

Connection Manager : A FAHP-based System for Classifier and Decision-Making

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Abstract—This Connection Manager Intelligence Agent (CMIA) is an attractive feature of use the network traffic and behavior with multi-attributes to find the best network devices and connection devices meet user habits that it possible to access various multimedia contents everywhere at any time. In this agent, information process is thoroughly integrated into embedded system for connection manager of Meego or Android. We have implemented an interactive interface through this function (User interactive interface are based on Qt Creator IDE and CMIA) acquisition user behavior and to scholars of the machine. We have a successful user interaction of the agent can be decision making the choice of match the user intent.

Keywords—attribute; decision-making; combining models; boosting; Fuzzy-AHP ; seamless network ;classifier; ranking;

I. INTRODUCTION

This is new kinds of Web apps on network connection manager of force that will be more ubiquitous and smarter than current applications and will be accessible anytime, anywhere. This will require us to development a multi-network how to switch and decision. Faced with the new wave of mobile device applications for service wide range of use, seamless network access is an important issue. Nowadays, mobile service software contains some techniques form artificial intelligence (AI) research. As for a connection manager of intelligence system (or Connection Manager of Intelligence Agent, CMIA) interaction with the owner becomes important. However, the interaction is usually limited to the predefined command or few typewriting. We propose a way for the user to define a new behavior to enhance the interaction. This human-machine interaction multi-attributes for the user to define a new degree of rating scales such [1] as received signal strength indicator (RSSI), energy consumption, traffic, throughput and other attributes of wireless devices must be based on knowledge and action mechanism of this fuzzy analytic hierarchy process (Fuzzy AHP).

This paper describes the experiences that we learned from building such devices. Based on the observation of real connected devices and their relationship with their owners, the goal that we set is to create a CMIA that may grow in its relationship with the owner. The goal of the research is to give the CMIA the following ability:

Autonomous interaction. The CMIA is to interact with the user without pre-written scripts.

Learning ability. The CMIA is to become more mature by learning skills through the training provided by the user.

Dynamic ranking. The CMIA is to adjust the three parts of attribute (RSSI, energy consumption, traffic, throughput) of behaviors dynamically through networking environment and interaction changes.

The concept of multi-attributes is the most important issue in this research. Our idea is based on the APH architecture proposed by Thomas L. Saaty in the 1990s [2] (Figure 1.), where the goal and condition input from the user environment (Figure 2.) and prepares the input attributes degree to finding Importance of rating scales for user experience. The results from the classifier module are then passed to the multi-attributes for each of classes to produce a set of use cases array comparison. After decided is switch the network connection of a use case.

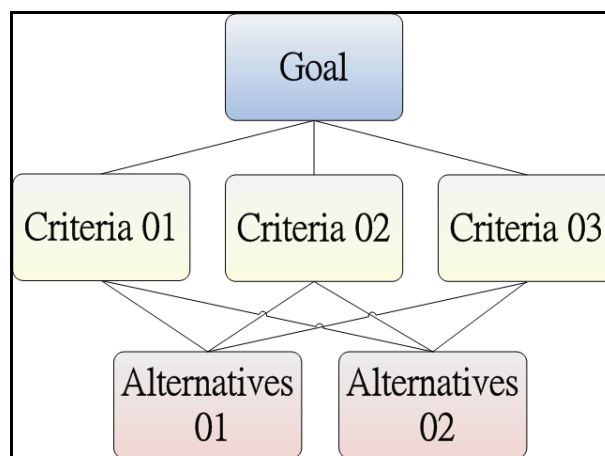


Figure 1. A sample architecture for AHP

The prototype system is described and the conclusion is given. The approach involves introduction of fuzzy theory into the Analytic Hierarchy Process developed by Saaty (1980) in

order to assess the weights of various assessed items and to sort their importance.

The rest of the paper is organized as follows. The next section explains the system concept. That is followed by the detail discussion on ranking and Fuzzy AHP.

II. SYSTEM CONCPET AND BACKGRAND

A. System Concpet

Based on the observation of Fuzzy AHP and its relationship with owner attributes, the goal was to create a use-case that enables the connection manager to find attributes automatically in its relationship with the attribute pattern-based model. The CMIA consists has five sublevel of depicted in Figure 2. : the target of sublevel, the network link type of sublevel, devices of sublevel and attribute of sublevel.

