



RestaurantTEC

Project

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1. RestaurantEC

1.1. Source code

Check out the project source code at



1.2. Objective

Develop an application that allows to reaffirm the knowledge of the logic programming paradigm, through:

- ♦ Create an application that behaves like an Expert System using the Prolog programming language.
- ♦ Application of the concepts of the logic programming paradigm.
- ♦ Creation and manipulation of lists as data structures.

2. Description

Expert systems (ES) are computational applications that involve non-algorithmic expertise to solve a certain type of problem. For example, expert systems are used for diagnostics in the service of humans and machines. There are SEs that play chess, make financial decisions, configure computers, monitor real-time systems, decide insurance policies, and perform other tasks that require human expertise.

The SE should recommend restaurants to users who tell it their preferences and it will search its vicinity for the best match. The user interface must be completely natural using the Spanish language (it must be implemented using BNF) and the SE must behave like a human.

3. Requirements

The development environment used during the development of the RestaurantEC application was:

- ♦ Programming language: Prolog v. 9.0.4
- ♦ IDE : SWI-Prolog
- ♦ Operative System: Windows 10
- ♦ RAM : 8 GB
- ♦ Storage : 300 KB

4. Facts and Rules

An Expert System behaves like a person who is an expert in a specific domain. These systems usually consist of three modules:

- ◆ Knowledge base
- ◆ Inference engine
- ◆ User interface

Where each module respects modularity, incremental knowledge, adaptability to possible changes and transparency in its decisions. For the inference process of the data stored in the database, the system defines a language structure. For this project, the structure respects the rules of the Spanish language to define its own grammar with syntax in a BNF. Listed below are the most important facts and rules used in the data processing of the SE restaurant recommendation algorithm.

Note: RestaurantEC's facts and rules specified in this document are the base form, to find all facts and rules visit the project repository and read them in detail in the source code files.

4.1. Nouns

The defined nouns refer mainly to the food or restaurant that the user might want.

Table #. RestaurantEC's BNF people nouns.

Format	Class	Form	Gender	Noun
		[sing-plu]	[fem-masc]	
<i>noun(form, gender, [noun S], S)</i>	People	sing	masc	hombre
		sing	fem	mujer
		sing	masc	hijo
		sing	fem	hija
		sing	masc	esposo
		sing	fem	esposa

Table #. RestaurantEC's BNF food nouns.

Format	Class	Form [sing-plu]	Gender [fem-masc]	Noun
<i>noun(form, gender, [noun S], S)</i>	Food	sing	fem	comida
		sing	fem	manzana
		sing	fem	hamburguesa
		plu	fem	papas
		sing	masc	casado
		sing	masc	postre
		sing	masc	casado
		sing	masc	mondongo
		sing	fem	prensada
		sing	fem	tortilla
		sing	masc	sandwich
		sing	masc	emparedado
		sing	fem	ensalada
		sing	fem	pasta
		sing	masc	falafel
		sing	fem	pizza
		sing	masc	spaguetti
		sing	fem	lasagna
		sing	masc	gelato
		plu	fem	gyozas
		plu	masc	dumplings
		sing	masc	cantones
		sing	masc	tofu

Table #. RestaurantTEC's BNF drink nouns.

Format	Class	Form [sing-plu]	Gender [fem-masc]	Noun
<i>noun(form, gender, [noun S], S)</i>	Drink	sing	fem	bebida
		sing	masc	fresco
		sing	masc	refresco
		sing	masc	coctel
		sing	fem	gaseosa
		sing	fem	cerveza
		sing	masc	cas
		sing	fem	fresa
		sing	masc	cafe
		sing	masc	chocolate
		sing	masc	capuchino
		sing	fem	cocacola
		sing	fem	sprite
		sing	fem	fanta
		sing	masc	martini
		sing	fem	margarita
		sing	fem	nacional
		sing	fem	corona

Table #. RestaurantTEC's BNF location nouns.

Format	Class	Form [sing-plu]	Gender [fem-masc]	Noun
<i>noun(form, gender, [noun S], S)</i>	Location	sing	–	'Cartago'
		sing	–	'Alajuela'
		sing	–	'Heredia'

Table #. RestaurantTEC's BNF restaurant nouns.

