Optimization Model of Smart Phone and Smart Watch base on Multi Level of Elitism (OMSPW-MLE)

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Abstract. As a result of the development in the world of technology today, therefore, the use of smart phones and smart watches has become part of our world, as there are many activities that can be managed by these electronic devices. Therefore, in this study we deal with building a multi-level optimization model in order to perform a clustered process of large volume data streams. The proposed model consists of five basic stages, including: First: Collecting data from four types of sensors, two of which are related to the smart phone and two related to the smart watch (gyroscope, Accelerometer). Second: Conducting a preliminary processing of those data by drawing a network for each type of device. These networks are characterized by being complex as there are more than one relationship linking each node with other nodes. These relationships have (18) activities that can be accomplished by each person using a smart phone. and smart watch. Third: The DSA algorithm was proposed as a tool to find the most influential nodes in complex networks in order to divide them into a group of Subgraph. Fourth: An optimization algorithm called ALO was used after it was developed using different effective functions to find the best Subgraph that includes both networks. Fifth: The results evaluated through three basic measures. As a result, three levels of interdependence were reached between the activities through the relationship between time, activity and the ID of the person, where the first level linked the six activities represented (A, B, C, D, E, F), while the second level Linking activities between (G, H, I, J, K, L) and the last (third) level, also linking six other types of activities, namely (M, N, O, P, Q, S).

Keywords: IoTs, Smartphone, Smartwatch, Ant Lion Optimization, Dselect, Human Activities.

Introduction

Internet of things (IoTs) is a term refer to interconnected hardware and software technologies that allow sharing the resource among the devise or used the serive of some devices by other, also it used to produce the data from connection device and senser to internet. In the simplest concept of the Internet of things, it is any device that

is able to connect to the Internet and the ability to convey data through the network don't need to interaction between user and computer [1].

Smartphone and Smart Watch, A smartphone is a phone that includes a compact computer and other software that is not originally connected to phones, such as the operating system and the ability to work to run other applications. Smartphones are nowadays an integral part of people's daily life. Smartphones have been used for communication between people and browsing on Internet platforms and social media [2].

Smart watches in light of the recent progress taking place in the world, smart watches spread and competition began to produce design and superior features. It is a wrist watch that performs multiple tasks such as accounts, games and answering calls and works on playing audio files, including those equipped with a camera. It may contain several applications such as the measurement of the number of pulses and the measurement of blood pressure [3]. The 10 Best Smartwatches of 2019 is (Best Overall, Best for Samsung Owners, Best Fitness Tracking, Best Health Features, Best Rugged, Best Battery, Best Value, Best for Minimalists, Best for Kids and Best for Music).

Humman Biometic features Intelligent Computation, Biometrics is the result of conclusion of mix two Greek words a: Bio(Life) ,b: Metric (for measurement), it can be defined as the Science and statistically analyzing biological data and technology of measuring. Use to measure the characteristics (physiological and behavioural), that can be used to know the identity of a person. Biometric is a science for measuring behavioral and/or physical characteristics That are unique to each person and they belay that a person is who he or she pretends [4].

"Biometrics" means "life measurement" The unique physiological characteristics of individual identification are related to this term. A number of biometric as pects have been evolved and are used to verify the individual's identity. Using the characteristics of a person to get to know him This is the idea, and using the special properties means that we are using the features such as the iris, face, signature, fingerprint, etc.

Intelligent Computation the study of the design of agents intelligent. the agent is that acts in an environment—it does something. Agents consist society, dogs, and humans. An intelligent agent is a system is plays intelligently. Flexible to change environments and goals through its smart role. The goal of smart computing is to understand smart behavior and then it can be applied in industrial and natural systems [5] .

Optimization It is part of machine learning under the supervised learning. Its means change for the better, and it is a way to achieve continuous improvement and it can be applied in all aspects of life. The optimization aims to continuously develop processes and activities related to individuals and the production path.

