-Expert for sending output directly to the printer and for creating text windows on the display screen. We will introduce a few more of VP-Expert's capabilities in the short and long problems at the end of this chapter. If you are interested in learning more about VP-Expert, explore the built-in help facility. It contains clear descriptions of every VP-Expert feature. You can also read the well-written user manual that comes with the commercial version of VP-Expert.

Exercises

Multiple Choice

Choose the best selection to complete each statement.

- _____ 1. An expert system is a computer program that contains a collection of facts and a list of
- | | |
|-----------------|-----------------|
| (a) worksheets. | (c) attributes. |
| (b) rules. | (d) shells. |