Format	Class	Form	Gender	Noun
		[sing-plu]	[fem-masc]	
<i>noun(form, gender, [noun / S], S)</i>	Restaurant	sing	–	'McDonalds'
		sing	–	'KFC'
		sing	–	'Balcon Criollo'
		sing	–	'Samadhi'
		sing	–	'Subway'
		sing	–	'La Dolce Vita'
		sing	–	'Ragu'
		sing	–	'Cuchara Oriental'
		sing	–	'Yong Xing'

4.2. Pronouns

The pronouns defined are the basic pronouns used in the Spanish language.

Table #. RestaurantTEC's BNF pronouns.

Format	Form	Person	Pronoun
	[sing-plu]	[fst-thrd]	
<i>pronoun(form, person, [pronoun / S], S)</i>	sing	fst	yo
	plu	fst	nosotros
	sing	thrd	el
	sing	thrd	Ella
	plu	thrd	Ellos
	plu	thrd	Ellas
	sing	thrd	'Marco'
	sing	thrd	'Oscar'
	sing	thrd	'Sebastian'
	sing	thrd	'Valerie'

4.3. Determinants

The determinants defined are the basic determinants used in the Spanish language.

Table #. RestaurantTEC's BNF definite/indefinite articles.

Format	Class	Form	Gender	Person	Determinant
		[sing-plu]	[fem-masc]	[frst-thrd]	
<i>determinant(form, gender, person, [determinant S], S)</i>	Article	sing	masc	thrd	el
		sing	fem	thrd	la
		plu	masc	thrd	los
		plu	fem	thrd	las
		sing	masc	thrd	un
		sing	fem	thrd	una
		plu	masc	thrd	unos
		plu	fem	thrd	unas

Table #. RestaurantTEC's BNF demonstrative adjective.

Format	Class	Form	Gender	Person	Determinant
		[sing-plu]	[fem-masc]	[frst-thrd]	
<i>determinant(form, gender, person, [determinant S], S)</i>	Adjective	sing	masc	thrd	aquel
		sing	fem	thrd	aquella
		plu	masc	thrd	aquellos
		plu	fem	thrd	aquellas
		sing	masc	thrd	ese
		sing	fem	thrd	esa
		plu	masc	thrd	esos
		plu	fem	thrd	esas
		sing	masc	thrd	este
		sing	fem	thrd	esta
		plu	masc	thrd	estos
		plu	fem	thrd	estas

Table #. RestaurantEC's BNF possessive adjective.

Format	Class	Form	Gender	Person	Determinant
		[sing-plu]	[fem-masc]	[first-thrd]	
<i>determinant(form, gender, person, [determinant S], S)</i>	Adjective	sing	–	thrd	mi
		plu	–	thrd	mis
		sing	masc	thrd	nuestro
		sing	fem	thrd	nuestra
		plu	masc	thrd	nuestros
		plu	fem	thrd	nuestras

4.4. Adjectives

The defined adjectives refer mainly to the description of the food that the user might want.

Table #. RestaurantEC's BNF adjectives.

Format	Form	Gender	Adjective
	[sing-plu]	[fem-masc]	
<i>adjective(form, gender, [adjective S], S)</i>	sing	masc	rico
	sing	masc	pequeno
	sing	–	grande
	sing	masc	frio
	sing	masc	frito
	sing	–	caliente
	sing	fem	natural
	sing	fem	gaseosa
	sing	fem	nacional
	sing	fem	corona
	sing	fem	rapida
	sing	fem	italiana
	sing	fem	china
	sing	fem	saludable
	sing	fem	tipica

4.5. Adverbs

The adverbs defined are the basic adverbs used in the Spanish language.

Table #. RestaurantEC's BNF adverbs.

Format	Adverb
<i>adverb([adverb / S], S)</i>	cerca
	lejos
	antes
	luego
	pronto
	hoy
	manana
	ahora
	ahorita
	si
	claro
	tambien
	no
	tampoco
	ni
	quiza
	igual
	posiblemente
	probablemente
	seguramente

4.6. Verbs

The verbs defined are the basic verbs used in the Spanish language in a situation where a customer requests information and recommendations about food places. Only one of the verbs implemented by the ES is shown in the following table. To see all verbs, go to the project repository and read the source code.

Table #. RestaurantEC's BNF verbs sample.