The problem statement of this study is with develop the technology become the Biometric Activities related to Smartphone and Smartwatch as one of the main activities perform from any person Such as [Walking, Jogging, Stairs, Sitting, Standing, (Eating – Soup, Pasta, Chips, Sandwich), Brushing Teeth, Drinking, kicking (Soccer Ball), Clapping, Writing, (Playing – Tennis, Basketball), Typing, and Folding Clothes). On other side, time is considered one of the main important challenges facing us today this is due to speed development technologies and increase number of activities required to achieves from any person in specific time. Therefore, time management is one of the secrets of success in everyday life. The challenge of this study is how to accomplish

eighteen different smartwatch and smartphone activities that fifty-one people can perform in less than one hour (54 minute). Therefore, this study will be described new a model.

While the main objectives of this paper are Find the main split point (Pivot or start point) to divided the complex network into multi subgraphs. Design optimization model for hug dataset related to activities, based on cooperative between two of deep learning techniques (i.e.,DSA & ALO).

In general, we can summarization the aim of this study is design multi-level optimization system, in each level find the best decision than pass it into next level through applied the elitism principle. In general; the system can deal with the hug dataset by combination between two deep learning techniques (i.e., Deterministic Selection Algorithm and Ant lion optimization algorithm).

The system divided the complex network into multi subgraph then find the optimal subgraph for each complex network and find the correlation among the activities in each level based on the relationships among Time, coordinations and activities.

Complex Network

Networks consist of set of elements known as nodes or vertices and edges that connected between them. The system taking the structure of networks also called graphs. Complex networks are networks that have important topological features, non-trivial and patterns that not exit in simple networks.

Complex network is characterizing that is expansive, consisting of huge number element; associations patterns are not regular or simply random. Developments in technology cause the increasing computational power and the size of storage area, so that can be gathering of large volumes of information from it; this can be useful for the analysis complex networks much more detail. Complex networks are mostly dynamic in their nature and with time its advance their topology [37].

2.1 Characterizing Networks

Recently, the analysis of topological properties of complex networks is considering one of the important directions for scientific researchers. It can be representing as any topological changes to graph [38]. To understand the behavior of network must use the measurement that capable of illustrating the most relevant topological features of that network. And by using these measures we can synthesis, analysis and discrimination of complex networks in useful way [38].

Chosen specific set of topological measures is depending on the task we perform and networks. There are large set of topological measures that can be used, each one express a specific feature in the networks such as connectivity, clustering coefficient, degree distribution, diameter, centrality, connected component, betweenness centrality and etc. [39].

Connectivity

. Consider have graph G (V, E), it vertex is V and edges is E. if path present between all vertices pair then the graph is called connected, if not is disconnected. Connected components (components) is consider sub graphs of G if have largest connected (i.e. Networks consider highly connected if there are number of vertices in one components) [40].

If there is path from v1 to v2 and there is also path from v2 to v1 then this graph is called strongly connected.

There are straightforward ways to compute the connected components for the graph G (i.e. the numbers of edges and node in one component) such as breadth-first search or depth-first search. In order to discover whole connected component in the graph, loop over its nodes, whenever the search reaches a node that existing in connected components earlier found, starting a new loop using depth first or breadth first search.

Clustering Coefficient

Clustering coefficient CC for node v ∈ V represent how whole neighbors connected to node v. Can also be defining as relationship between the present connections of its neighbors and possible connections among them] as follows:

$$\boldsymbol{CC(v) = \frac{2mv}{nv(nv-1)}} \quad \text{... (1)}$$

Where nv is represent the total number of vertex neighbors, and mv is represent the number of edges between them [49]. Sometimes CC also called local clustering coefficient. To compute average $\overline{CC}$ for graph G is by compute CC values for all networks nodes as follows:

$$\boldsymbol{\overline{CC}(G) = \frac{1}{n}\sum_{v \in V} cc(v)} \quad \text{... (2)}$$

Where the number of nodes is representing by n. The low values of $\boldsymbol{\overline{CC}}$ is represent that the pairs of nodes have low connectivity [44] [45].

Diameter

Average diameter is one of networks property, mean that any two nodes are connecting by minimum number of edges, average over the possible set of pairs in the networks. Naturally, the diameter has important impact on network dynamics. For example, over the large diameter networks the data takes long time to flow [46].