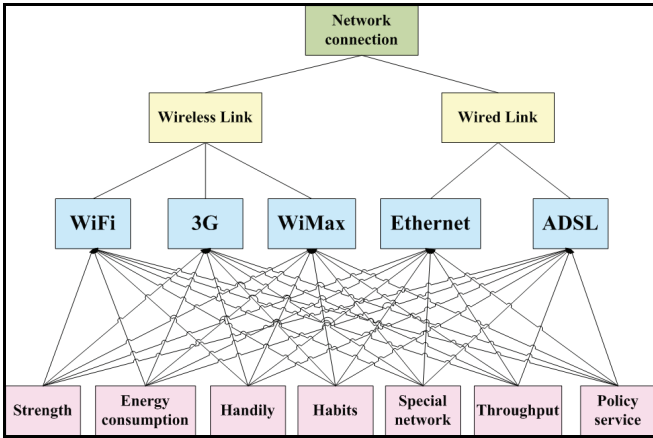


Figure 2. The five levels architecture for CMIA

However, the CMIA has combined modeling subsystem is based on the previous result for Fuzzy AHP and weighted-product model (WPM) processing which accepts the each all level weighted for WPM uses multiplication to rank alternatives with gesture of the user as the input for each kinds of levels weights in series.

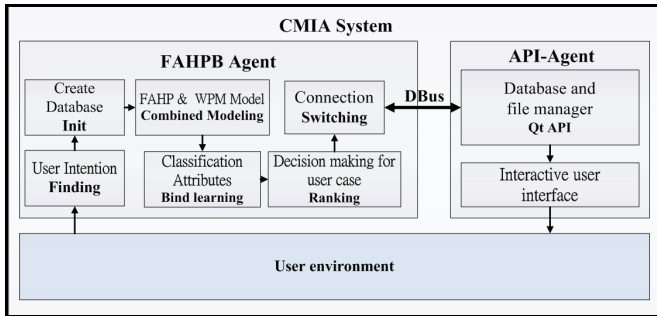


Figure 3. The System parts for CMIA

However, the implemented system contains five main modules of the elements, the input will be sent to the modeling subsystem which is the main topic reported in this paper. Within such system, learning and modeling are used for building the behavior definitions. The ranking subsystem is to

carry out the behavior sequence produced by the connection switching subsystem. Such high-level behaviors are collection of basic actions that the CMIA can perform.

The attributes are processed in the combined modeling subsystem where those attributes are transformed to the user case for the CMIA to follow. The CMIA has the basic attributes (alternatives) and network devices (criteria or network classes) already defined. Thus, the main work of the combined modeling subsystem is to use such basic attributes and to construct more complicated behaviors to meet the network devices associated with the attributes. For such process, we use classification learning techniques to process the decomposition of goals to sublevels and to find the relationships associated of sublevels to the basic attributes for user case class.

The ranking subsystem is responsible for ranking the attributes (alternatives) of network class sublevel and connection link sublevel which are the collection of each levels weight in series to provide network connection recommended. The switching system (Qt API User Interface, QAUI) which shows the network device connected information of the CMIA in ConnManager list table. The interface between the switching subsystem and the QAUI is defined with ConnManager components to represent the basic connected device. This is sometimes proposed system provides the list of devices with the connMan for MeeGo network devices are currently repeat, we must establish a more updated list and delete list data. We used a state diagram approach to define the rational action relationship, which is reported in Section IV.

B. System Problems

This section describes the designing problem that system automated the processes of the dynamic parameters is difficult for convergence in CMIA. Thus, use classifier to filter a larger-scale problem given solving which can be dynamic space reduction. The storage unit is stores a network connection class, operating item, and network connection option. The processing unit performs of learning approach was self-control a dynamic parameters for classifier which in controller system can be establish an automatic network link mode. CMIA can through the user to operating some of function given a connected in network device of list table, generates a network classification link model according to the network connection class, the operating item in the network connection option which in system adopt this approach of obtained after weight calculation are ranking each all network device within user-case after classification of case of attributes in serial weights value. System have following encountered some problems:

- The characteristics of network devices are different attributes to quantify the process can not use the same method. For example, units of radiation measurement is a logarithmic expression, the user habits can simply attribute used to score.
- The environment must be immediately real-time updated parameters, the system is the application of a technology in mobile devices, the device is necessary to address the demand uncertainty and environmental

factors of space, these attributes will affect the degree of decision-making processes.

- Classification, however, parameters to be set for different connection modes will be connected by different device. Unless the user has considerable knowledge and specialty in the network and can set the connection modes by himself/herself to configuration. This network configuration is complex and difficult to install for general user. Also, they are unfamiliar connected with the network how to grasp setting manners of various network for connection modes. Which in usually because a user does not know how to set the network connection mode, an error occurs in the setting of the network connection mode so that network resources cannot be used, or a long time is required to research the setting manner, which causes trouble to the user.

III. FAHP AND CLASSIFIER

Michele Grimaldi (2011)[10] have presents a framework based on the analytic hierarchy process (AHP) methodology to select the most appropriate set of Knowledge Management (KM) tools to support the innovation and complex processes in organizations. In this study, multi-network connection mechanism is a complex of problem, which in structure will be use hierarchical architecture to solve complex problems associated with the level. The problem affected is the user of intend for interactive elements of weight-based number, we use the AHP framework to solve complex problems relationship of class and user case, there are simplify classification processes but also has affected relations between hierarchy structure.

