

# IMPLEMENTATION OF AN EXPERT SYSTEM FOR FUNDAMENTAL-COSMETICS RECOMMENDATIONS USING PROLOG

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## ABSTRACT

Nowadays, regardless of sex or age, significant attention is paid to personal appearance, resulting in the ever-increasing spending in the beauty and fashion markets. Especially, great-looking skin is a foremost desire; however, there are various components, forms, and functionalities, and these are diversifying further. The recommended product depends on the user's skin condition, weather exposure, age, and sensitivity. Therefore, this paper proposes an expert system that recommends the most suitable fundamental cosmetics for the user, which is the very first touch point between the cosmetics seller and the user. Accordingly, the advantages of the rule-based expert system and the logic-based language PROLOG are exploited. The system first receives inputs from the user, and then the inference engine makes a suggestion for its recommendation of the fundamental cosmetics that result in the user's satisfaction.

**Keywords:** *Customized, Fundamental Cosmetics, Inference Engine, Prolog, Rule-based Expert System, Recommendation*

## 1. INTRODUCTION

In fundamental cosmetics, there are various types such as cream type, latex, face lotion, and pack-type cosmetics and they are the base level of make-up. Also, all of the basis cosmetics like wash-up products, soap, and cleanser, which keep our skin healthy and clean, are included. The fundamental cosmetics maintain the beauty of the skin, so they represent a vital step for users who seek to use make-up effectively [1]. When choosing the fundamental cosmetics, it is important to consider not only the components of the cosmetics - whether they are suitable or not - but also the user's skin condition, weather exposure, age, and sensitivity of the user's skin [2]. According to this statement, this paper contains a study of an inference-engine system that recommends the most suitable fundamental cosmetics to make the purchasing decisions of customers easier. To do so, we made a process of this study - recognize the issue, design and demonstrate the system, and think of an expansion of this study. First, we focused on the problem then found the solution, that is, customized recommendation.

## 2. PROBLEM DEFINITION

### 2.1 Need Of A Fundamental-Cosmetics Recommendation System

It is no surprise that customers today experience difficulty when they try to choose the right fundamental cosmetics to buy, because the types of ingredients, forms, and functionalities in cosmetics are numerous and a component which is good for some can be bad for the other so it's getting more complicated. Further, every person has a different skin complex, the weather changes as time passes, it is necessary to consider the user's age, and some people have sensitive skin so they must be careful when using cosmetics [3, 4] and it is not an issue for only customers, cosmetics industries also feel for this problems and having a struggling time meet the customer's satisfaction. To lessen the concerns of these worrying customers and also to assist the relevant industries' marketing strategies, this paper presents the design and demonstration of an inference-engine system that recommends the fundamental cosmetics using a rule-based expert system and Prolog.

## 2.2 Criteria Of The Selection Of The Fundamental Cosmetics

The standard of the fundamental-cosmetics example that will be recommended to the user in this paper is based on the Internet sites that are popular, including those that are popular among beauty-product customers. These days, it is natural that many people search for the product they are planning to buy, so this fact is utilized in this study. Of course, some rules exist regarding the attainment of information from the websites, because even though this study presents just an example, plausibility needs to be established to show the need of this study. The sites that have been taken advantage of either have followers of more than ten thousand people or total visitors of more than one million people. Also, a limited range of the fundamental-cosmetics brands were sent to shops to heighten the users' familiarity regarding the products.

## 3. DESIGN OF THE EXPERT SYSTEM FOR FUNDAMENTAL COSMETICS RECOMMENDATION

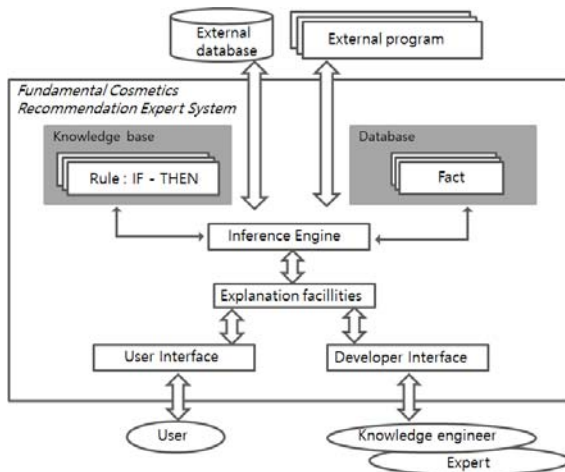


Figure 1: Common structure of a rule-based expert system for the fundamental-cosmetics recommendation