The diameter of G is the length of the greatest distance in G [47] [48]. The eccentricity for networks vertexes is represent as greatest distance from any node to vertex v can be illustrated as follow:

$$\sigma(V) = \max_{u \in V} d(u, v) \quad \text{... (3)}$$

Therefore, the diameter for connected graph is representing as the maximum distance between any two vertices [37] [49]. This shown as:

$$\sigma(V) = \max_{u \in V} d(u, v) \quad \ldots (4)$$

However, there are many disadvantages to diameter. First, it's more difficult to compute it. Second, its number instead of as an alternative of a distribution, therefore contains far less information that the distribution of large distances between vertices. Finally, the diameter impact of any changes to the graph so it more sensitive [40].

Vertex Degree

.For the graph G, the number of edges that connected to vertex V is representing its degree [50]. It considers important parameter to analysis the complex networks. The whole degrees of graph vertices are double number of its edges [37] it represents as follows:

$$\sum_{v \in V} \delta(v) = 2m \quad \ldots (5)$$

Where, m is number of edges and δ(v) is representing vertex v degree.

Modularity and Community

. Measure that uses in structure of graph or networks. It was used to measure the power of dividing the network into units that can be called communities, cluster or modules [37]. Community is group of nodes that sharing common property or feature such as in topic, color and other features. The network has a high value of modularity indicates that it has density between the nodes within that communities but sparse connection between the nodes in the other communities. It considers optimization methods for community detection algorithms. The modularity value is lies between [-1, 1]. Can be defining as following [37]:

$$Q = \sum_{i=1}^{k} (e_{ii} - a_i^2) \quad \ldots (6)$$

Where, e_ii is edges percentage within module i and is the percentage of edges with at least one end in module i.

Density

Graph with number of edges is near to maximal number of edges is called dense graph different to graph with small number of edges is called sparse graph. If graph G is unweight the density can be defined as ratio between the actual numbers of edges to number of possible edges as follow [37]:

$$Density(G) = \frac{2m}{n(n-1)} \quad \ldots (7)$$

Where, the number of exiting edged is representing by m and possible number of edges in the graph with node n is represent by n (n-1).

Design OMSPW-MLE

Time is considered one of the main important challenges facing us today this is due to speed development technologies and increase number of activities required to achieves from any person in specific time. Therefore, time management is one of the secrets of success in everyday life. The challenge of this thesis is how to accomplish eighteen different smartwatch and smartphone activities that fifty-one people can perform in less than one hour (54 minute). Therefore, this chapter will be described new a model called Optimization Model of Smart Phone and smart Watch base on Multi Level of Elitism (OMSPW-MLE).

OMSPW-MLI consist of four stages: The first stage related to collection and preprocessing data sets, in general preprocessing include two steps: split data into two groups of activities (activities achieve through using smartphone or smartwatch) then draw graph for each group (i.e., the number of nodes in that graph is constant while the labels of link are different therefore this graph is considered complex graph).

The second stage split each complex graph into multi subgraph through apply the Deterministic selection algorithm (Dselect) to find the set of roots help in split that complex graph into multi-subgraph.

The third stages find the optimal subgraph through Ant lion optimization algorithm (ALO).

The final stage evaluation the patterns through apply three measures, the connected of the nodes within and without the graph, in addition to modularity.

Figure 1 explain block diagram of OMSPW-MLI. While the main stages of that model show in algorithm (1).

In general, we can summarize the main points of this thesis as explain below:

- It deals with a large database collected by sensors (accelerometer and gyroscope) implanted on the smartphone and Smartwatch.
- Preprocessing the data through convert the complex graph into multi subgraph by Dselect.
- Use the Ant Lion Optimization algorithm to find the optimal subgraph for each group of datasets.
- Evaluations the optimal sub graph based on three measures; the connected of the nodes within and without the graph, in additions to modularity.
- Find the relationships among the time, coordination's and activities represent by multi-levels.

