

Formula 1

EXPERT SYSTEM

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Formula 1 Expert System

The F1 expert system is designed with the purpose of assisting F1 teams with the correct selection of tires, fuel loads, and racecar settings such as front and rear downforce levels. The F1 expert system was created using CLIPS (Quicksilver Beta 12/31/07).

The F1 expert system is designed based on the 2008 Formula 1 season rules and tracks. With 18 races across the world, the Formula 1 2008 season presents different challenges to the teams based on different tracks, racecar setups, weather conditions, and driver abilities and styles.

The 2008 season visits 18 different tracks, each of which has different configuration. Length, track surface, difficulty, number of laps, all these settings must be taken into account by F1 teams in order to determine the correct setup for each race.

2008 F1 Season

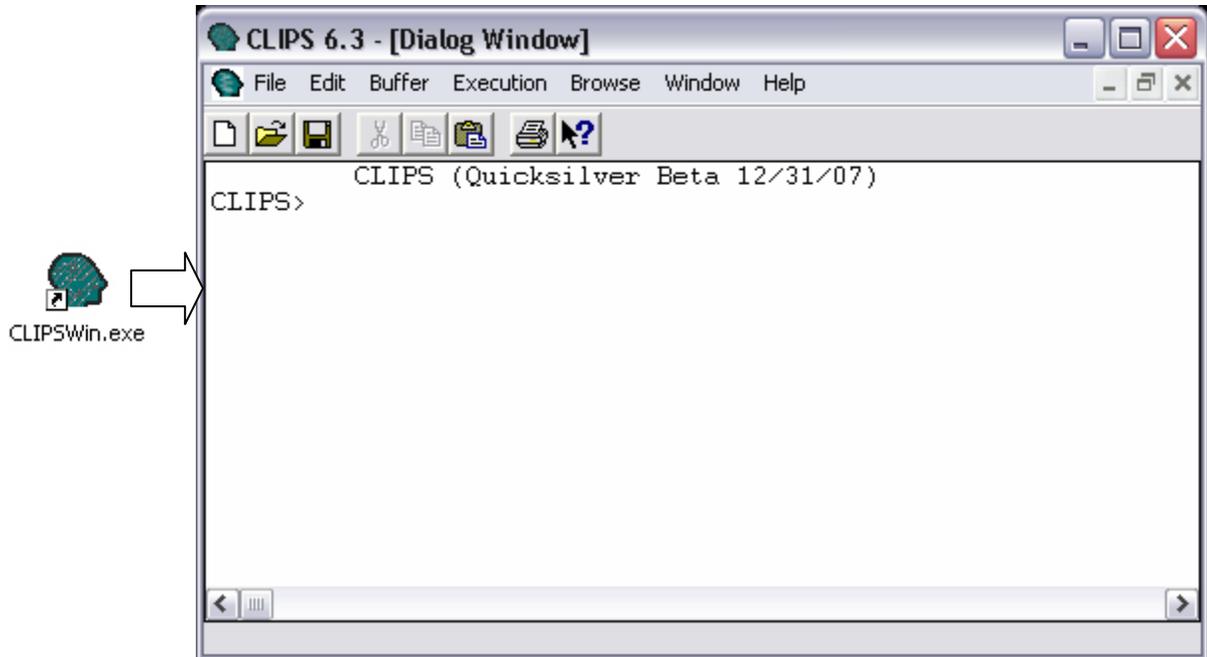
1. Australia	7. Canada	13. Belgium
2. Malaysia	8. France	14. Italy
3. Bahrain	9. UK	15. Singapore
4. Spain	10. Germany	16. Japan
5. Turkey	11. Hungary	17. China
6. Monaco	12. Europe	18. Brazil

The F1 expert system based on the track selection loads the correct track settings and uses them as integral part of its knowledge database. Race conditions such as weather and best track times must also be considered when taking decisions about fuel loads, tire selection, and downforce levels.