Format	Time	Form	Person	Verb
		[sing-plu]	[frst-thrd]	
<i>verb(form, person, [verb / S], S)</i>	Present	sing	frst	busco
		sing	thrd	busca
		plu	frst	buscamos
		plu	thrd	buscan
	Future	sing	frst	buscare
		sing	thrd	buscara
		plu	frst	buscaremos
		plu	thrd	buscaran
	Past	sing	frst	buscaba
		sing	thrd	buscaba
		plu	frst	buscabamos
		plu	thrd	buscaban
	Conditional	sing	frst	buscaria
		sing	thrd	buscaria
		plu	frst	buscaríamos
		plu	thrd	buscarían

4.7. Prepositions

The prepositions defined are the basic prepositions used in the Spanish language.

Table #. RestaurantEC's BNF prepositions.

Format	Preposition
<i>preposition([preposition / S], S)</i>	a
	ante
	bajo
	cabe
	con
	contra
	de
	desde
	en
	entre
	hacia
	para
	por
	según
	sin
	sobre
	tras

4.8. Conjunctions

The conjunctions defined are the basic conjugations used in the Spanish language.

Table #. RestaurantEC's BNF conjunctions.

Format	Conjunction
<i>conjunction([conjunction / S], S)</i>	y
	o
	u

5. Data Structures

Given the fact that the programming language is not very flexible compared to other programming languages seen during the course. The only data structure used in this project were the lists. These were implemented in the knowledge database so that the system could offer restaurant options based on them.

5.1. Restaurant

The first list implemented was for recording the general data that a restaurant can offer.



```
restaurant([
    name,
    food_category,
    [drink_category],
    location,
    address,
    [menu],
    capacity,
    slogan
]).
```

Figure #. RestaurantEC's restaurant data structure.

A total of 15 possible restaurants were implemented that the system can suggest based on the user's needs, the following table shows the data of the popular McDonald's restaurant.

Table #. RestaurantEC's restaurant structure data sample.

<i>name</i>	'McDonalds'
<i>food_category</i>	'rapida'
<i>drink_category</i>	['gaseosa','caliente']
<i>location</i>	'Cartago'
<i>address</i>	'150 m sur del walmart de caballo blanco'
<i>menu</i>	['Hamburguesa','Desayuno','Postre','Papas','Pollo']
<i>capacity</i>	'30'
<i>slogan</i>	'Este es un restaurante para toda la familia, area de juego para ninos'

5.2. Food

Text



Figure #. RestaurantEC's food data structure.

Text

Table #. RestaurantEC's food structure data sample.

<i>category</i>	'tipica'
<i>menu</i>	['casado','prensada','mondongo','tortilla','chifrijo']
<i>restaurant</i>	['Balcon Criollo', 'Rancho Los Coyotes']

5.3. Drink

Text



Figure #. RestaurantEC's drink data structure.

Text

Table #. RestaurantEC's drink structure data sample.

<i>category</i>	'natural'
<i>menu</i>	['cas','fresa','limon','sandia']
<i>restaurant</i>	['Balcon Criollo', 'Rancho Los Coyotes', 'Samadhi', 'Subway', 'Cuchara Oriental', 'Yong Xing', 'La Dolce Vita', 'Ragu']

5.4. Location

Text



Figure #. RestaurantTEC's location data structure.

Text

Table #. RestaurantTEC's location structure data sample.

<i>location</i>	'Alajuela'
<i>case</i>	['alajuela']
<i>restaurant</i>	['Balcon Criollo', 'Cuchara Oriental', 'Yong Xing', 'Samadhi', 'KFC', 'Rancho Los Coyotes']

6. Solution's algorithm

The processing of the user sentences consists in three phases: lexical analysis, syntactic analysis, and semantic analysis. The first two phases are processed by the BNF who checks the use of valid words and the structure of valid sentences, the third phase (semantic) is processed by the Expert System who make sure to find a meaning on the sentence and act accordingly.