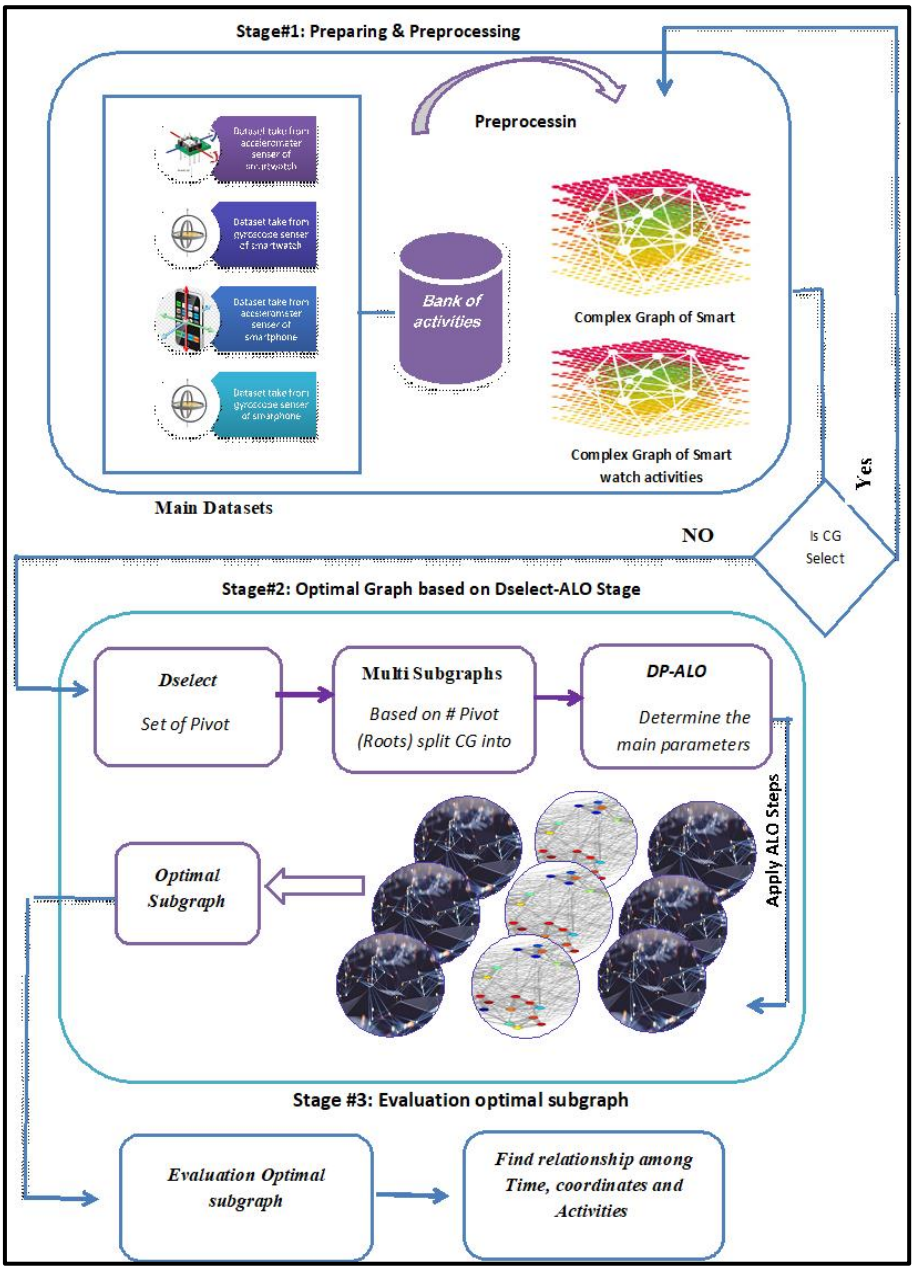

Fig. 1. Block diagram of *OMSPW-MLE*

```
Algorithm#1: OMSPW-MLE
Input: Dataset take in real-time from smartphone and smartwatch senses
Output: Optimal subgraph
// Collection & Preprocessing Stage
1:    For each row in datasets
2:       For each column in datasets
3:             Call split base on activity related to SP and SW
4:       End for

5:    End
6:    For each row in SP
7:       For each column in SP
8:             Call draw graph
9:       End for
10:   End
11:   For each row in SW
12:      For each column in SW
13:            Call draw graph
14:      End for
15:   End
// Find Optimal Graph based on Dselect-ALO Stage
// Determine the Pivot
16:   For each id_dataset
17:      Find the Pivot according to DSA
18:   End for
19:   For each sub graph from multi subgraphs
20:      Call ALO
21:   End
// Evaluation Stage
23:   For all patterns generated from optimal graph
24:      Compute Degree of connected node within graph
25:      compute degree of connected node without graph
26:      compute Modularity
27:      find relationships (time, corredinaties, Activities)
28:   End;
End OMSPW-MLI
```

3.1 Main Stage of OMSPW-MLE

In this section, the main stages related to OMSPW-MLE will described with all details for each stage.