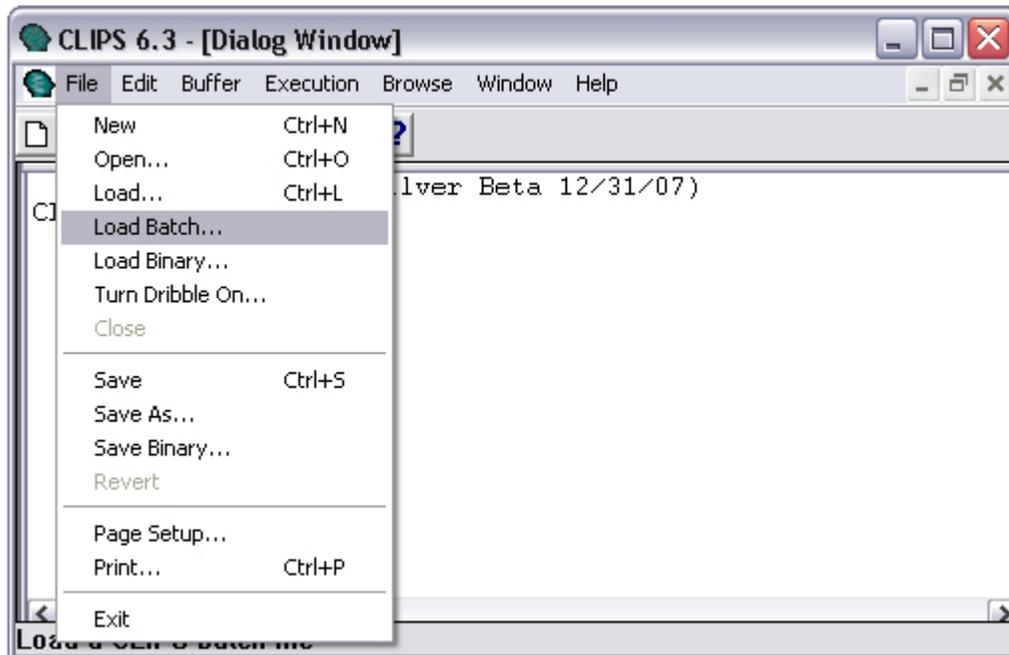
In the next sections we will describe how to run the expert system using CLIPS for windows, as well as describing the different parts that conform the expert system, how the system works, and explain the results provided by the system.

How to run the F1 Expert System?

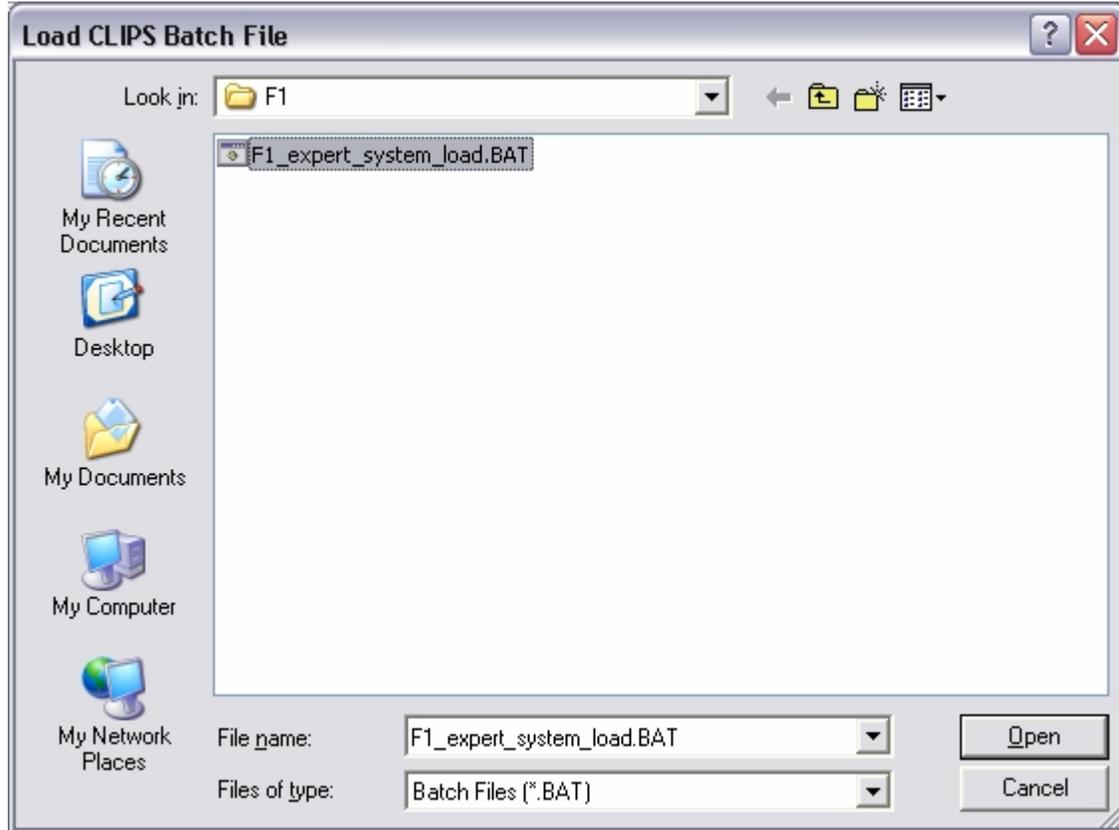
1. Start CLIPS 6.3 for windows.