A. FAHP and PSM Methods

We use the Fuzzy technique is used for different attributes to quantify the process include the RSSI. When the decision maker considers the problem of ranking the m alternatives $A_1, A_2, \dots, A_m$ with respect to the N criteria $C_1, C_2, \dots, C_N$, it will feel great difficulty in assigning numbers, or ratios of numbers to alternatives[1]. The merit of using a fuzzy approach is to assign the relative importance of attributes using fuzzy numbers instead of crisp numbers. For numbers we use triangular fuzzy number (TFN), because they are step order for measurement data unit have dBm, mA, package rate, etc.

$$M = \{A_1, A_2, \dots, A_M\} \quad (1)$$

The fuzzy weighted-product model (PWM) [3] is best alternative according to this mode is one which satisfies (2), and for the fuzzy version of this model the corresponding formula [1] is (3):

$$R\left(\frac{A_k}{A_L}\right) = \prod_{j=1}^N \left(\frac{a_{kj}}{a_{Lj}} \right)^{w_j} \quad (2)$$

where $\hat{a}_{kj}$, $\hat{a}_{Lj}$, and $\hat{w}_j$ are TNF numbers. Alternative attribute A_K dominates alternative A_L if and only if the numerator (3) is greater than the denominator. We have instance in the following example:

$$R\left(\frac{A_k}{A_L}\right) = \prod_{j=1}^N \left(\frac{\hat{a}_{kj}}{\hat{a}_{Lj}} \right)^{w_j} \quad (3)$$

The weighted-sum model (WSM) is a the weight of the public will use the sum of methods for decision-making [3]. A previous research discusses the notion of additive utilities in the expected-utility context when the set of consequences M can be written as the product of n other sets: $M = M_1 \times M_2 \times \dots \times M_n$. where M is a subset of the product of n other sets: $M \subset M_1 \times M_2 \times \dots \times M_n$. Under a finiteness restriction, an additivity axiom leads to an additive utility representation for the elements in M . The potential usefulness of the theory in connection with incomplete product sets is demonstrated with priority orderings and assignments [4]. There are M is alternatives and N criteria in a decision making problem. Then the best alternative, A^* , is the one which satisfies the following expression[3][4]:

$$P_{WSM}^* = \max_{M \geq i \geq 1} \sum_{j=1}^N a_{ij} W_j \quad (4)$$

There are weights in the maximization case, in each category of network devices, we find the best alternative according to (4). Currently, the performance values of the i th alternative for network devices attributes in terms of j th network device class that is a triangular fuzzy number denoted as $\hat{a}_{ij} = (a_{ijl}, a_{ijm}, a_{iju})$. Similarly, it is assumed that decision makers will use the triangular fuzzy number to express the importance of weight standards. These weights are denoted as $\hat{w}_{ij} = (w_{ijl}, w_{ijm}, w_{iju})$. The PSM model values of the fuzzy triangular numbers which represent the criterion weights for network device of class. It follows that best alternative is the one which satisfies the following relation [1]:

$$P_{WSM}^* = \max_{j=1}^N \hat{a}_{ij} \text{ for } i = 1, 2, 3, \dots, M. \quad (5)$$

m_l is that the lower value, m_m is that the median, m_u is located at a higher value. , show in Figure 4.

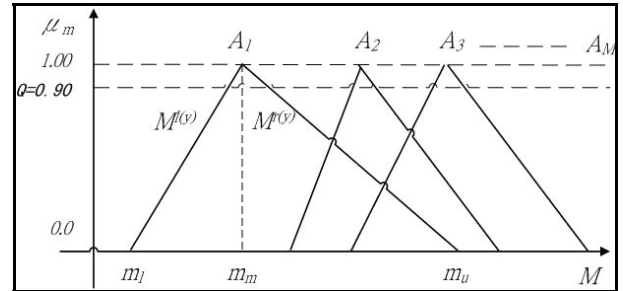


Figure 4. The fuzzy alternatives AM

So we can define each attribute fuzzy number step order for attributes scale degree mapping list, the RSSI and Energy attributes of scale degree samples such as TABLE I. In our system can be real-time update attributes values for RSSI, energy consumption, traffic, throughput. Through the reference TABLE I, we are also use a fuzzy number M on $R \in (-\infty, +\infty)$ is defined to be a fuzzy triangular number if its membership function $\mu_m : R \rightarrow [0, 1]$ is equal to:

$$\mu_m(x) = \begin{cases} \frac{1}{m-l}x - \frac{l}{m-l}, & x \in [l, m], \\ \frac{1}{m-u}x - \frac{l}{m-u}, & x \in [m, u], \\ 0 & \text{otherwise,} \end{cases} \quad (6)$$

A fuzzy triangular number, as denoted by (l, m, u) .

