5.2. Application

As mentioned above, we will use video conferencing in the case of a mobile user who needs to take a path where the signal quality drops to an unacceptable level due to a gap in coverage, giving a very low QoS. This can be remedied by using the CR. but problematic arises: WHEN and WHY to use cognitive radio?

Most research related to the QoS of video conferencing, take into account throughput as pertinent parameter. For this reason, we choose the '"Throughput" as a single pertinent parameter for our application. For this, a throughput classification is required, and as we play the role of the expert, we have created our own database following certain rules in order to apply our approach. The database was divided into two parts, the first one for learning and the second one for testing. The value of the throughput will change almost ever)' time it is measured during the day even on the same route, for this reason, our measures have been taken into account for 5 weeks at 3 different intervals of the day (Sam - I lam. I lam - 3pm, 3pm - 5pm) excluding weekend.

We proposed to affect throughput on three classes:

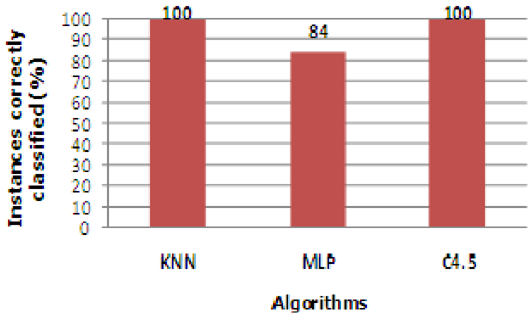
- Gold for samples where the throughput is greater than 384 Kb/s, ensuring 100% quality satisfaction of the user.
- Silver for samples where the throughput is between 160 Kb/s and 384 Kb/s, of acceptable quality.
- Bronze for samples where the throughput is less than l60Kb/s. This means that video conferencing is not satisfactory, and it is the class that interests us because this is when we use the CR.

Figure 2: Database Classes

5.2.1. First Question "WHEN"?

For the data classification, we used three different algorithms derived from the field of machine learning.

- The k-nearest neighbor's algorithm (K-NN) which is a supervised classification algorithm.
- The multilayer perceptron algorithm (MLP of neural networks).
- The C4.5 algorithm of decision trees.



We remark lhat the multi layer perceplron has not given satisfactory results compared with the other algorithms: however we did not get 100%. Despite the change of parameters such as the number of hidden layers, the number of epochs and the learning rate.

We remark also that the two other algorithms (KNN and C4.5) have given results of 100%, however if we take a look at the generated tree, we see is not exactly what we want because for him the GOLD class starts from a rate of 380 Kb/s instead of 384 Kb/s, this can generate after mistakes with misclassifying some instances.

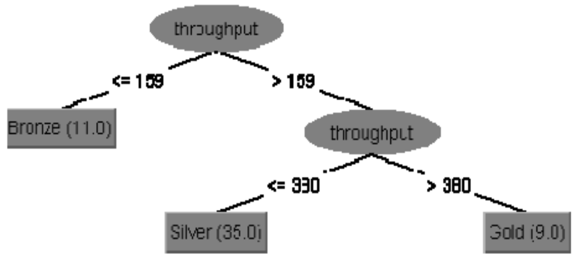


Figure 4: Decision rate

Concerning the K-NN algorithm, it was tested with several values of K on the test database and each time the result was different, but it is satisfactory until the value of K=6.

For our approach, we chose this algorithm, as it gave the best results (shown below) in terms of reliability and Clustering.

Table 1: Classification obtained with KNN

Values of K	Instances correctly classified		Misclassified Instances	
K=l	20	100%	0	0%
K=2	19	95%	1	5%
K=3	19	95%	1	5%
K=4	18	90%	2	10%
K=5	18	90%	2	10%
K=6	18	90%	2	10%

For K= 1: All ihe throughput examples were well posted in their appropriate class. Whereas, with K=2, one sample was misclassifled, we notice that in the graph.