3.2.1. Data Collection & Preprocessing Stage

The data sets used in this thesis is an open-source database called Wireless Sensor Data Mining (WISDM)1. This data was collected in a global laboratory in the

[1]http://archive.ics.uci.edu/ml/da-tasets/WISDM+Smartphone+and+Smartwatch+Activity+and+Biometrics+Dataset+

department of computer and information sciences of for dham university through the use of four sensors (two of each type), which are the accelerometer and the gyroscope, these sensors were implanted into smart devices (smart watch and smartphone). The dataset contains 15,630,426 samples. It was recorded by relying on 51 people who can carry out 18 daily activities for the average person per day, and each activity does not exceed 3 minutes to implement it (54 minutes). The preprocessing is one of the important processes for analyzing the data, in this study the preprocessing includes split datasets based on the source that collection from it then convert each dataset into a graph. In general, there are several types of graph, which are as follows:

The random graph, which is either direct or indirect, and has no fixed shape or behavior, which means that the number of nodes in the graph is subject to increase or decrease. The undirected graph in which all the edges are bidirectional means that the edge is two different directions. The directed graph all edges in this type of graph in one direction. Algorithm (2) show the process convert dataset to graph.

After we have collected the data, at this stage we need to do the pre-processing process, which is one of the important processes for analyzing the data, here we convert the database into a graph as a pre-processing of the collected data. There are several types of graph, which are as follows:

Algorithm # 2: Covert Data into Graph(CDG)

Input: Dataset_id take from smartphone &smartwatch sensors

Output: Complex Graph_id

// Random graph

For each sample in Dataset_id Do

    G=nx.random_geometric_graph (len(Dataset_id.count()))

End for

// Undirected Graph

For each sample in Dataset_id Do

    G=G1.to_directed()

End for

// Directed Graph

For each sample in Dataset_id Do

    G=G1.to_directed()

End for

End CDG

After convert database to graph, we encountered difficulty in dealing with the graph, so the deterministic selection algorithm was proposed that divides the graph into multiple subgraphs. This algorithm chooses the optimal root from among the multiple roots of the sub-graphs. After applying the DSA algorithm, several optimal sub-graphs were found.

3.2.2 Apply Deterministic selection algorithm (Dselect)

The proposed system is implemented on a raw dataset to take results. DSA used to determine the best seed for each cluster from dataset as in algorithm #.3

Algorithm #3 Dselect

Input: Complex Graph

Output: Set of Pivot to Split the Complex Graph

// Split Dataset_id into multi groups and sort each group

1: Split Dataset_id into groups of 5, sort each group

2: create empty matrix called C number of element n\5 // n total number of samples of Dataset_id

3: P = Dselect (C, N\5, N\10) // recursively computer median of C

4: Partition Dataset_id around P

5: **For** I in range 1 to N-J

6: **For** j in range N-I to N

7: **IF I=J**

8: Return P

9: **End IF**

10: **IF J<I**

11: Return Dselect (1st part of Dataset_id ,J-1,I)

12: **Else**

13: Return Dselect (2nd part of Dataset_id, N-J,I-J)

14: **End IF**

15: **End for**

16: **End for**

End Dselect

3.2.3. Apply Ant Lion Optimization Algorithm (ALO)

ALO is one of the main optimization algorithms described in algorithm 4

Algorithm #4. ALO

Input: multi subgraphs

Output: optimal subgraph

1: Initialize the first population of ants and antlions randomly

2: Calculate the fitness of ants and antlions

// Find the best antlions and assume it as the elite (determined optimum)

3: While the end criterion is not satisfied

4: **For** every ant

5: Select an antlion using Roulette wheel

6: Update c and d using equations Eqs

7: $c^t = \frac{c^t}{I}$; $d^t = \frac{d^t}{I}$

8: Create a random walk and normalize it using

9: $X(t) = [0, cumsum(2r(t_1) - 1), cumsum(2r(t_2) - 1), \dots, cumsum(2r(t_n) - 1)]$