To recommend the customized fundamental cosmetics, the inference engine collects the Complex, Environment, Age, and Sensitivity inputs from the user; that is, it asks those four questions – 1. What complex do you have? 2. Which environmental condition are you in? 3. What age group are you in? 4. Is your skin sensitive? Then the user inputs his or her answers. After that, the inference engine compares the input values to the rules that are already saved, and it is

triggered if a coincidence is registered. The triggered rule turns into a new fact in the database, and again, this will become a fact that will be compared to another rule in the knowledge base when the user starts running the system. This is how the forward-direction inference-engine system works [5]. Through the circulation of the inference process, the system is able to commend the suitable fundamental cosmetics to the user.

The First-Order-Logic (FOL)-based inference engine offers limited values that will be used for the inputs. Its objects will be Complex, Environment, Age, and Sensitivity. Each object has the allowed values that the user can type in. Among them, the Complex, Environment, and Age inputs are the IF part of the IF-THEN rule system (refer to Fig.1.), whose facts are saved in advance.

### Rule 1

IF COMPLEX is freckle.  
OR COMPLEX is pimple.  
OR COMPLEX is scar.  
OR COMPLEX is atopic dermatitis.  
THEN NEEDS is spot-focused-care.

### Rule 2

IF COMPLEX is dark-skin.  
OR COMPLEX is face-flush.  
OR COMPLEX is yellow-skin.  
OR COMPLEX is spotted-tanning.  
THEN NEEDS is whitening.

### Rule 3

IF COMPLEX is coarse-skin.  
OR COMPLEX is face-dryness.  
OR COMPLEX is magnified-horny-layer.  
THEN NEEDS is replenish-moisture.

### Rule 4

IF COMPLEX is oily-face.  
OR COMPLEX is sebum.  
OR COMPLEX is blemish.  
THEN NEEDS is oil-control.

### Rule 5

IF COMPLEX is pore.  
OR COMPLEX is skin-lacking-elasticity.  
OR COMPLEX is wrinkle.  
THEN NEEDS is anti-aging-skin-care.

### Rule 6

IF ENVIRONMENT is yellow-dust.  
OR ENVIRONMENT is pollen.  
OR ENVIRONMENT is frequent-temperature-change.  
THEN SEASONALLY\_RECOMMENDED\_FORM is spring\_protectiveType.

Rule 7  
IF ENVIRONMENT is rainy-season.  
OR ENVIRONMENT is air-condition.  
OR ENVIRONMENT is high-temperature.  
THEN SEASONALLY\_RECOMMENDED\_FORM is summer\_freshType.

Rule 8  
IF ENVIRONMENT is dryness.  
OR ENVIRONMENT is large-temperature-differential.  
OR ENVIRONMENT is refreshing.  
THEN SEASONALLY\_RECOMMENDED\_FORM is fall\_nutritiousType.

Rule 9  
IF ENVIRONMENT is heater.  
OR ENVIRONMENT is snowy-weather.  
OR ENVIRONMENT is biting-wind.  
THEN SEASONALLY\_RECOMMENDED\_FORM is winter\_moisturizingType.

Rule 10  
IF AGE is junior-high-pupil.  
OR AGE is high-schooler.  
THEN GROUP is teenager.

Rule 11  
IF AGE is twenty.  
OR AGE is thirty.  
THEN GROUP is youth.

Rule 12  
IF AGE is forty.  
OR AGE is fifty.  
OR AGE is sixty.  
THEN GROUP is middle-aged.

Rule 13  
IF NEEDS is spot-focused-care.  
AND SEASONALLY\_RECOMMENDED\_FORM is summer\_freshType.  
AND GROUP is teenager.  
AND SENSITIVE.  
THEN cosmetics is SKINFOOD-Broccoli-Watery-Ampoule.

Rule 14  
IF NEEDS is whitening.  
AND SEASONALLY\_RECOMMENDED\_FORM is spring\_protectiveType.  
AND GROUP is youth.  
AND SENSITIVE.  
THEN cosmetics is TONYMOLY-Floria-Whitening-Spot-Eraser.