TABLE I. ATTRIBUTES SCALE DRGREE FOR TFM TABLE LIST

Scale degree	A triangular fuzzy numbers
Weak strength	$\tilde{1} = (1, 1, 1) \cong (1, 10, 20)$
Degree of between	$\tilde{2} = (1, 2, 3) \cong (21, 25, 30)$
Low strength	$\tilde{3} = (2, 3, 4) \cong (31, 35, 40)$
Degree of between	$\tilde{4} = (3, 4, 5) \cong (41, 45, 50)$
Strength	$\tilde{5} = (4, 5, 6) \cong (51, 55, 60)$
Degree of between	$\tilde{6} = (5, 6, 7) \cong (61, 65, 70)$
Very strength	$\tilde{7} = (6, 7, 8) \cong (71, 75, 80)$
Degree of between	$\tilde{8} = (7, 8, 9) \cong (81, 85, 90)$
Higher strength	$\tilde{9} = (8, 9, 10) \cong (91, 95, 100)$

Finally, in this section will presents of the extent analysis method on fuzzy AHP are given and then the method classification applied to supplier selection problem. The CMIA is an AHP-Based system that goal is define and non-define for user free. The relationship between the various properties and weight (importance), we usually are based on pairwise comparison matrix properties used to calculate the average number of attributes of all weights.

Building pair-wise comparison matrix : the system have suppose classification function when the decision maker is asked to compare the nine attributes for network devices to classification these attributes to correct class.

- First: We are input a rating scale value of variables from each of attribute then use the fuzzy membership function to determine the matching variables of pair-wise comparison matrix about the ownership level degree, the process such as Figure 5.
- In this research, in synthesizing experts' opinions, the geometric mean method(GMM) proposed by Buckley (1985) [8] the average of the proposed method to integrate the views of respondents, integration formula, using the arithmetic mean method (AMM), you can calculate the ratio between the weight of property.

	Strength	Run trip time	Throughput	Packet loss rate
Strength	1,1,1	Strength / Run trip time	Strength / Throughput	Strength / Packet loss rate
Run trip time	Run trip time / Strength	1,1,1	Run trip time / Throughput	Run trip time / Packet loss rate
Throughput	Throughput / Strength	Throughput / Run trip time	1,1,1	Throughput / Packet loss rate
Packet loss rate	Packet loss rate / Strength	Packet loss rate / Run trip time	Packet loss rate / Throughput	1,1,1

	Strength	Run trip time	Throughput	Packet loss rate
Strength	1,1,1	1,2,7	1,1,1	2,5,7
Run trip time	1/7,1/2,1	1,1,1	1/9,1/6,1/3	1,6,8
Throughput	1,1,1	3,6,9	1,1,1	2,5,9
Packet loss rate	1/7,1/5,1/2	1/8,1/6,1	1/9,1/5,1/2	1,1,1

Figure 5. Using pairwis comparisons method

The fuzzy eigenvector of the above matrix is estimated. Recall that given a crisp reciprocal matrix then according with Saaty's matrix of right upper half of principal eigenvector of the matrix is expresses the importance of the attributes. We calculate the properties of the vertical for column is the average, show in Figure 6.

	Strength	Run trip time	Throughput	Packet loss rate
Strength	1,1,1	1,2,7	1,1,1	2,5,7
Run trip time	1/7,1/2,1	1,1,1	1/9,1/6,1/3	1,6,8
Throughput	1,1,1	3,6,9	1,1,1	2,5,9
Packet loss rate	1/7,1/5,1/2	1/8,1/6,1	1/9,1/5,1/2	1,1,1
	S1	S2	S3	S4

Figure 6. Vertical column for reciprocal judgment matrix of property

- And the properties of pair-wise comparison of the level of the multiplication of the sum of the field.

$$\begin{matrix} \text{Strength} \\ \text{Run trip time} \\ \text{Throughput} \\ \text{Packet loss rate} \end{matrix} \begin{bmatrix} (A11/S1+A21/S2+A31/S3+A41/S4)/4 \\ (A12/S1+A22/S2+A32/S3+A42/S4)/4 \\ (A13/S1+A23/S2+A33/S3+A43/S4)/4 \\ (A14/S1+A24/S2+A34/S3+A44/S4)/4 \end{bmatrix} = \begin{bmatrix} V11 \\ V21 \\ V31 \\ V41 \end{bmatrix} = \begin{matrix} \text{Strength} \\ \text{Run trip time} \\ \text{Throughput} \\ \text{Packet loss rate} \end{matrix} \begin{bmatrix} P11 \\ P21 \\ P31 \\ P41 \end{bmatrix}$$

Attributes Sum Sum Model Normalization model

Figure 7. A pairwise comparison of the multiplication of the sum

- Above the results of the steps, only know the extent attributable to the pairing property can not be used for decision-making, with the judge to obtain measures of value, must use the fuzzy approach, a common center of gravity method (CGM), the largest collection with minimal set and so on, so before using this ambiguity to determine the value of the decision-making.
- Defuzzication :

According to the method of Teng&Tzeng(1993)[7], the DF_{ij} solution for fuzzy weight calculation process is:

$$DF_{ij} = [(R_{ij} - L_{ij}) + (M_{ij} - L_{ij})] / 3 + L_{ij} \quad (7)$$

These are finished properties matching matrix, followed by the cascade (series level weight, SLW) calculation of the weight level, the process is to Class un-normalization weights and attribute sum model for the sum of the product, the fuzzy eigenvectors of the pair-wise comparisons when the four attributes are compares in the terms of each of the remaining criteria are also derived in a similar manner, along with the weights of importance of five classes, and form the vectors in the following fuzzy matrix, such as follows Figure 8. .

