

CHAPTER VI

CONCLUSION AND FUTURE WORK

6.0 Introduction

The research arrives at its end in this chapter. Before doing so, a brief summary on the preceding chapters is deliberated. In the first chapter, the problem related with the dilemma of applying intelligent approaches is explained. This is due to the fact that the cost of implementation is not compensated enough by the possible improvement of performance in forecasting, thus making the notion inescapably dubious.

The second chapter thus explores the idea of WiMAX, network traffic, and forecasting from the perspective of statistical and artificial intelligence. Only one stochastic approach is studied, known as auto regressive integrated moving average (ARIMA). Three main intelligent approaches are covered in detail here, namely the k-nearest neighbor (KNN), artificial neural network (ANN), and fuzzy time series (FTS), which were all selected on the merit of their mentioned credentials in forecasting.

In the third chapter, the research methodology is elaborated. The data collection as well as the flowchart of each intelligent approach is given to enable a greater understanding of the process involved. The designs models in chapter four which explain each method of artificial intelligent. Results gathered from the experimentation is analyzed and discussed in the five chapter.

6.1 Conclusion

Intelligent approaches such as the k-nearest-neighbor (KNN), artificial neural network (ANN), and fuzzy time series (FTS) have a high potential in WiMAX network traffic forecasting. This is proven by their remarkable performance in predicting the network traffic based on gathered data. The accuracy of their forecasting is quite high, which is supported by the emergence of minimal error in the experiment. In effect, nullifying the qualm presented by the following situation.

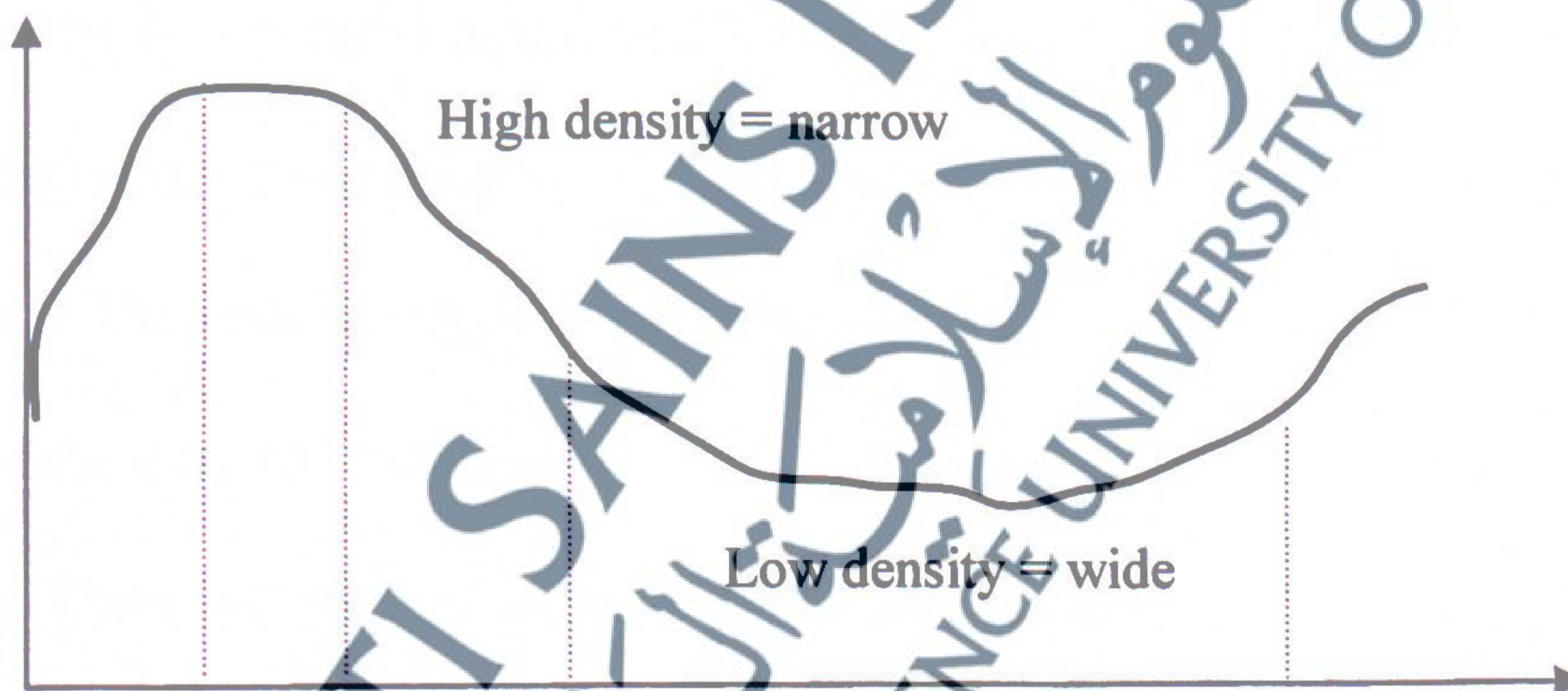
In the comparison between an intelligent approach known as ANFIS (Adaptive Neuro Fuzzy Inference System) with ARIMA, a statistical or stochastic method (Yadav & Balakrishnan, 2014), the former is proven to be superior than the latter in most of the forecasting cases. The degree of error between both methods however, does not differ that greatly, which induces reservation since the computational cost of ANFIS is considerably higher than ARIMA. Fortunately, the results gathered in this research affirm the potential of intelligent approaches in forecasting.