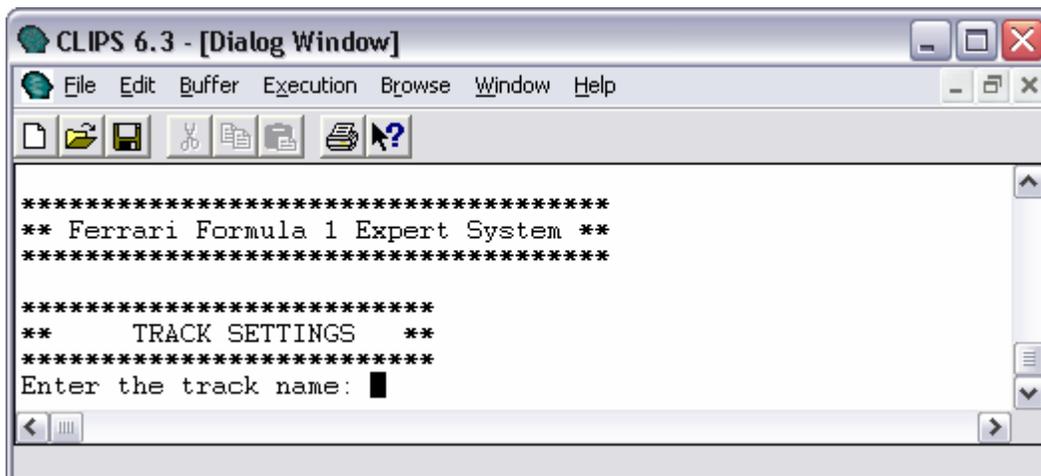
2. Go to File->Load Batch...



3. Select the F1_expert_system_load.BAT file.



4. The batch file will clear the current CLIPS environment (sending a (clear) command). Then it will load all the necessary classes, rules, and object definitions to run the system. Once loaded, the batch file will create the class instances (sending a (reset) command) and then it will run the program (sending a (run) command).



How does the F1 Expert System work?

The F1 expert system was designed as an infinite state machine which will run until the user decides to leave the system. During the first run of the program after it has been started the system will ask the user all of the questions necessary for the system to make an initial assessment of the current state of the race. Once the first run is over, the system will ask the user if he/she wants to change the current state of the system. The state of the system is divided in three main categories:

- Track Settings
- Weather Conditions
- Driver's status

Each of the above categories encapsulates different set of questions that allows the user to change from the current track that is being run to the damage levels to the chassis of the car.