Rule 15  
IF NEEDS is replenish-moisture.  
AND SEASONALLY\_RECOMMENDED\_FORM is winter\_moisturizingType.  
AND GROUP is middle-aged.  
AND SENSITIVE.  
THEN cosmetics is SKINFOOD-RoyalHoney-Propolis-Essence.

Rule 16  
IF NEEDS is oil-control.  
AND SEASONALLY\_RECOMMENDED\_FORM is summer\_freshType.  
AND GROUP is teenager.  
AND not SENSITIVE.  
THEN cosmetics is SKINFOOD-Lettuce\_Cucumber-Watery-Emulsion.

Rule 17  
IF NEEDS is anti-aging-skin-care.  
AND SEASONALLY\_RECOMMENDED\_FORM is fall\_nutritiousType.  
AND GROUP is middle-aged.  
AND not SENSITIVE.  
THEN cosmetics is SKINFOOD-GinsengFruit-Revital-Capsule-Essence.

Rule 18  
IF NEEDS is spot-focused-care.  
AND SEASONALLY\_RECOMMENDED\_FORM is summer\_freshType.  
AND GROUP is youth.  
AND not SENSITIVE.  
THEN cosmetics is TONYMOLY-2X-FirstEssence.

Rule 19  
IF NEEDS is whitening.  
AND SEASONALLY\_RECOMMENDED\_FORM is spring\_protectiveType.  
AND GROUP is youth.  
AND not SENSITIVE.  
THEN cosmetics is TONYMOLY-GoatMilk-Premium-cream.

Rule 20  
IF NEEDS is oil-control.  
AND SEASONALLY\_RECOMMENDED\_FORM is summer\_freshType.  
AND GROUP is teenager.  
AND SENSITIVE.  
THEN cosmetics is SKINFOOD-FreshApple-Toner.

Rule 21  
IF NEEDS is anti-aging-skin-care.  
AND SEASONALLY\_RECOMMENDED\_FORM is winter\_moisturizingType.  
AND GROUP is youth.  
AND SENSITIVE.  
THEN cosmetics is TONYMOLY-TheBlackTea-LondonClassic-Serum.

Figure 2: Knowledge base, Rule : IF-THEN

<Figure 3>

In Fig.3, you can find a table of the objects and the allowed values. The object part contains COMPLEX, ENVIRONMENT, AGE, NEEDS, SEASONALLY\_RECOMMENDED\_FORM, GROUP, and SENSITIVITY. Each object has allowed values, which are set by an engineer. For this study, two to seventeen cases of allowed values are determined for each object. However, allowed values again divided into some parts and those are connected to another object's allowed value. For instance, Object COMPLEX has freckle, pimple, scar, atopic dermatitis, dark-skin, face-flush, yellow-skin, spotted-tanning, coarse-skin, face-dryness, magnified-horny-layer, oily-face, sebum, blemish, pore, skin-lacking-elasticity and wrinkle. These COMPLEX values can be diverged to parts and can be united to NEEDS values.

If the user chooses freckle, pimple, scar or atopic dermatitis, the engine will run and be aware that this user's NEEDS is spot-focused-care. In a same manner, all the four questions and answers will be saved in the system when typed, to get the information of the user and through it, to recommend the suitable, customized fundamental cosmetics for the user. Fig. 4, Fig.5, and Fig.6 show the details of this process.

For Sensitivity, only two options, yes or no, are available, so the user will input one of these options. Fig.4, Fig.5 and Fig.6's inference engine will run, and there, the system will add Sensitivity input, then finally the recommendation inference engine system will commend the customized fundamental cosmetics to the user.

