

## WINE ADVISOR EXPERT SYSTEM USING DECISION RULES

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**Abstract:** *In this article I focus on developing an expert system for advising the choice of wine that best matches a specific occasion. An expert system is a computer application that performs a task that would be performed by a human expert. The implementation is done using Delphi programming language. I used to represent the knowledge bases a set of rules. The rules are of type IF THEN ELSE rules, decision rules based on different important wine features.*

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**JEL classification:** C41, C61

### Introduction

Expert system represents a computer application that performs a task that would otherwise be performed by a human expert. For example, there are expert systems that can diagnose human illnesses, make financial forecasts, and schedule routes for delivery vehicles, advise people. Some expert systems are designed to take the place of human experts, while others are designed to aid them.

Expert systems are part of a general category of computer applications known as artificial intelligence. To design an expert system, one needs a knowledge engineer, an individual who studies how human experts make decisions and translates the rules into terms that a computer can understand [14].

An expert system is an artificial intelligence tool used to model and aid human decision making in a highly specialized problem domain. Expert systems represent human expertise through a combination of some form of knowledge base and inferencing technique. Some historical uses of expert systems include disease diagnosis, chemical analysis, wine selection, and armored vehicle identification.

The typical expert system receives input describing a problem in its field of expertise, then uses its inferencing technique to extract appropriate information from its knowledge base to produce an answer, diagnosis, or description of a solution. One strength of an expert system is that it can produce a report describing the chain of inference it followed, allowing a human operator to check on the system's reasoning. However, because expert systems are highly specialized, static systems, they can be extremely brittle when presented with novel problems or situations.

Expert systems have a number of major system components and interface with individuals in various roles. The major components are:

- Knowledge base - a declarative representation of the expertise, often in IF THEN rules;
- Working storage - the data which is specific to a problem being solved;

- Inference engine - the code at the core of the system which derives recommendations from the knowledge base and problem-specific data in working storage;
- User interface - the code that controls the dialog between the user and the system.

To understand expert system design, it is also necessary to understand the major roles of individuals who interact with the system. These are:

- Domain expert - the individual or individuals who currently are experts solving the problems the system is intended to solve;
- Knowledge engineer - the individual who encodes the expert's knowledge in a declarative form that can be used by the expert system;
- User - the individual who will be consulting with the system to get advice which would have been provided by the expert.

### Case Study: Application Presentation

I have done a wine advisor expert system. I thought that maybe not many people knows so many things about Romanian wine, that's why I have chosen this field to promote Romanian wine. I have also used in my advisor of wine wines from all over the world. It can be considered a point of start, this application can be much more developed, but, for the moment, I tried to make it easy to manage.



Figure 1. The main window.

When somebody wants to choose a wine, I thought first he/she thinks about what the wine is for, if the wine is to be served as an aperitif (before meal), during the meal (entrée or dinner category), to accompany a dessert or to be used after meal. I think that this is the first thing that somebody is thinking about when wants to choose a wine. The person who wants to be helped to choose a wine I think should know at least this information. So, I extracted the knowledges about wine and I divided then first in these categories. If the wine is to be served as an aperitif then I choose to advise in this field only wines from Romania so I think Romanian wine can be better known. The wine can have full body, medium body or light body. If the wine has a full body then all selected wines are from the Cotnary vineyard. If the wine has a medium body then all selected wines are from Dealu Mare vineyard. If the wine has a full body then all selected wines are from Jidvei vineyard. If the wine has bubbles then it is a sparkling wine, otherwise it is a table wine. All this categories of wines (it does not matter which vineyard do they belong ) can be sparkling or table wine. Then ,when we have all this information depending on the wine colour I can advise the user to choose a specific type of wine by giving a name of a specific type of wine which match the preferences. A wine expert system can be extended more. I am so sorry but in only something around 40 rules my expert system can't be developed extremely much.

If the wine is to be used to accompany an entree (it belongs to dinner category) then I have chosen here wines from all over the world and I extracted information about which wine best suits different kind of food. For example, if the wine is to be served with white meat, steak, barbecues, pizza, chinese food, cheese, fish or salad. Then, according to other characteristics ,as the preferred colour, they can be advised to choose a kind of wine. If they want something for dessert, according to the chosen dessert, if it is a fruit of primary fruit dessert the users will be advised to choose a type of wine (a Rougeon wine) and

if it is something very sweet such as chocolate they will be advised something else, so the right choice can be taken. If the

wine is to be used after the dinner then also a specific type of wine will be specified to the user.