	Class #1	Class #2	Class #3	Class #4	Class #5		Class #1	Class #1
	Class #1	Class #2	Class #3	Class #4	Class #5		UC01	UC02
Strength	V11	V12	V13	V14	V15	Strength	P11	P12
Run trip time	V21	V22	V23	V24	V25	Run trip time	P21	P22
Throughput	V31	V32	V33	V34	V35	Throughput	P31	P32
Packet loss rate	V41	V42	V43	V44	V45	Packet loss rate	P41	P42
						Normalization model		Normalization model
	Class #1	Class #2	Class #3	Class #4	Class #5		Class ID	
	$(V11 * \text{Class \#1} + V12 * \text{Class \#2} + V13 * \text{Class \#3} + V14 * \text{Class \#4} + V15 * \text{Class \#5}) / 5$						P1	
	$(V21 * \text{Class \#2} + V22 * \text{Class \#2} + V23 * \text{Class \#2} + V24 * \text{Class \#2} + V25 * \text{Class \#2}) / 5$						P2	
	$(V31 * \text{Class \#3} + V32 * \text{Class \#3} + V33 * \text{Class \#3} + V34 * \text{Class \#3} + V35 * \text{Class \#3}) / 5$						P3	
	$(V41 * \text{Class \#4} + V42 * \text{Class \#4} + V43 * \text{Class \#4} + V44 * \text{Class \#4} + V45 * \text{Class \#4}) / 5$						P4	
						Normalization model		

Figure 8. A pairwise comparison of the multiplication of the sum

Our approach, is based on (4) after the weights to different categories User-Case, this method is used to solve (The same device conflict., When simultaneously the occurrence of a category have more than one access point (AP), must be decision-making.

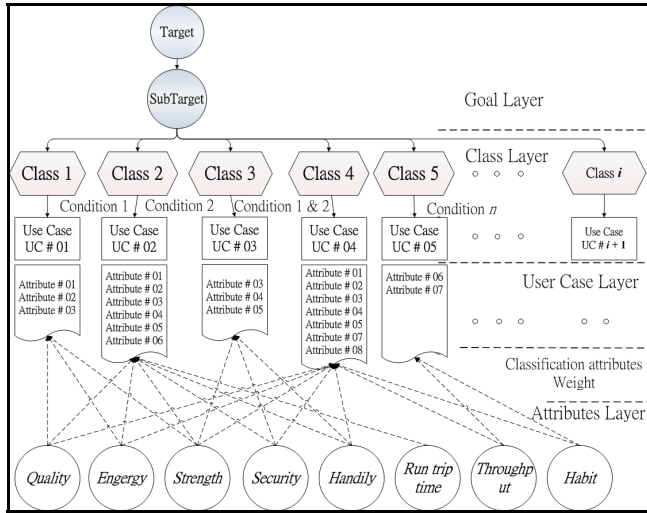


Figure 9. Fig A pairwise comparison

However, example have a decision problem with five criteria of classes (in user case, UC and include the WiFi, 3G, WiMax, Ethernet, ADSL and other classes) and four attributes in terms of first criterion by using pairwise comparisons.

We use the FAHP to building hierarchical structure for CMIA, shown in Figure 2. We are research by the FAHP [6], and modified an algorithm from fuzzy pairwise to describe our approach. The main purpose is to determine the user behavior intention as training data (TD) while satisfying constraints. The

parameters, $\tilde{M}$ is a fuzzy triangular number (FTN), $1/\tilde{M}$ is a establish value of fuzzy matrix is inverted M. The FAHPTD is a training data form survey of questionnaire for 120 copies. The ConnMan is connection manager list table that record about each all devices of network device information data. Given user procession input data set:

$FAHPTD = \{(A_1, \text{Class}(C_1)), (A_2, \text{Class}(C_2)), \dots, (A_N, \text{Class}(C_N))\}$, where A_i is a user input sample from the GD table, $Y(A_i) \in y = \{C_1, C_2, \dots, \text{Class}_L\}$ denotes the classes (A_i) belongs to L is the number of the different classes (as like fowler formula: $\text{Class}(C_j) \in y = \{\text{WiFi}, 3G, \text{WiMax}, \text{Ethernet}, \text{ADSL}, \dots, \text{Class}_L\}$).