The F1 expert system consists of five main classes:

- Track
- Driver
- Racecar
- Tire
- Race Conditions

During the load process the following objects are created with particular initialization values:

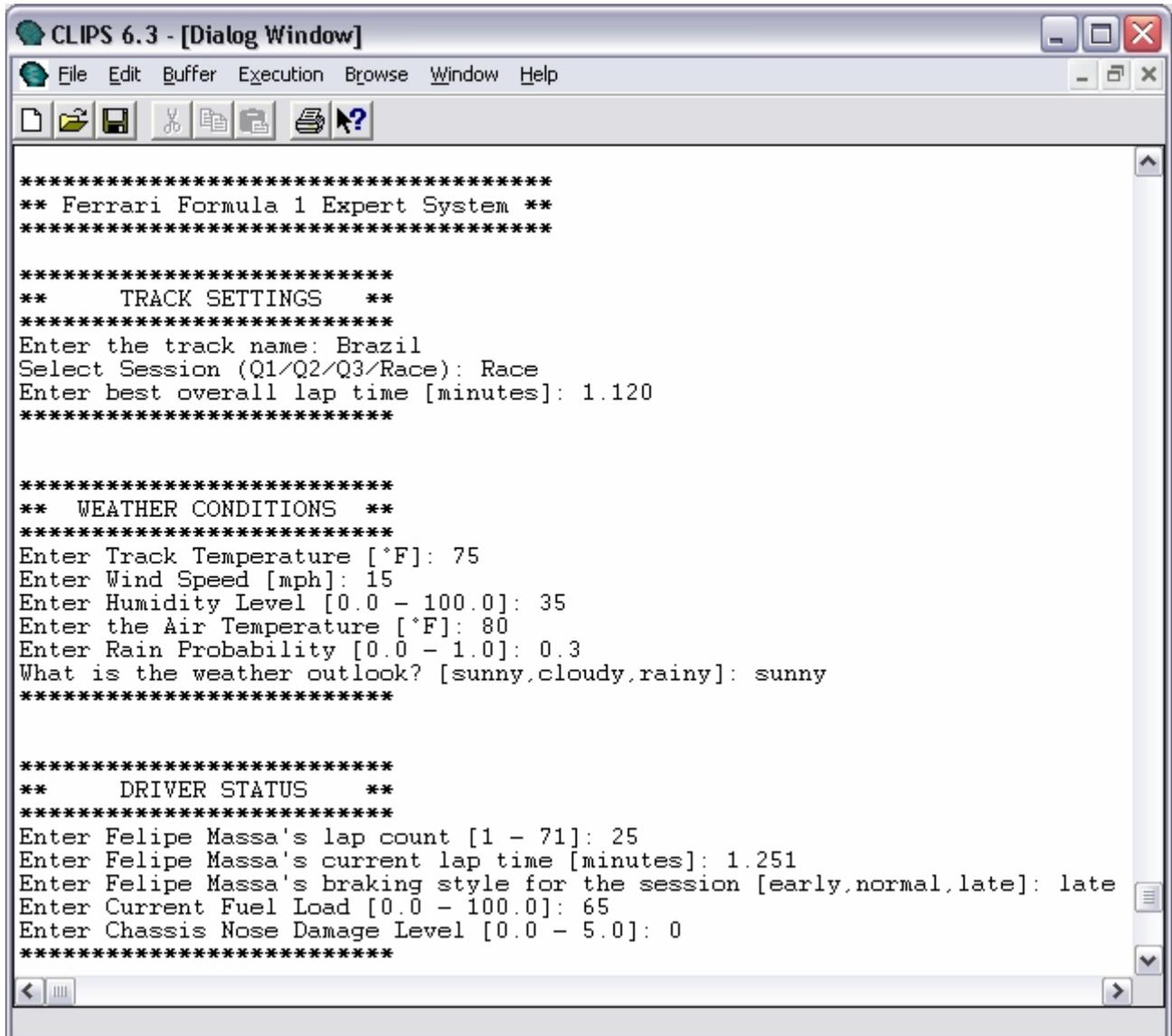
- [track] of TRACK
- [driver] of DRIVER
- [raceconditions] of RACECONDITIONS
- [racecar] of RACECAR

The [racecar] object dynamically creates 4 new objects of type TIRE using the (gensym*) construct and assigns them to slots in the [racecar] object.

Note: see Appendix A for class diagram

Once the object definitions have been loaded the program executes rules based on their salience. The rules are divided in two sets: Query Rules, and Knowledge Base Rules. The Query rules are the ones in charge of prompting the user for input. This set of rules has a higher salience than the Knowledge Base Rules in order to assure that they will be processed first. The Query Rules are also divided as mentioned before in three main categories: Track Settings, Weather Conditions, and Driver's Status.