I used to represent the knowledge bases a set of rules. For instance: 'if the person wants a wine to be served after the dinner then he/she should choose a Pinot wine. This is an example of a short rule. A rule is, thus, a statement of a relationship, not an instruction. Using a set of assertions, which collectively form the 'working memory', and a set of rules that specify how to act on the assertion set, a rule-based system can be created. Rule-based systems are fairly simplistic, consisting of little more than a set of if-then statements, but provide the basis for so-called "expert systems" which are widely used in many fields. The concept of an expert system is this: the knowledge of an expert is encoded into the rule set. When exposed to the same data, the expert system AI will perform in a similar manner to the expert.

Rule-based systems are a relatively simple model that can be adapted to any number of problems. As with any AI, a rule-based system has its strengths as well as limitations that must be considered before deciding if it's the right technique to use for a given problem. Overall, rule-based systems are really only feasible for

problems for which any and all knowledge in the problem area can be written in the form of if-then rules and for which this problem area is not large. If there are too many rules, the system can become difficult to maintain and can suffer a performance hit. I tried to manage it.

I have done a set of rule and when the algorithm of making a recommendation is applied one rule precedes the other one following the user's desire until a right recommendation is done.

There are two ways in which an inference engine can attempt to apply a set of rules. These are known as 'forward chaining' and 'backward chaining'. In forward chaining, the inference engine starts from known facts and looks at the left-hand 'if' side of the rules, to find any that fit, and then goes on to look for further rules that follow on from those that have been found to apply. In backward chaining, the inference engine starts from the end, from the aim which is sought. So, it starts from the right-hand 'then' side, to find any rules that satisfy the requirement, and works backwards to find what starting conditions are necessary to reach the goal.

In reaching a good option of wine from some given desired from one person, I think the forward reasoning process is the most appropriate.

I have done a user interface which allows the user to choose from multiple answer questions. A dialog with the user is like:

The wine is:

- \*to be consumed before a meal(aperitif)
- \*to accompany an entrée
- \*to accompany dessert
- \*to be consumed after dinner

and when the user makes a choice by clicking one of the buttons then a new page appear for the next step where it can choose another characteristics he/she wants the wine to have.

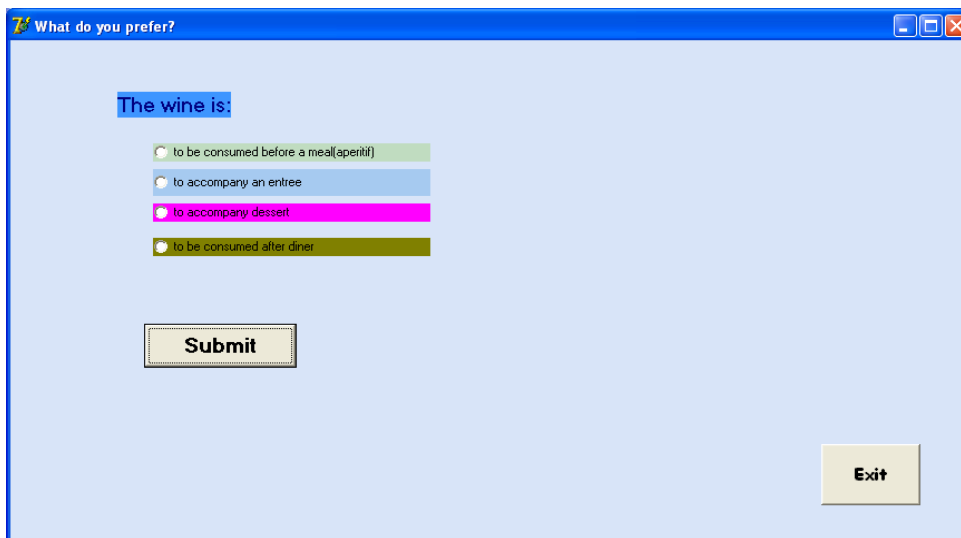


Figure 2. The window with selection' options

## EXAMPLE OF USING MY KNOWLEDGE BASE

I suppose that one person needs help to choose a wine .At the first step he chooses a wine to be consumed before a meal (aperitif), and then he chooses a full body wine and non- sparkling and the color pink. The recommended type of wine is Romanian and the name of wine is Busuioaca Romaneasca .