10: $x_i^t = \frac{(x_i^t - a_i) * (d_i - c_i^t)}{(d_i^t - a_i)} + c_i$

11: Update the position of ant

12: $Ant_i^t = \frac{R_A^t + R_E^t}{2}$

13: ***End for***

Calculate the fitness of all ants Replace an antlion with its corresponding ant it if becomes fitter //

14: sum(x.^ 2 - 10 * cos(2 * pi. * x)) + 10 * dim

15: **-20*exp(-.2*sqrt(sum(x.^2)/dim))-**
exp(sum(cos(2*pi.*x))/dim)+20+exp(1)

16: Update elite if an antlion becomes fitter than the elite

17: **End while**

Return elite

Results and Analysis

we will present the results of implementing the main stages of OMSPW-MLE that described with details in section three. Where, the model includes five main stages; the first stage related to collection and preprocessing data sets from smartphone and smartwatch by two types of sensor (Gyroscope and Accelerometer) Then draw graph for each dataset. The second stage finds the optimal root "seed" for each subgraph. The third stage, Find the optimal subgraph from multi subgraph using the ALO. The Fourth stage related to verification and Evaluation the optimal subgraph generated from each dataset based on combination Deep learning techniques (DSA & ALO) through compute three measures degree of connected nodes inside and outside the graph add to the Modularity of the optimal sub graph.

4.1 Implementation OMSPW-MLI Stages

In this part; we will show the results for each stage in OMSPW-MLI model and justification for all results will be given.

4.2.1 Description of database

.In this section, we will describe the raw data used in this work. The database used in this thesis is an open-source database called Wireless Sensor Data Mining (WISDM). This data was collected in a global laboratory in the Department of Computer and Information Sciences of Fordham University through the use of four sensors (two of each type), which are the accelerometer and the gyroscope, these sensors were implanted into smart devices (smart watch and smartphone). The database contains 15,630,426 lines (4,804,403 lines for phone accel data/ 3,604,635 line for phone gyro data/ 3,777,046 line for watch accel data/ 3,440,342 line for watch gyro data). It was recorded by relying on 51 people who can carry out 18 daily activities for the average person per day, and each activity does not exceed 3 minutes to implement it (54 minutes). The person coding in range (1600-1650) and the activity in formula character range from (A to S) without using (N).

Table 1. Show the name of each activity with the code of it.

Seq.	Name of Activity	Code
1	Walking	A
2	Jogging	B
3	Stairs	C
4	Sitting	D
5	Standing	E
6	Typing	F
7	Brushing Teeth	G
8	Eating Soup	H
9	Eating Chips	I
10	Eating Pasta	J
11	Drinking from cup	K
12	Eating Sandwich	L
13	Kicking (Soccer Ball)	M
14	Playing Catch w/tennis	O
15	Dribbling (Basketball)	P
16	Writing	Q
17	Clapping	R
18	Folding Clothes	S

4.2.2 Draw Network

In this stage, we will be drawing the network for each dataset after split database into two datasets come from smartphone and smartwatch. as shown in Figure 2.