6.2 Limitation and Future Work

Fuzzy time series exhibited the most inferior performance of WiMAX network traffic forecasting when compared with the other intelligent approaches. As such, it would be beneficial to investigate the cause of this failure more thoroughly to figure out a viable direction of improvement. Perhaps it lies within the manner of which the intervals are dissected. If this is the case, delving further into this issue would be a worthy area of research in the future.

One of the ways to improve the partitioning of the time series is via the implementation of interval information granules (Lu et al., 2015). The approach initially divides the temporal dimension into a predefined segment. Afterwards, it would adjust the boundary of each segment to maximize the level of information imbued within. Another mechanism of this particular approach exploits the use of prototypes (Wang, Liu & Pedrycz, 2013) to enhance the calculation of intervals by widening them at low density spaces and narrowing them at high density ones (Figure 108).

Figure 108: Setting Intervals Based on Density (Wang, Liu & Pedrycz, 2013)



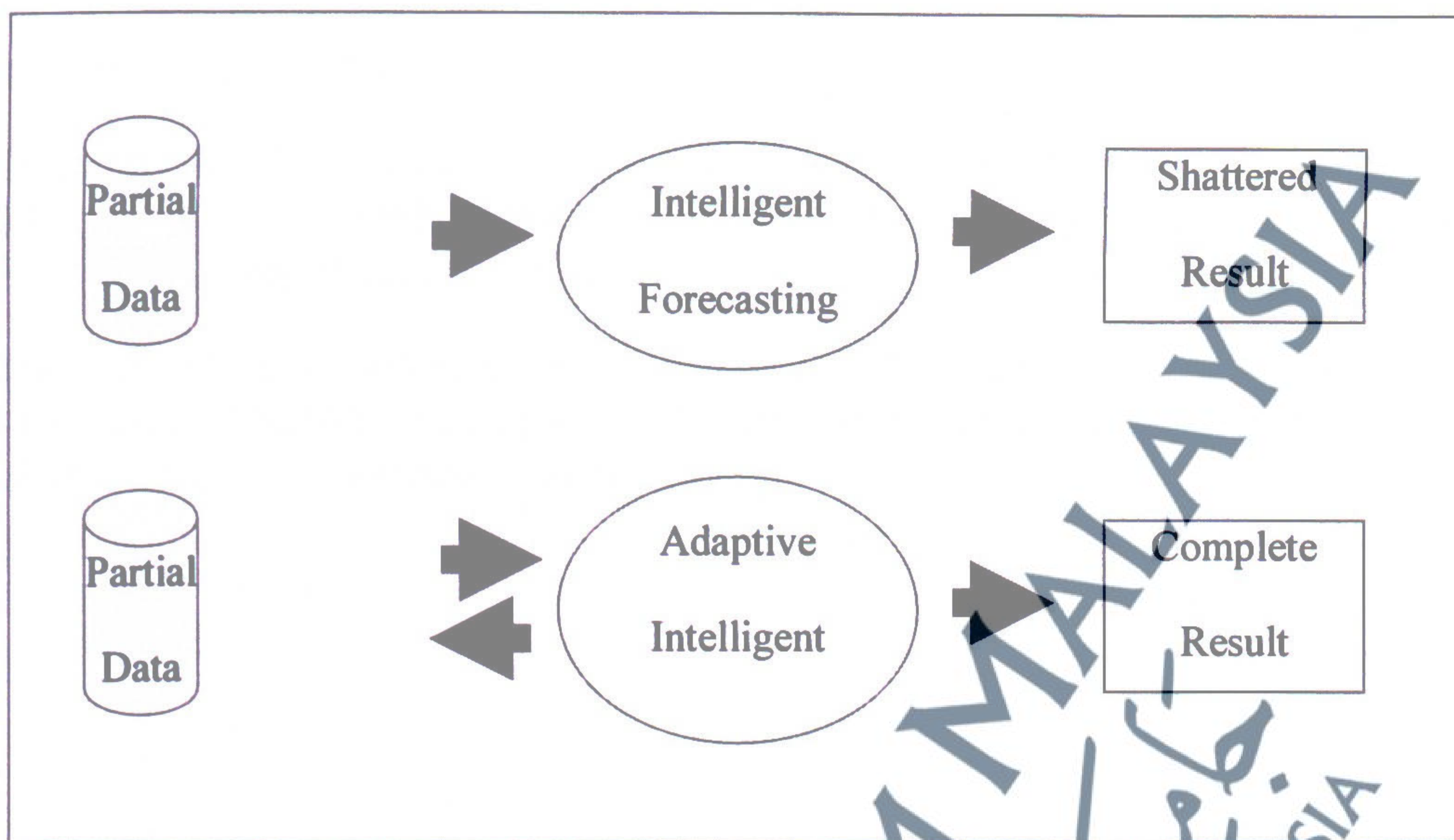
K nearest neighbor is quite sensitive to the number of reference points or k . In this research, the parameter is explored systematically by increasing it by two for every scenario. It is definitely better if the optimal cluster of neighborhood is computed on the basis of more well defined strategies. A number of methods can be explored for this purpose. For instance, using the Akaike Information Criterion (Lee & Ouarda, 2011) in determining the selection of k as well as the order of the model.

Apart from the selection of optimal k , the approach can also be enhanced by introducing a better way to evaluate the distance between the data with the orbiting neighbors. Currently, only the classical Euclidean distance is employed. It is compelling to consider other distance metrics such as fusing neighborhood information (Lin et al., 2014) and mahalanobis distance (Melnykov & Melnykov, 2014).