Applying forward-chaining the result was Busuioaca Romaneasca wine. The rules applied inside of my program to make this recommendation are:

Rule 1 => Rule 2 => Rule 3 => Rule 9 => Rule 11

Second example :

I suppose that somebody chooses at first step a wine to be consumed before a meal, a light body wine, non-sparkling and then he/she chooses a pink colour for the wine. Applying forward-chaining the result was "Feteasca Regala" wine. The rules applied inside of my program to make this recommendation are:

Rule 1 => Rule 2 => Rule 17 => Rule 19

Another example can be:

Somebody wants to choose a wine to accompany an entrée at first step and then he chooses a entrée be white meat and at the next step he chooses the color to be rose. The recommendation in this situation is: Pinot Grisio Rose,Veneto or Cuvee des Amardiens Rosé. Here I have extracted the knowledge about wines from many countries or the same country which can suit a kind of food. The rules applied inside of my program to make this recommendation are:

Rule 21=>Rule 23

I have tried to make many rules from my expert system to be able go one from the other. I have done from some of them, but it is a bit more difficult. All wine expert system I have found online are based on a composite rule to give a recommendation. Here I can give you an example, a link where I have seen an wine expert system and it was also a bit my point of inspiration [9]. I worked hard to do it. It was a bit difficult to separate them in classes but I think now it is well done. I hope you like it.

I have implemented my program in Delphi. I have done a user friendly interface. It is really easy to use it. You can execute my program using "Project1.exe".If you have Delphi program installed on your computer you can see all the source code. Maybe if you don't have Delphi installed on your PC not all the pages will be displayed at their real quality .If sometimes the program does not respond when you try to push a button you must open the program again because it is a Delphi error . It happens sometimes.I can't give you a copy in Notepad with the source code because it is too much.

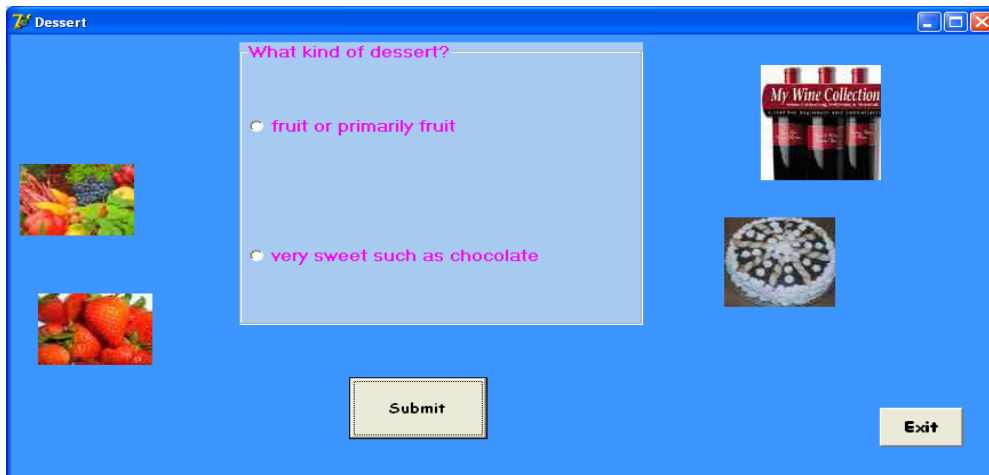
When you are executing my program, first you can see the welcome page that was presented in Figure 1:

After you click the button "Help me choose a wine" you can go to the next step, the next page will be displayed. It can be seen in "Figure 1" here on the paper.

I have implemented my program by using Radio Buttons and Labels. Each button has in front of him a corresponding label for the choice which can be done. You must click on the button which has near it the choice which best fits your desire. You must make a choice at every page.

For example:

After choosing "to accompany dessert" at the first page the next page is:



**Figura 3. Intermediar decisions**

The user should choose the answer which better fits him/her. When you have click on a button then you can go to the next step by clicking on "Submit" button so a new page will appear.

And then, after this step he/she will go to the next step and so on until the goal is reached and a recommendation of wine is made.

If you have changed your mind and want to exit then you can click on "Exit" button.

This is my wine advisor expert system. I hope it is usefull.