**Complex -> Needs**

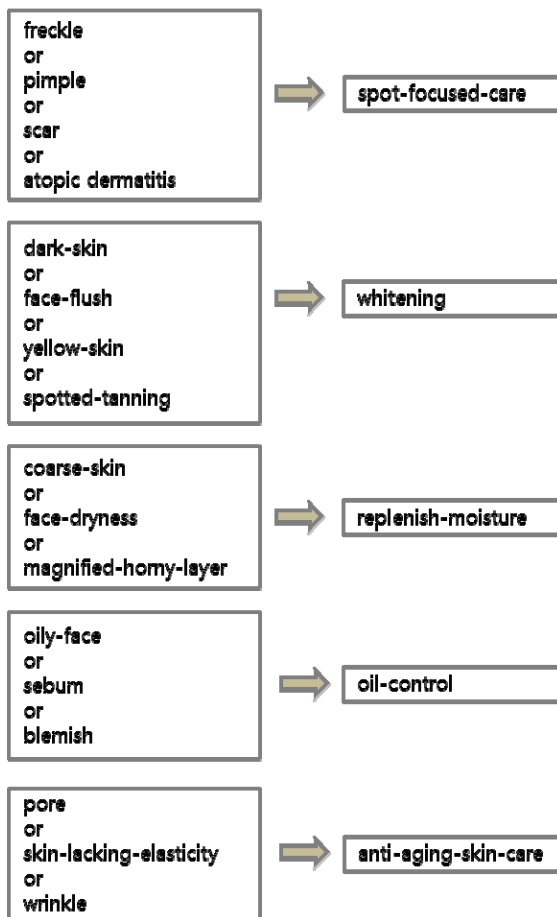


Figure 4: Knowledge base of the Needs from the Complex input

**Environment -> Seasonally\_recommended\_form**

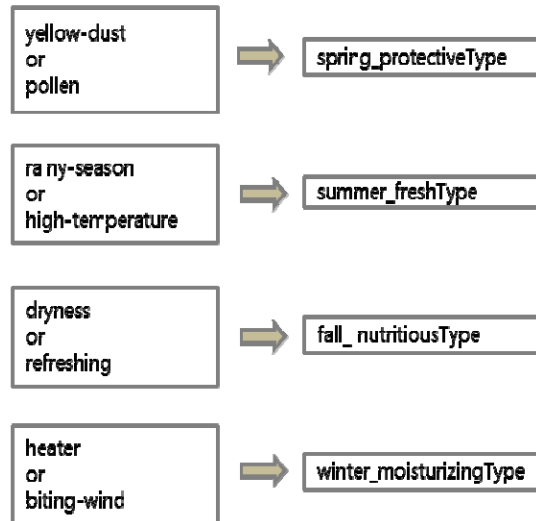


Figure 5: Knowledge base of the seasonally recommended form from the Environment input

**Age -> Group**

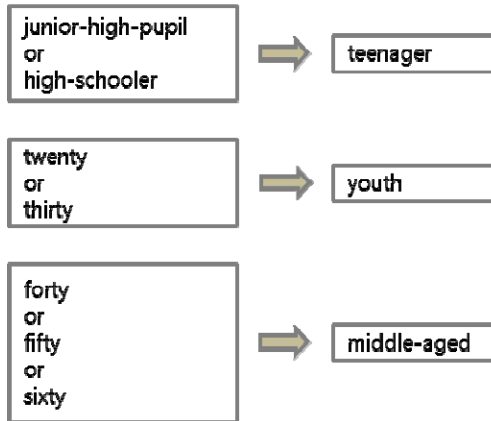


Figure 6: Knowledge base of the Group from the Age input

## 4. EXPERIMENTS

### 4.1 Implementation of the recommendation system of the fundamental cosmetics using the Prolog language

<Figure 7>

Fig. 7 shows the final tree diagram for the rule-based expert system of the fundamental cosmetics based on the knowledge bases of Fig.4, Fig.5, and Fig.6. According to this diagram, the Prolog language of the recommendation system of the fundamental cosmetics was implemented.