6.1. Backus-Naur Form (BNF)

The BNF make use of context free grammar, specifically with a Backus-Naur Form, with the following structure and using the facts such as nouns, verbs and all the other facts already showed before.

```

<sentence> --> <noun_phrase> <verb_phrase> <sign>
<sentence> --> <pronoun> <verb_phrase> <sign>
<sentence> --> <verb_phrase> <sign>
<sentence> --> <verb_phrase> <question_sign>
<sentence> --> <question> <noun_phrase> <verb> <question_sign>
<noun_phrase> --> <determinant> <noun>
<noun_phrase> --> <determinant> <noun> <name_complement>
<noun_phrase> --> <noun> <name_complement>
<noun_phrase> --> <prepositional_phrase>
<noun_phrase> --> <determinant> <noun> <conjunction> <determinant> <noun>
<noun_phrase> --> <noun>
<verb_phrase> --> <adverb> <verb> <noun_phrase>
<name_complement> --> <prepositional_phrase>
<name_complement> --> <adjectival_phrase> <prepositional_phrase>
<name_complement> --> <adjectival_phrase>
<adjectival_phrase> --> <adjective>
<prepositional_phrase> --> <adverb> <preposition> <noun>
<prepositional_phrase> --> <adverb> <preposition> <noun> <adjective>
<pronoun> --> el, ella, Oscar, Valerie...
<determinant> --> el, la, unos, unas...
<noun> --> pizza, pollo, papas...
<verb> --> como, comemos, comeremos...
<preposition> --> a, ante, de, desde...
<conjunction> --> y, o, u...
<adjective> --> rapida, saludable...
<adverb> --> si, no, tambien, hoy...
<question> --> que, cual, cuales...

```

A simple example of a visualization of a sentence that follows the structure shown, can be seen below .

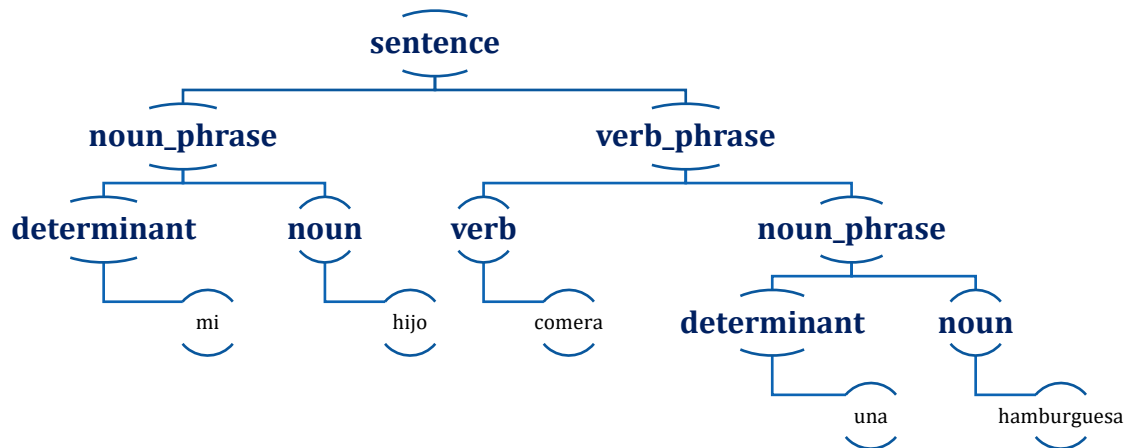


Figure #. RestaurantEC's BNF structure.

An important detail on the implementation of the BNF is that the verbs has attributes such as person (first or third) and number (singular or plural), and the determinants and nouns have person, number and gender (masculine or feminine) in order to control a better syntactic restriction, avoiding sentences with no sense such as “el muchacha quieren comer papas frita” and forcing common sentences such as “mi esposa quiere comer papas fritas”. The program is also capable of recognize questions as a sentence.

6.2. Expert System (ES)

The Expert System makes questions for the user to get the necessary information in order to find a restaurant with the qualifications that the user wants, the ES can also detect what the user is saying, so you can ask questions to it, like what kind of food or drinks are available or specific item menus, it also detects if you asked for help and brings a help menu with some information about it.

Some of the questions made by the system are about the type of food or the type of drinks that the user wants, the place where the user is going to be and the amount of people going to the restaurant, with that information the system can check if the database has a restaurant that fills the values sent by the user.

To check if the database has a restaurant with the user preference it takes all the restaurants that have the type of food wanted by the user and the place it's going to be and

checks if the desired drink is available and has the capacity for the amount of people coming, if this checks are true then it recommends a restaurant to the user, else it says that a restaurant with the user preference was not found and gives the user the option to make another search.

7. Issues

As in any kind of software development, there were multiple issues found along the development process, the issues were successfully solved and still require a solution. For both circumstances, those active and solved issues are described in section 7.1 and 7.2.