### **USED RULES**

Used rules are:

APERITIF

RULE 1 [Choosing a aperitif wine]

If [this wine] = "to be consumed before a meal (aperitif)"

Then [a recommended generic wine type] = "aperitif wine"

RULE 2 [Choosing a Romanian wine]

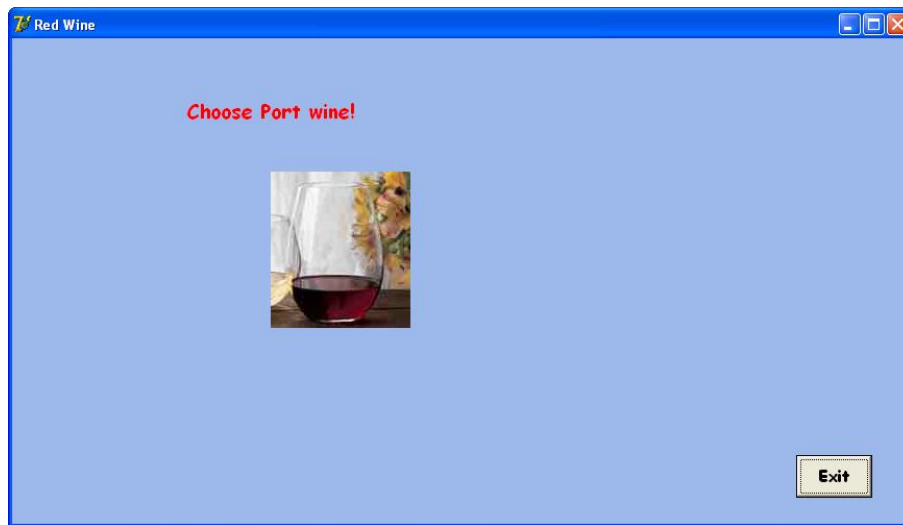
If [this wine] = "aperitif wine"

Then [a recommended generic wine type] = "Romanian wine"

RULE 3 [Choosing a full bodied aperitif Romanian]  
If [a recommended generic wine type] = "Romanian wine"  
[the preferred body] = "full" and  
Then [a recommended generic wine type] = "Cotnary vineyard wine"

RULE 4  
If [a recommended generic wine type] = "Cotnary vineyard wine"  
And  
[a sparkling wine is preferred] = true  
Then [a recommended generic wine type] = "sparkling wine"

RULE 5  
If [a recommended generic wine type] = "sparkling wine"  
Then [a recommended generic wine type] = "Champagne"



**Figura 4. The final recomandation**

RULE 6  
If [a recommended generic wine type] = "Champagne"  
And  
[the preferred colour] = white  
And  
[the preferred body] = "full/medium/light"  
Then [a recommended generic wine type] = "White Champagne"

RULE 7  
If [a recommended generic wine type] = "Champagne"  
And  
[the preferred colour] = pink

And  
[the preferred body] = "full/medium/light"  
Then [a recommended generic wine type] = "Pink Champagne"

RULE 8  
If [a recommended generic wine type] = "Champagne"  
And  
[the preferred colour] = black  
And  
[the preferred body] = "full/medium/light"  
Then [a recommended generic wine type] = "Black Champagne"

RULE 9  
If [a recommended generic wine type] = "Cotnary vineyard wine"  
And  
[a sparkling wine is preferred] = false;  
Then [a recommended generic wine type] = "table wine"

RULE 10  
If [a recommended generic wine type] = "table wine"  
And  
[the colour]=white  
Then [a recommended wine] = " Tamaioasa Romaneasca "

RULE 11  
If [a recommended generic wine type] = "table wine"  
And  
[the colour]=pink  
Then [a recommended wine] = " Busuioaca Romaneasca wine "

RULE 12  
If [a recommended generic wine type] = "table wine"  
And  
[the colour]=red  
Then [a recommended wine] = " Cabernet Sauvignon wine "

RULE 13  
If [a recommended generic wine type] = "Romanian wine"  
and  
[the preferred body] = "medium"  
Then [a recommended generic wine type] = "Dealu Mare vineyard wine"

RULE 14  
If [a recommended generic wine type] = "Dealu Mare vineyard wine"  
And [a sparkling wine is preferred] = false;



[the colour]=white;  
Then [a recommended wine ] = "Feteasca Regala wine"

RULE 15

If [a recommended generic wine type] = "Dealu Mare vineyard wine"  
And  
[a sparkling wine is preferred] = false  
And  
[the colour]=pink  
Then [a recommended wine ] = "Feteasca Roz wine"

RULE 16

If [a recommended generic wine type] = "Dealu Mare vineyard wine"  
And  
[a sparkling wine is preferred] = false  
And  
[the colour]=red  
Then [a recommended wine ] = "Feteasca Neagra, Pinot Noir or Cabernet Byzantium wine"

RULE 17

If [a recommended generic wine type] = "Romanian wine"  
and  
[the preferred body] = "light"  
Then [a recommended generic wine type] = "Jidvei vineyard wine"

RULE 18

If [a recommended generic wine type] = "Jidvei vineyard wine"  
And  
[a sparkling wine is preferred] = false  
And  
[the colour]=white  
Then [a recommended wine ] = "Sauvignon Blanc or Dry Muscat wine"