### 4.2 Demonstration of the recommendation system of the fundamental cosmetics using the Prolog language

<Figure 8>

To demonstrate the proposed system, the logic-based language Prolog was used. It is an advanced-logic programming language for artificial intelligence [6]. The inputs and the outputs and the behavior of the system when it obtains the values were declared by the authors, and the “retractall” function was also used to erase all of the information inside each cycle when the cycle ends, as this enables the next cycle to run clearly. In the cords of the Prolog, “comma (,)” and “semicolon (;)” are present. The comma indicates “and,” and the semicolon indicates “or.” So, “animal(cat) : - (characteristic(fluid), appearance(cute))” means that if the user types “fluid” for the characteristic question and “cute” for the appearance question, the inference engine will inference “cat” for the animal. Also, for “food (fruits) : - (object (apple); object (banana)),” if the user types “apple” or “banana” for the object, the system inferences “fruits.”

```
1 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? freckle.
- Which environmental condition are you in?: rainy-season.
- What age group are you in?: high-schooler.
- Is your skin sensitive?: yes.
SKINFOOD Broccoli Watery Ampoule
true .
```

```
2 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? dark-skin.
- Which environmental condition are you in?: yellow-dust.
- What age group are you in?: twenty.
- Is your skin sensitive?: yes.
TONYMOLY Floria Whitening spot Eraser
true .
```

```
3 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? face-dryness.
- Which environmental condition are you in?: heater.
- What age group are you in?: forty.
- Is your skin sensitive?: yes.
SKINFOOD Royal Honey Propolis Essence
true .
```

```
4 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? oily-face.
- Which environmental condition are you in?: high-temperature.
- What age group are you in?: junior-high-pupil.
- Is your skin sensitive?: no.
SKINFOOD Lettuce and Cucumber Watery Emulsion
true .
```

```
5 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? pore.
- Which environmental condition are you in?: dryness.
- What age group are you in?: fifty.
- Is your skin sensitive?: no.
SKINFOOD Ginseng Fruit Revital capsule Essence
true .
```

```
6 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? pimple.
- Which environmental condition are you in?: air-condition.
- What age group are you in?: thirty.
- Is your skin sensitive?: no.
TONYMOLY 2X First Essence
true .
```

```
7 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? face-flush.
- Which environmental condition are you in?: frequent-temperature-change.
- What age group are you in?: twenty.
- Is your skin sensitive?: no.
TONYMOLY Goat Milk Premium Cream
true .
```

```

8 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? sebum.
- Which environmental condition are you in?: high-temperature.
- What age group are you in?: high-schooler.
- Is your skin sensitive?: yes.
SKINFOOD Fresh Apple Toner
true .

9 ?- start.
****Road Shop Cosmetic products Recommendation****
- What complex do you have? wrinkle.
- Which environmental condition are you in?: biting-wind.
- What age group are you in?: thirty.
- Is your skin sensitive?: yes.
TONYMOLY the Black Tea London Classic Serum
true .

```

Figure 9: Demonstration of Prolog [7-15]

As can be seen in this Prolog demonstration, Fig.8 shows the cords that were typed for the study; that is, those regarding the fundamental-cosmetics recommendation system for which the rule-based expert system is used. Fig. 9 presents the results of the Prolog demonstration, wherein the questions that are needed to inference the user's information are entered, and to answer these questions, the system proceeds to check for a match; if there is, it shows the program output with the recommended fundamental cosmetics.

## 5. CONCLUSIONS

This paper presents the design and demonstration of a fundamental-cosmetics recommendation inference engine for which a rule-based expert system and Prolog are used to lessen the customers' concerns regarding their product choices, and it can also assist the relevant industries' marketing strategies.

The research in this paper does not include all fundamental cosmetics as it is only based on some road shops' cosmetics, and so it has limitation that it might not be widely used, however, we are expecting that this study's subject and range of the depth can be differently researched by the researcher so that it can be customizingly changed to whatever the researcher or the user want. Also, this program can be developed into a device-connected program such as an application (app) in mobile, then it will be more comfortable and

helpful when using. The intention here is to fulfill the needs and satisfaction of the users who are in needed.

## ACKNOWLEDGEMENT:

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014R1A1A1A05008028).

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- [9] Result of the Prolog demonstration No.3, SKINFOOD Royal Honey Propolis Essence, <http://sunkjydbgn.blog.me/220194731931?Redirect=Log&from=postView>.
- [10] Result of the Prolog demonstration No.4, SKINFOOD Lettuce and Cucumber Watery Emulsion, <http://blog.naver.com/hyuni2mail/220353027418>.
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- [13] Result of the Prolog demonstration No.7, TONYMOLY Goat Milk Premium Cream,

- <http://blog.naver.com/sujinkongjoo/2202933763>  
56.
- [14] Result of the Prolog demonstration No.8,  
SKINFOOD Fresh Apple Toner,  
<http://blog.naver.com/plm3334/220762991798>.
- [15] Result of the Prolog demonstration No.9,  
TONYMOLY the Black Tea London Classic  
Serum,  
<http://blog.naver.com/yangjoohyun/2207947709>  
85.