N is the number of training samples from to FAHPTD table for 100 questionnaires single. $i = 1, 2, \dots, N$ numbers.

procedure FAHPB (FAHPTD, A, T)

$FAHPTD_{Table}[i, j]$ for all $i=1, 2, \dots, N$; set for all $j=1, 2, \dots, N$;

$ConnMan_{Table}[i, j]$ for all $i=1, 2, \dots, N$; set for all $j=1, 2, \dots, N$;

//Building Comparison matrix :

$$FAHPTD_{Table}[i, j] = \frac{w_i}{w_j} = \frac{1}{FAHPTD_{Table}} > 0, \forall i, j$$

//Building a fuzzy value matrix is inverted

//the value of fuzzy matrix is inverted M.

$$M = [\tilde{M}_{ij}] ; \quad \tilde{M}_{ij} = (L_{ij}, M_{ij}, R_{ij}) ; \quad \tilde{M}_{ij} = 1/\tilde{M}_{ji} ,$$

$$\forall i, j = 1, 2, \dots, n$$

//Groups combined

$$\tilde{m}_{ij} = (1/N) \otimes (\tilde{m}_{ij}^1 \oplus \tilde{m}_{ij}^2 \oplus \dots \oplus \tilde{m}_{ij}^N)$$

//Calculate the fuzzy weight

//Obtained by the following calculus of $\tilde{w}_i$ weight:

$$\tilde{Z}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \dots \otimes \tilde{a}_{in})^{\frac{1}{n}}, \forall i = 1, 2, \dots, n$$

$$\tilde{w}_i = \tilde{Z}_i \otimes (\tilde{Z}_1 \oplus \tilde{Z}_2 \oplus \dots \oplus \tilde{Z}_n)^{-1}$$

//Defuzzication

DF_{ij} solution for fuzzy weight calculation process is:

$$DF_{ij} = [(R_{ij} - L_{ij}) + (M_{ij} - L_{ij})] / 3 + L_{ij} \quad // \text{Normalization}$$

//Normalization weights for DFW_{ij} calculation process

$$DFW_{Ni} = \frac{DF_{ij}}{\sum DF_{ij}}$$

// Calculate the weight of level series, SLW

$$w_k = w_i + w_{ij} + w_{ijk}$$

//Running the Classifier core

```

if Rules R1 THEN UC01 update core process
if Rules R2 THEN UC02 update core process
if Rules Rn THEN UC0n update core process

//return the final hypothesis with weights for solving the
//classifier

Reading  $ConnMan_{Table}[i, j]$ 

//Update RSSI, energy consumption, traffic, throughput

Update user_parameter_weightTable[i,j]

return FAHPB process
end FAHPB

```

B. Classification of Approach

The Bayesian approach to classification estimates the probability that an instance Attributes (A_i) belongs to a class (C_j). Given the observed attribute values is the instance. There are L is the class labels $\{C_j\}$, $j = 1, 2, \dots, L$ numbers. When making a conditional than probabilistic classification, the class with the highest estimated posterior probability is selected. For the general problem of the user connection, each once have different conditions, there will have different the posterior probability.

The technology classified is to used for classifying different attribute and is classified in the cases of different users. According to the method of (8),(9) and [9], we can then derive the following relationship :

$$p(Y = y_i | X = x_i) = \frac{n_{ij}}{c_i} \quad (8)$$

$$p(Y = y_i, X = x_i) = \frac{n_{ij}}{N} = \frac{n_{ij}}{c_i} \cdot \frac{c_i}{N} = p(Y = y_i | X = x_i) p(X = x_i) \quad (9)$$

,which in the generating rule of probability. Conditional Probabilities of the principle with our paper is: Having constructed the GD network nodes, we will define the conditional probabilities which quantify the arcs of the GD network. We request define the second layer have two nodes are wireless link and wired link. We are reference form (8) and (9) can written (11) as follows:

$$\begin{aligned}
P(WirelessLink | 3G) \\
= \frac{P(3G | WirelessLink) P(WirelessLink)}{P(3G)} \quad (11)
\end{aligned}$$

In our system applied about the wireless link or wired link of posterior probability for connection is as flows:

Suppose there is a mixed network having 60% WiFi connection and 40% 3G link as connection switch. The wireless link 3G or WiFi in equal numbers; the wired link all Ethernet connection. An observer sees a (random) connection from a distance; all the observer can see is that this connection is 3G. What is the probability this connection is a wireless link The correct answer can be computed using Bayes' theorem.

- $P(WirelessLink)$, or the probability that the wireless link is a 3G of any other information. Since the observers sees a random wireless link, meaning that all connection links have the same probability of being observed, and the percentage of connection among the wireless links is 40%, this probability equals 0.4.
- $P(WirelessLink')$, or the probability that the Wireless link connection is a WiFi regardless of any other information (A' is the complementary event to A). This is 60%, or 0.6.
- $P(3G|WirelessLink)$, or the probability of the connection for habits given that the connection is a wireless link. As they are as likely to habits as energy consumption, this is 0.5.
- $P(3G|WirelessLink')$, or the probability of the wireless link to habits given that the connection is a link. This is given as 1.
- $P(3G)$, or the probability of a (randomly selected) connection to 3G regardless of any other information. Since $P(3G) = P(3G|WirelessLink) \times P(WirelessLink) + P(3G|WirelessLink') \times P(WirelessLink')$, this is $0.5 \times 0.4 + 1 \times 0.6 = 0.2 + 0.6 = 0.8$.