RULE 19

If [a recommended generic wine type] = "Jidvei vineyard wine"  
And  
[a sparkling wine is preferred] = false  
And  
[the colour]=pink  
Then [a recommended wine ] = "Feteasca Regala wine"

RULE 20

If [a recommended generic wine type] = "Jidvei vineyard wine"  
And  
[a sparkling wine is preferred] = false  
And  
[the colour]=red

Then [a recommended wine ] = "Pinot Noir wine"

RULE 21

If [the wine is to accompany an entree]

Then

If [a recommended generic wine type] = "dinner(entree) wine"

RULE [Is the wine for a white meat entree?] 22

If [this wine] = "entrée wine" and

[the entree] : "white meat"

[the colour]:"white"

Then [a recommended wine] = "Muscat Sec,Samur Blanc or Griffin Vineyards Verdelho"

RULE [Is the wine for a white meat entree?] 23

If [this wine] = "entrée wine" and

[the entree] : "white meat"

[the color]:"rose"

Then [a recommended wine] = "Pinot Grigio Rose,Veneto or Cuvee des Amardies Rose"

RULE [Is the wine for a white meat entree?] 24

If [this wine] = "entrée wine" and

[the entree] : "white meat"

[the color]:"red"

Then [a recommended wine] = "Corbieres 2003,Domain Modelen or Mayor de Castilla 2004,Ribera del Duero"

RULE [Is the wine for a steak entree?] 25

If [this wine] = "entrée wine" and

[the entree] : "steak" and

[the colour]:"white"

THEN [a recommended wine] = "Chateau Agnel 2000,Minervois(France) or Chateau Syrah 2004(France)"

RULE [Is the wine for a steak entree?] 26

If [this wine] = "entrée wine" and

[the entree] : "steak"

[the color]:"rose"

Then [a recommended wine ] = "Busuioaca Romaneasca"

RULE [Is the wine for a steak entree?] 27

If [this wine] = "entrée wine" and

[the entree] : "steak"

[the color]:"red"

Then [a recommended wine ] = "Rosso di Sicilia 2004,Cantine Settesoli(Italy)"

RULE [Is the wine for a barbecues entree?] 28

If [this wine] = "entrée wine" and

[the entree] : "barbecues"

[the colour]: "white"

Then [a recommended wine] = "Riojo Blanco CVNE 2003,Vino Real (Spain) or  
Chateau Camplazens Syrah 2004(France)"

RULE [Is the wine for a barbecues entree?] 29

If [this wine] = "entrée wine" and

[the entree] : "barbecues"

[the color]: "rose"

Then [a recommended wine type] = "Tamaioasa Regala(Romania)"

RULE [Is the wine for a barbecues entree?] 30

If [this wine] = "entrée wine" and

[the entree] : "barbecues"

[the color]: "red"

Then [a recommended wine type] = "Riojo Tempranillo 2003(Italy),Berberana(Spain)  
or Protocola Tinto(Spain)"

RULE [Is the wine for a pizza entree?] 31

If [this wine] = "entrée wine" and

[the entree] : "pizza"

[a recommended wine type] = "Chianti wine"

RULE [Is the wine for Chinese Food entree?] 32

If [this wine] = "entrée wine" and

[the entree] : "Chinese Food"

Then [a recommended wine type] = "White Riesling wine"

RULE [Is the wine for cheese entree?] 33

If [this wine] = "entrée wine" and

[the entree] : "cheese"

Then [a recommended wine type] = "Burgundy wine"

RULE [Is the wine for fish entree?] 34

If [this wine] = "entrée wine" and

[the entree] : "fish"

Then [a recommended wine type] = "Chardonnay wine"

RULE [Is the wine for salads entree?] 35

If [this wine] = "entrée wine" and

[the entree] : "salads"

Then [a recommended wine type] = "Bordeau Blanc wines"

DESSERT WINE

RULE [dessert class] 36  
If [this wine] = "is to accompany an dessert" and  
Then [a recommended generic wine type] = "dessert wine"

RULE [Fruit-based dessert] 37  
If [this wine] = "dessert wine" and  
[the dessert] = "fruit or primarily fruit"  
Then [a suggested wine type] = "Rougeon"

RULE [Sweet dessert] 38  
If [this wine] = "dessert wine" and  
[the dessert] = "very sweet such as chocolate"  
Then [a recommended generic wine type] = "Port"

#### AFTER DINNER WINE

RULE [After dinner] 39  
If [this wine] = "to be consumed after dinner"

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