With regard to the speed of computation, k -nearest neighbors tend to consume a considerable length of time as the number of sample increases. As shown in the research, the data for WiMAX traffic is often very high i.e. by the millions. This can be alleviated with the employment of better sorting strategies (Beliaikov & Li, 2012), which allows a faster procedure of recognizing the top k neighbors. Speed can also be improved with the use of two tier k – nearest neighbors (Xiaoyu, Yisheng & Siyu, 2013). This particular approach increases the speed by optimizing the historical data that is utilized in the calculation of the nearest neighbor. It is developed based on the notion that although the influx of data can be compounded through time, most of them are not crucial for forecasting. Thus, selective omission enhances efficiency.

The notion of ad hoc network adaptivity (Alsaahag et al., 2014) in intelligent forecasting is an intriguing venue for potential research as well. In this research, most of the learning part is done after the data is collected in its entirety. However, nothing has been done on the development of an adaptive intelligent forecasting algorithm (Morales-Arias & Moura, 2013) that can attune to a changing environment on a continuous basis (Figure 109). This way, it can be made versatile to the capture of new data without the need to wait for the accumulation to reach completion.

Figure 109: Adaptive Intelligent Forecasting (Morales-Arias & Moura, 2013)



Achieving dynamicity of learning is quite a feasible endeavor. It would be exciting to contemplate on the possibility of merging (Cai et al., 2015) the intelligent approaches covered within this research with nature-inspired algorithms such as ant colony optimization (Deng et al., 2015) or bee algorithm (Govardhan & Roy, 2015; Ozturk, Hancer & Karaboga, 2014) for the purpose of devising the ability to adapt. This would allow the WiMAX network to calibrate (Lemamou, Chamberland & Galinier, 2013) itself to a given traffic demand in the act of sustaining optimization.