7.1. Active Issues

During the development period we found some errors in the implemented algorithm. Most of them depended on the way the programming language is structured. However, all of them were solved before the release date. However, we cannot assure that the application is error free.

7.2. Fixed Issues

As in any programming project, throughout the development process there were found and solved a several issues. But fortunately, all of them were solved successfully by the end of the due date. So, below you can find more information about some of the most relevant solved issues in table:

Table #. RestaurantEC project fixed issues.

I	Description	Tries	Solution	Considerations	Results	References
1	File corruption	2	A solution to the corruption of the file was to eliminate all the symbols not included on the UTF-8 table	Most of the version control software process data in UTF-8 tables as a standard for english, if we add characters from another language its gonna have conflicts	After changing all the corrupt characters in all the files, using the version control no longer had stopped the problem	docs.github.com/en/about-large-files-on-github
2	App exit	1	It was implemented a condition were the systems checks the user input to close the	It is difficult to handle the close event from the windows X button	It was resolved the problem and avoided bigger problems	swi-prolog.org/pldoc/halt

			program safely			
3	Accents	3				<i>swi- prolog.org/pl doc/unicode</i>

8. Project management

As a software project, there was conducted some project management techniques to handle and track the development process, especially because the limited time of only two weeks disposed to develop the RestaurantTEC solution.

8.1. Plan

The planification consisted mostly of three activity tables with deadlines for each task, with specified description, deadline, student responsible.

Table #. Weekly goals.

Activity	May	
	1 st Week (22 - 28)	2 nd Week (29 - 31)
Operational and administrative aspects assessment.		
Possible solutions research and analysis.		
Algorithm development.		
UI development.		
Code debugging.		
Technical documentation.		

In the next table you can see the development of the activities in the project with a brief description, date and the respective responsible. But you can see an extended description of the tasks in the table .

Table #. Activities implemented by contributors in deadlines calendar.

[illegible]

8.2. Log

In this section you can find one log table for each member, where you can track the progression and work of each student individually along with the commits in the GitHub repository.

Table #. Óscar's Log.

Date	Duration (hr.)	Description
22/05/2023	10	Statement of Facts and Deductions for a simple BNF. Request and reception of phrases from the CMD interface.
26/05/2023	10	BNF structure improved including pronouns and name complements
29/05/2023	5	BNF structure improved with more than 20 verbs and the implementation of name complements
31/05/2023	3	Add restaurants, foods, drinks, and locations to the database
01/06/2023	6	Add adjectives, names, verbs, nouns, conjunctions, food, drinks, restaurants to the BNF.
02/06/2023	3	BNF validates the numbers, and the DB was update.
03/06/2023	5	DB and BNF updated. Some words were replaced to only have single word drinks and meals at the DB and the BNF now accepts the end of a sentence and a noun structure.

Table #. Sebastián's Log.

Date	Duration (hr.)	Description
26/05/2023	3	Create the databased with the first structures for the restaurant and matching values.
29/05/2023	5	Updated format for the database, added the food and drink categories to sort the restaurant.
30/05/2023	8	ES structure. Added first atomic functions and small chat with the user for the ES and new functions to the ES and new questions.
31/05/2023	5	Update some functions in the ES for the input validation.
01/06/2023	3	Code cleanup and BNF update.
02/06/2023	5	Expert system enhanced.

Table #. Valerie's Log.

Date	Duration (hr.)	Description
24/05/2023	1	Create the log form.
25/05/2023	2	Setup the technical documentation file structure.
29/05/2023	1	Send some recommendations about the DB structure.
01/06/2023	5	Technical documentation file updated.

9. Conclusions

It was possible to successfully develop an application of an expert system in charge of giving restaurant recommendations based on user preferences.

The concepts and techniques of the logical programming paradigm were applied to solve the problem faced.

The use of lists and data structures typical of the logical programming paradigm and the prolog programming language was planned and implemented in order to develop a stable solution to the problem.

10. Recommendations

It is recommended to expand the information database to cover a complete urban area in order to apply the program to a test audience.

The use of another language is recommended to develop a more attractive interface for the user

11. References

Lim, H. S. (1999). *Estudio sintáctico-semántico de la ambigüedad del sintagma nominal del español*. Español como lengua extranjera, enfoque comunicativo y gramática: actas del IX congreso internacional de ASELE, Santiago de Compostela, 1998 (pp. 643-650).