OBJECT	ALLOWED VALUE	OBJECT	ALLOWED VALUE
<b>COMPLEX</b>	freckle	<b>NEEDS</b>	spot-focused-care
	pimple		wr tening
	scar		replenish-mo sture
	atopic derratitis		oil-control
	dark-skin		anti-aging-skin-care
	face-flush		
	yellow-skin		
	spotted-tanning		yellow-dust
	coarse-skin		pollen
	face-dryness		frequent-temperature-change
	magnified-homy-layer		rainy-season
	oily-face		air-condition
	sebum		high-temperature
	blemis1		dryness
	pore		large-temperature-different al
skin-lacking-elasticity	refresh rg		
wrinkle	heater		
	snowy-weather		
	biting-wind		
<b>AGE</b>	junior-high-pupil	<b>SEASONALLY RECOMMENDED FORM</b>	spring_protectiveType
	high-schooler		summer_freshType
	twenty		fall_rutritiousType
	thirty		w rter_moist.r zingType
	forty		
	fifty		
sixty			
<b>GROUP</b>	teer ager	<b>SENSITIVITY</b>	Yes
	youth		no
	middle-aged		

Figure 3: Table of the objects and allowed values

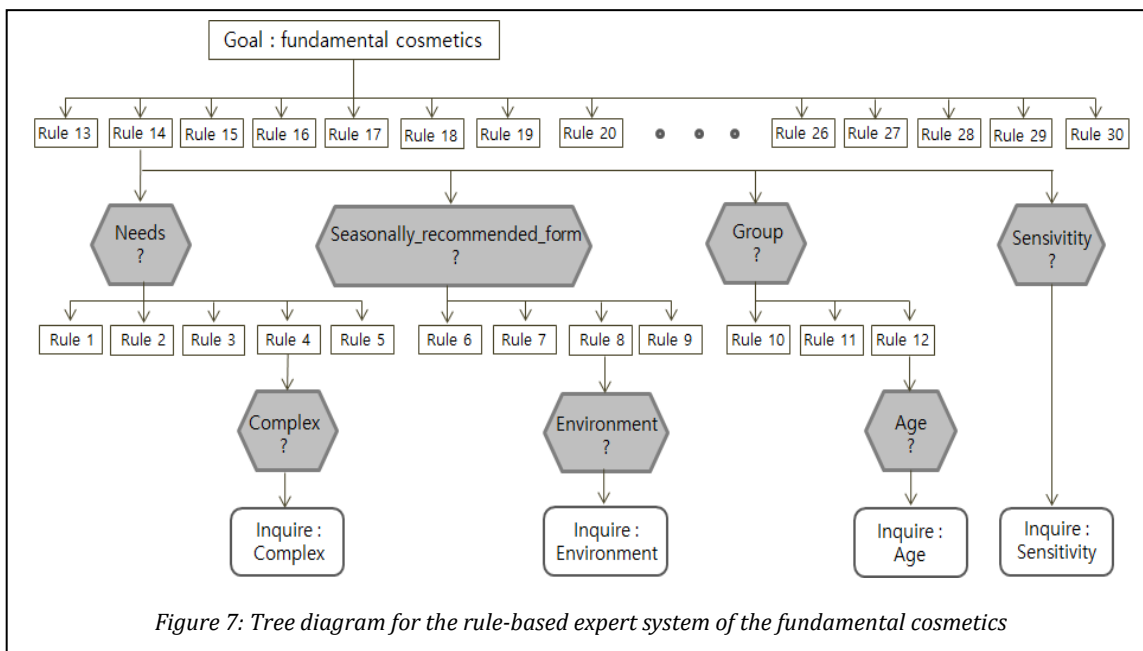


Figure 7: Tree diagram for the rule-based expert system of the fundamental cosmetics



```

start :-
  nl,write("*****Road Shop Cosmetic products Recommendation*****"),nl,nl,
  write("- What complex do you have?"),
  read(Input1),nl,
  write("- Which environmental condition are you in?"),
  read(Input2),nl,
  write("- What age group are you in?"),
  read(Input3),nl,
  write("- Is your skin sensitive?"),
  read(Input4),nl,
  assert(complex(Input1)),assert(environment(Input2)),assert(age(Input3)), assert(sensitivity(Input4)), result(r),
  retractall(complex(_)),retractall(environment(_)),retractall(sensitivity(_)),nl.

needs(spot-focused-care):- (complex(freckle);complex(pimple);complex(scar);complex(atopy)).

needs(whitening):- (complex(dark-skin); complex(face-flush);complex(yellow-skin); complex(spotted-tanning)).

needs(replenish-moisture):- (complex(coarse-skin);complex(face-dryness); complex(magnified-horny-layer)).

needs(oil-control):- (complex(oily-face);complex(sebum); complex(blemish)).

needs(anti-aging-skin-care):- (complex(pore);complex(skin-lacking-elasticity); complex(wrinkle)).

seasonally_recommended_form(spring_protectiveType) :- (environment(yellow-dust); environment(pollen);
  environment(frequent-temperature-change)).

seasonally_recommended_form(summer_freshType) :- (environment(rainy-season); environment(air-condition);
  environment(high-temperature)).

seasonally_recommended_form(fall_nutritiousType) :- (environment(dryness); environment(large-temperature-differential);
  environment(refreshing)).

seasonally_recommended_form(winter_moisturizingType) :- (environment(heater); environment(snowy-weather); environment(biting-wind)).