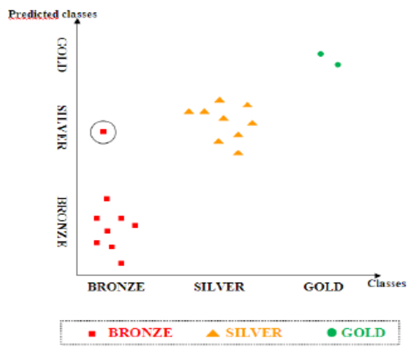


Figure 5: Classification result of KNN with K=2

Note: items close to the threshold of a class are misclassified. For example, the instance which have a throughput of 159Kb/s was ranked on Silver class instate of the Bronze one, for the other values of K. the result is more divergent.

Instance: 13
Throughput: 159.0
Predicted Class: Silver
Class: Bronze

Report: according to the results of the classification, the cognitive radio will be activated each first day of week from 8am to 1 lam and from 3pm to 5pm, and ever)' Wednesday from Sam to 5pm because in these intervals the throughput belongs to the Bronze class <160Kb/s. So, through this, the question When is answered.

For more general rules, it would be interesting to consider the other QoS video conferencing parameters and classify' these data using other methods of artificial intelligence such as fuzzy logic and genetic algorithms.

5.2.3. Experimentation Results

To support our proposal and to better understand, we compared the QoS with and without cognitive radio (case without CR means that our terminal has only one access technology and works on the same frequency band).

The graphs below illustrate this comparison. For being readable, we supposed that the maximum time of rupture is 5 min and that the tree band set contains 7 bands.

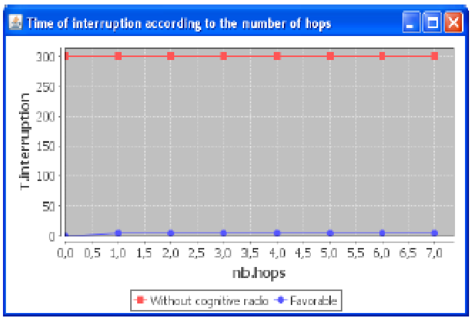


Figure 6: Comparison between the favourable scenario and the case without cognitive radio

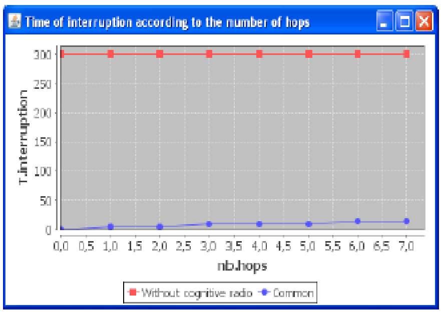


Figure 7: Comparison between the common scenario and the case without cognitive radio

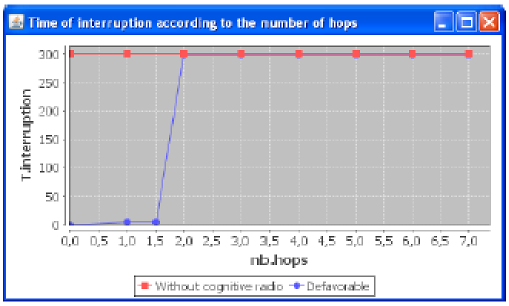


Figure 8: Comparison between the unfavourable scenario and the case without cognitive radio

6. Conclusions

We presented in this paper a new approach that uses Cognitive Radio to improve wireless communication for a cognitive radio mobile terminal by enhancing the QoS of video conferencing application. Our contribution is positioned in learning from events (machine learning). Our expert role has allowed us to choose the throughput parameter to perform a classification that allows the terminal used to gain experience for future events that means that it will know when and where it will activate the cognitive radio.

The usefulness of cognitive radio is a hypothesis that has been proved based on the required time for a connection to a new frequency band and this, whatever of the number of frequency bands that a terminal used to remedy a failed connection.

In our future work, we think we can improve the wireless links reliability and ensure good quality of service to CR mobile terminals |26| |27| |28| by integrating MAS. We will seek also to reduce the impact of mobility on cognitive radio communications by building predictive models of mobility by referring to previous work such as |29| and [30].

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