The following screen shows the first run of the system:



```
CLIPS 6.3 - [Dialog Window]
File Edit Buffer Execution Browse Window Help

*****
** Ferrari Formula 1 Expert System **
*****

*****
** TRACK SETTINGS **
*****
Enter the track name: Brazil
Select Session (Q1/Q2/Q3/Race): Race
Enter best overall lap time [minutes]: 1.120
*****

*****
** WEATHER CONDITIONS **
*****
Enter Track Temperature [°F]: 75
Enter Wind Speed [mph]: 15
Enter Humidity Level [0.0 - 100.0]: 35
Enter the Air Temperature [°F]: 80
Enter Rain Probability [0.0 - 1.0]: 0.3
What is the weather outlook? [sunny,cloudy,rainy]: sunny
*****

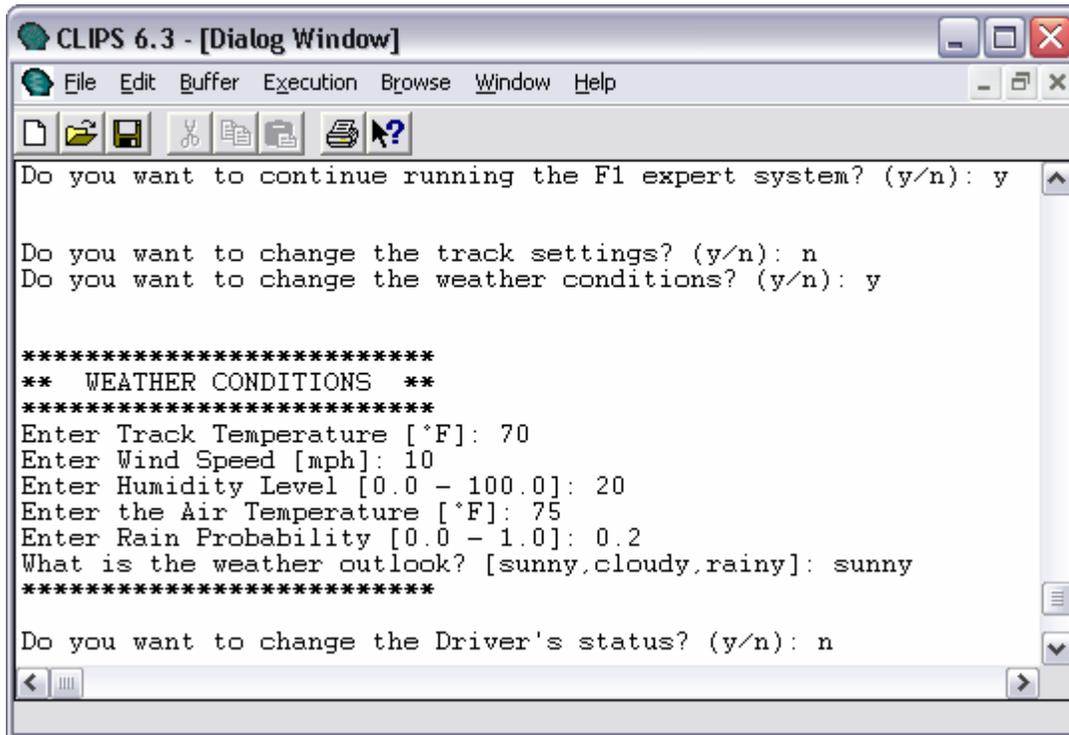
*****
** DRIVER STATUS **
*****
Enter Felipe Massa's lap count [1 - 71]: 25
Enter Felipe Massa's current lap time [minutes]: 1.251
Enter Felipe Massa's braking style for the session [early,normal,late]: late
Enter Current Fuel Load [0.0 - 100.0]: 65
Enter Chassis Nose Damage Level [0.0 - 5.0]: 0
*****
```

The next screen shows the results after the first run of the system:

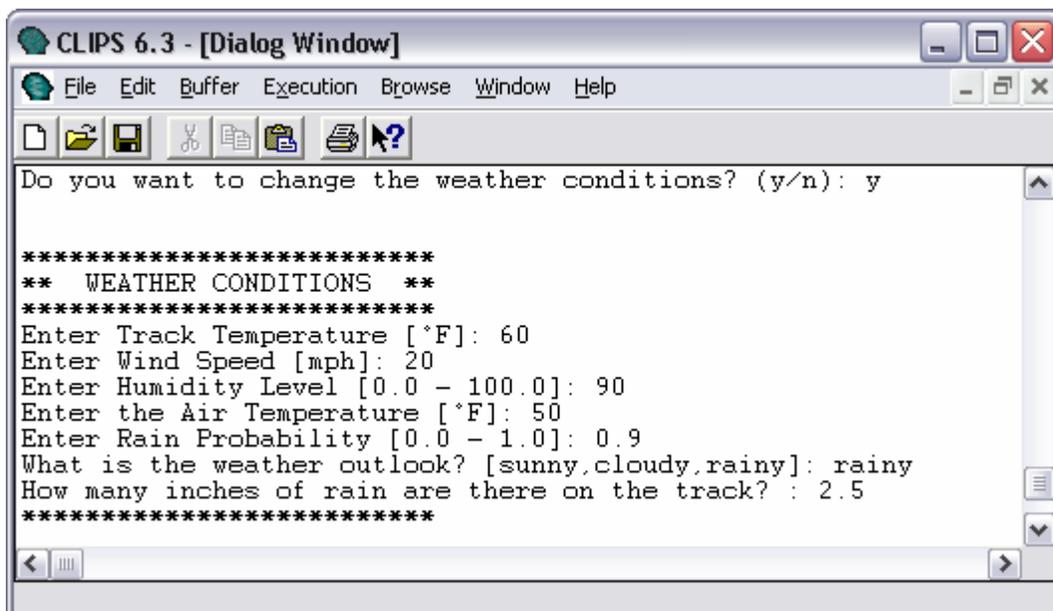
```
*****  
**                      RESULTS                      **  
*****  
Number of laps before going to pits: 23.1355302854491  
Gallons of fuel to pump during pit stop: No need to refuel.  
Front Downforce: normal  
Rear Downforce: normal  
*****          TIRES          *****  
*****          LEFT FRONT      *****  
          Type: dry  
          Compound: super-hard  
          Pressure: 41.0  
*****          RIGHT FRONT     *****  
          Type: dry  
          Compound: super-hard  
          Pressure: 39.0  
*****          LEFT REAR       *****  
          Type: dry  
          Compound: super-hard  
          Pressure: 33.0  
*****          RIGHT REAR      *****  
          Type: dry  
          Compound: super-hard  
          Pressure: 39.0  
*****  
Do you want to continue running the F1 expert system? (y/n):
```

After each run the system asks the user if he/she wants to continue running it. If the user decides to continue the system will ask if it wants to change any of the three categories. If the user answers “yes” the system will proceed to ask the questions associated with the correspondent section.