Given all this information, the probability of the observer having spotted a 3G connection given that the observed network connection is habits can be computed by substituting these values in the formula about the entropy is by (11) posterior probability model given the features observed as show in Fig. 10.

$$\begin{aligned}
P(WirelessLink | 3G) \\
= \frac{P(3G | WirelessLink) P(WirelessLink)}{P(3G)} = \frac{0.5 \times 0.4}{0.8} = 0.25
\end{aligned}$$

We observe the values of the variables for a set of wireless link and wire link session examples. A given quantization into k of the entropy is by (11) for interval case labels, Bayesian inference for the Gaussian distribution.

The maximum likelihood framework gave point estimates for the parameters Σ . Now we develop a Bayesian treatment by introducing prior distributions over these parameters. Where Class for $i=0, 1, \dots, L$ and $j=0, 1, \dots, L$.

$$p(Class_j | Attribute_i) = P(Class_j) \prod_{i=1}^n \prod_{j=1}^L P(Attribute_i | Class_j) \quad (12)$$

$p(Attribute)$ given by a Gaussian distribution. Case profile learn method for connection manager. In this implementation, User finding to using wireless link device via the Bayesian Network probability is $P(Wireless link | \tilde{M})$ can be re-expressed as the entropy is by (12). The PTFAHP is probability for EM (Mathematical Expectation) of class, the best alternative according to this model is one which satisfies (13). For the Fuzzy AHP method of Bayesian classifier model the corresponding formula is Figure 10.

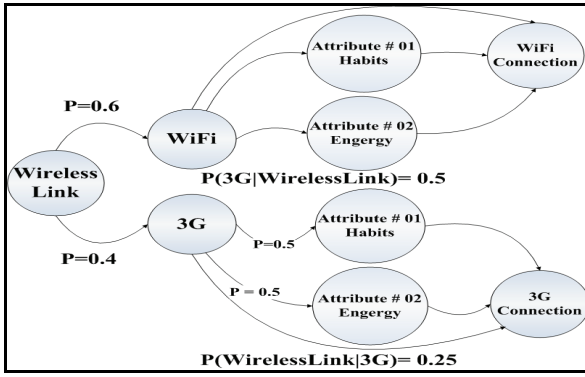


Figure 10. Connection Classifier model

$$PT_{FAHP} = \arg \max_{c \in C} P(Class) \prod_{i=1}^n P(\tilde{M}_i | Class) \quad (13)$$

IV. PROTOTYPE SYSTEM

The network devices connectivity of problems is currently facing in the embedded mobile device management, of multi-network connection manager problems. However, how to choose of accordance with past experience of capture user needs for system is currently an important problem, in our system will solve these technical difficulties.

A. System Architecture

We focused on the survey of questionnaire for 120 copies to build questionnaires table (*QTa*), the use of network devices for the intent of the process, after the computation of statistical methods FAHP be Training data, once again, the form through the user interface allows users to operate the network device operation process and then after FAHP understand user intent. Then, after repeated classification of learning to learn and update environment variables, classification of the property to meet the characteristics of the users of the device within the case, update the environment variables constant repeat users with FAHP operation user case *QTa*. The description to the components in is as follows, Figure 11. :

1) *For Connection Manager on Intelligent System (CMIA)*: There are have concept of multi-attributes is the most important issue in this research. Our idea is based on the Fuzzy APH architecture by CMIA system.

a) *Policy rule select*: User can be selection or added this function to execution device precedence policy.

b) *User input*: S Selection *QTa* function will through a questionnaire to capture user intended..

c) *Building relational table*: Building the goal and attributes between relational values.

d) *Condition rule of Pre-process*: According to the user any choice the policy rules select of component, and *QTa* table input. These will be the result of user selection, back to the condition rule changes the each all weight for attributes and classes.

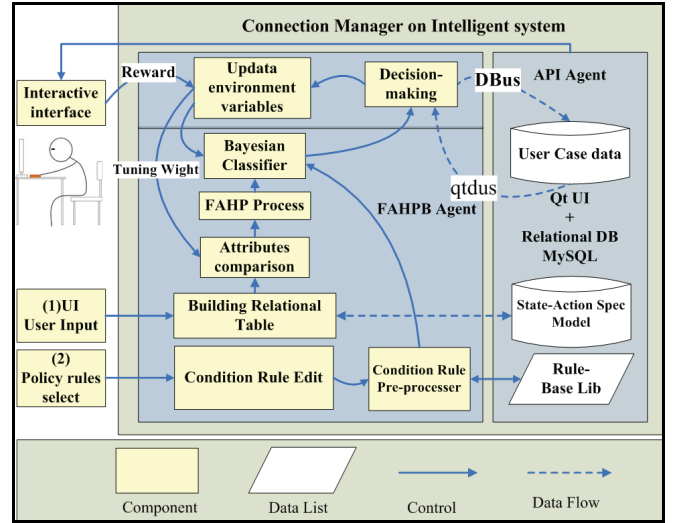


Figure 11. CMIA System Architecture

e) *FAHP Process*: This component is calculate the weight of Fuzzy AHP processes each attributes and level series weights.

f) *Bayesian of Classifier*: The Bayesian network methods and training for classification the attributes and learning from the selection palette.

g) *Decision-making*: Switching for Network device

h) *Update environment variables*: Update *RSSI*, energy consumption, traffic, throughput.