group(teenager):- (age(junior-high-pupil);age(high-schooler)).

group(youth):- (age(twenty); age(thirty)).

group(middle-aged):- (age(forty); age(fifty); age(sixty)).

cosmetics(sKINFOOD-broccoli-watery-ampoule):- (needs(spot-focused-care),
  seasonally_recommended_form(summer_freshType), group(teenager), sensitivity(yes)).

cosmetics(TONYMOLY-floria-whitening-spot-eraser) :- (needs(whitening),
  seasonally_recommended_form(spring_protectiveType),group(youth),sensitivity(yes)).

cosmetics(sKINFOOD-royalHoney-propolis-essence):- (needs(replenish-moisture),
  seasonally_recommended_form(winter_moisturizingType),group(middle-aged),sensitivity(yes)).

cosmetics(sKINFOOD-lettuceCucumber-watery-emulsion) :- (needs(oil-control),
  seasonally_recommended_form(summer_freshType),group(teenager),sensitivity(no)).

cosmetics(sKINFOOD-ginsengFruit-revital-capsule-essence) :- (needs(anti-aging-skin-care),
  seasonally_recommended_form(fall_nutritiousType),group(middle-aged),sensitivity(no)).

cosmetics(TONYMOLY-twoX-firstEssence) :- (needs(spot-focused-care),
  seasonally_recommended_form(summer_freshType),group(youth),sensitivity(no)).

cosmetics(TONYMOLY-goatMilk-premium-cream) :- (needs(whitening),
  seasonally_recommended_form(spring_protectiveType),group(youth),sensitivity(no)).

cosmetics(sKINFOOD-freshApple-toner) :- (needs(oil-control),
  seasonally_recommended_form(summer_freshType),group(teenager), sensitivity(yes)).

cosmetics(TONYMOLY-theBlackTea-londonClassic-serum) :- (needs(anti-aging-skin-care),
  seasonally_recommended_form(winter_moisturizingType),group(youth),sensitivity(yes)).

result(r):-cosmetics(sKINFOOD-broccoli-watery-ampoule),write('SKINFOOD Broccoli Watery Ampoule');
  cosmetics(TONYMOLY-floria-whitening-spot-eraser), write('TONYMOLY Floria Whitening spot Eraser');
  cosmetics(sKINFOOD-royalHoney-propolis-essence), write('SKINFOOD Royal Honey Propolis Essence');
  cosmetics(sKINFOOD-lettuceCucumber-watery-emulsion), write('SKINFOOD Lettuce and Cucumber Watery Emulsion');
  cosmetics(sKINFOOD-ginsengFruit-revital-capsule-essence), write('SKINFOOD Ginseng Fruit Revital capsule Essence');
  cosmetics(TONYMOLY-twoX-firstEssence), write('TONYMOLY 2X First Essence');
  cosmetics(TONYMOLY-goatMilk-premium-cream), write('TONYMOLY Goat Milk Premium Cream');
  cosmetics(sKINFOOD-freshApple-toner), write('SKINFOOD Fresh Apple Toner');
  cosmetics(TONYMOLY-theBlackTea-londonClassic-serum), write('TONYMOLY the Black Tea London Classic Serum');
  write('no result.').

```

Figure 8: Implemented prolog code