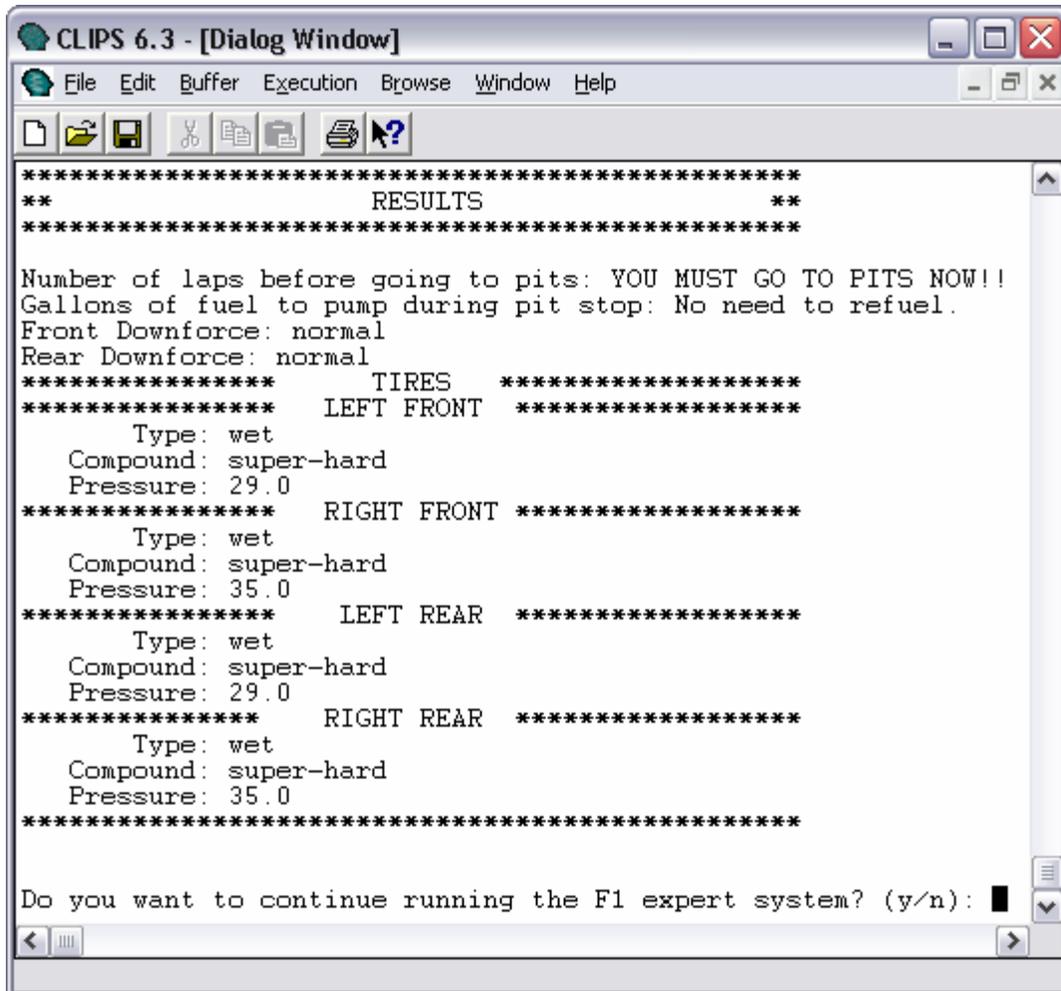
The following screen shows that the user decided to continue, and elected to change the weather conditions.



A new set of results will be displayed based on the new state of the system. Some questions are dependant upon other questions. For example, one of the questions is: "How many inches of rain are there on the track?" which will only be displayed if the appropriate values of rain probability, outlook, and humidity are selected.



The knowledge base rules use the information provided by the user as well as settings that are loaded based on options selected by the user like track surface, and number of laps in order to determine the best values for the results. For example, the previous screen showed a high probability of rain, high humidity, rainy outlook, and 2.5 inches of rain on track. Based on these settings the results advise the driver to go to pits right away, given than the current set of tires are not fit for the current track conditions and it could lead to an accident. Also, it advises the tire selection as “wet” in order to accommodate to the new conditions of the track.



```
CLIPS 6.3 - [Dialog Window]
File Edit Buffer Execution Browse Window Help

*****
**                               RESULTS                               **
*****

Number of laps before going to pits: YOU MUST GO TO PITS NOW!!
Gallons of fuel to pump during pit stop: No need to refuel.
Front Downforce: normal
Rear Downforce: normal
*****
                TIRES                *****
*****                LEFT FRONT                *****
    Type: wet
    Compound: super-hard
    Pressure: 29.0
*****                RIGHT FRONT                *****
    Type: wet
    Compound: super-hard
    Pressure: 35.0
*****                LEFT REAR                *****
    Type: wet
    Compound: super-hard
    Pressure: 29.0
*****                RIGHT REAR                *****
    Type: wet
    Compound: super-hard
    Pressure: 35.0
*****

Do you want to continue running the F1 expert system? (y/n):
```

Other results like tire pressure, tire compound, downforce levels depend on several values that are evaluated as part of the knowledge base set of rules. Some settings are specialized for specific tracks, and driver styles.

The F1 expert system provides a good example of how a forward rule engine can be adapted to run as an infinite state machine and provide interactive information based on its knowledge base.

Appendix A

F1 Expert System Class Diagram