B. Classification about of classes

1) *Classification* : Accordance with the above FAHPB steps, you can calculate the properties of the network link under the main weight of each case and weight rating, as shown in TABLE II.

TABLE II. CLASSIFICATION ABOUT OF CLASSES

Classification of Class	Attributes-Normalization weights	Level weights in series	Rank
UC01 (Functional) Class #1 0.2664	Quality-0.1280	0.0351	9
	Security-0.2222	0.0582	8
	Strength-0.3169	0.0834	7
	Energy consumption-0.3328	0.0896	6
UC02 (Non-functional) Class #2 0.4520	Handily-0.3805	0.1720	1
	Habit-0.3256	0.1472	3
	Special network-0.2939	0.1318	4
UC03 (Focus factors) Class #3 0.2817	Throughput-0.3978	0.1130	5

2) *Interactive questionnaire* : Our analysis of wired connection and wireless connection are each all through a questionnaire and statistical results, such as TABLE III.

TABLE III. QUESTIONNAIRE ABOUT WIRELESS AND LIRED LINK

Item	Wireless	Link (%)	Wired	Link (%)
Handily	Handily	Not Handily	Handily	Not Handily
	90	10	82	18
Habit	Habit	Not Habit	Habit	Not Habit
	52	46	96	4

C. Description of the Computational Results

It is ranking user case to provider a method that it is will automatically sort through Bayesian classification and find the weights in front of the properties of the three users for one case, while we get the evaluation result based on FAHP with constant weight by each all attributes weighting for actual questionnaire statistics of FAHPB process, as show in TABLE IV.

TABLE IV. THE ACTUAL QUESTIONNAIRE STATISTICS SAMPLE SET

	WiFi link		3G link		Wired link	
Item	Attributes	Weighting	Attributes	Weighting	Attributes	Weighting
1	Quality	0.038147	Quality	0.052358	Quality	0.038152
2	Security	0.043515	Security	0.059726	Security	0.043515
3	Strength	0.017694	Strength	0.024285	Strength	0.017695
4	Energy consumption	0.042312	Energy consumption	0.058074	Energy consumption	0.042312
5	Handily	0.03672	Handily	0.0504	Handily	0.03672
6	Throughput	0.056396	Throughput	0.077406	Throughput	0.056398
7	Habit	0.009643	Habit	0.013236	Habit	0.009625
8	Special	0.042312	Special	0.058074	Special	0.042329
9	Policy Service	0.009773	Policy Service	0.013414	Policy Service	0.009769
	Total weighting	0.296512	Total weighting	0.406973	Total weighting	0.296515

WiFi link: $0.043515+0.042312+0.056396 = 0.142223$

3G link: $0.059726+0.058074+0.077406 = 0.195206$

Wired link: $0.043515+0.042312+0.056398 = 0.142225$

Ranking : 3G > Wired link > WiFi

Using by FAHPB approach (Red line) is the rate which the WSM(blue line) , WPM(Green line) and FAHPB fuzzy method disagree in the indication of the best attribute. In Figure 12. the fuzzy AHP by WSM, fuzzy WPM and FAHPD respectively.

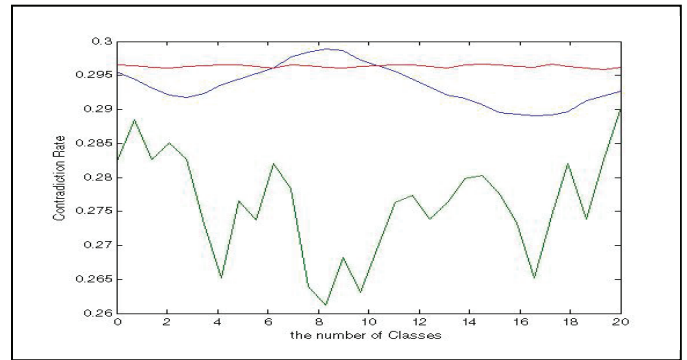


Figure 12. Contradiction rate when the number of attributes is classification

V. CONCLUSIONS

This research focuses on the connection manager of network equipment using fuzzy analytic hierarchy process in decision-making and classification classes for CMIA. The main contribution of this paper is to propose a flexible policy implementation model, including the training of classification and ranking of the optimal scheduling mechanism.

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