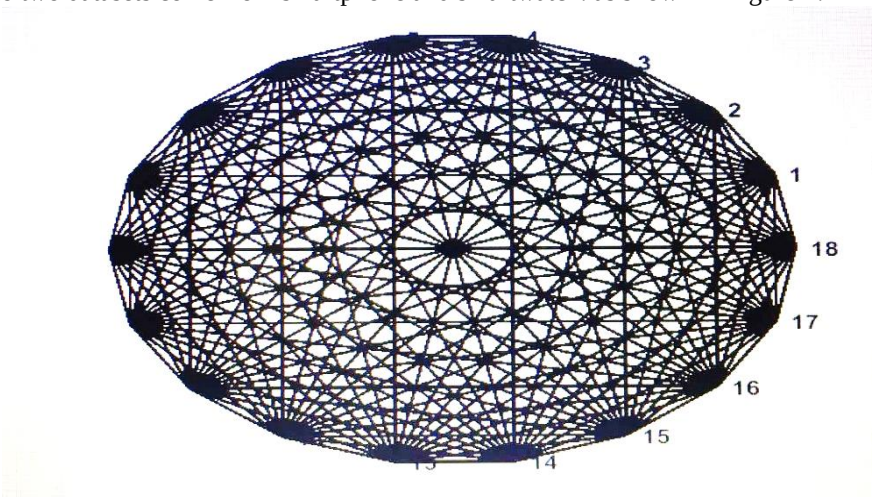

Fig. 2. Complex network represents the activity

4.2.3. The Results of Dselect algorithm

. We found that the Smartphone Accelerometer sensor network was divided into 65 subgraphs, while it was found that the Smartphone Gyroscope Sensor network was divided into 50 subgraphs, while the Smartwatch Accelerometer sensor network was divided into 47 subgraph and the other type, the Smartwatch gyroscope sensor, is divided into subgraph 59, depending on the Dselect. As a result, table (2) shown the main result get by Dselect into Four sensors. While Figures (3,4 ,5 and 6) shown distribution subgraphs in each network and number of nodes related to it.

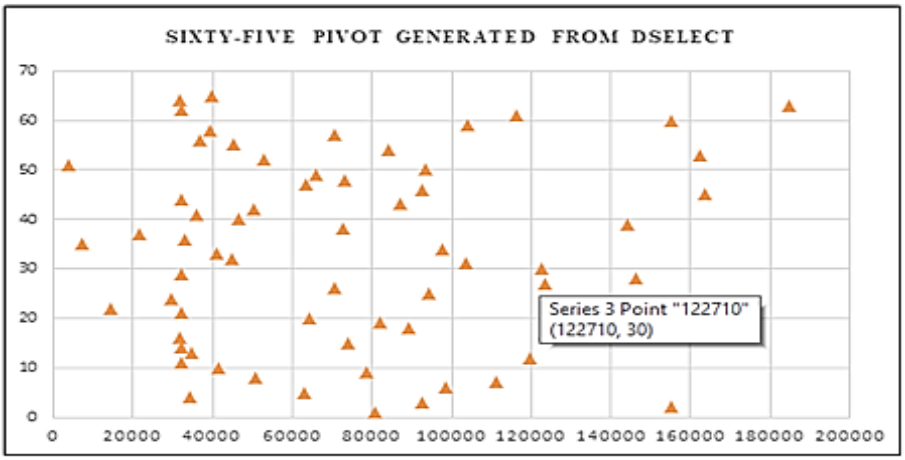

Fig. 3. Sixty-Five Pivot generation by Dselect related to Smartphone- Accelerometer

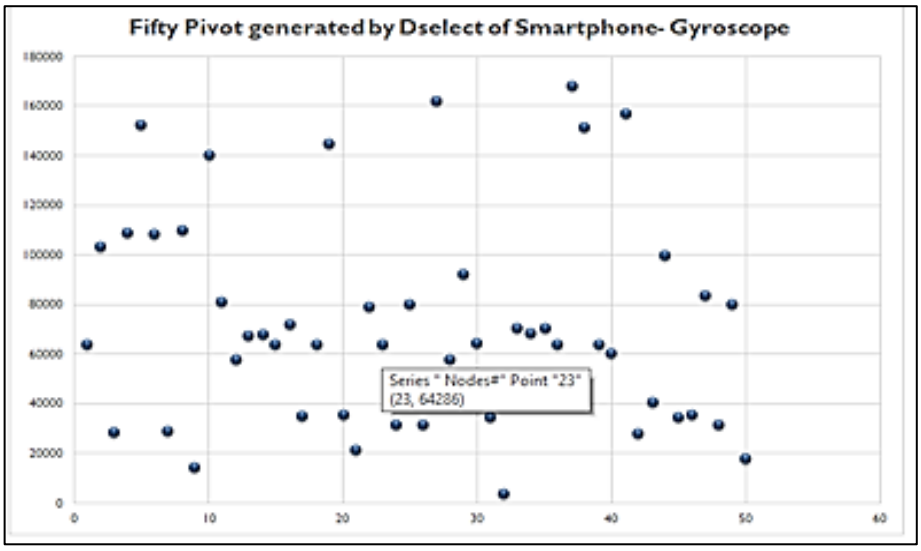

Fig. 4. Fifty Pivot generation by Dselect related to Smartphone- Gyroscope

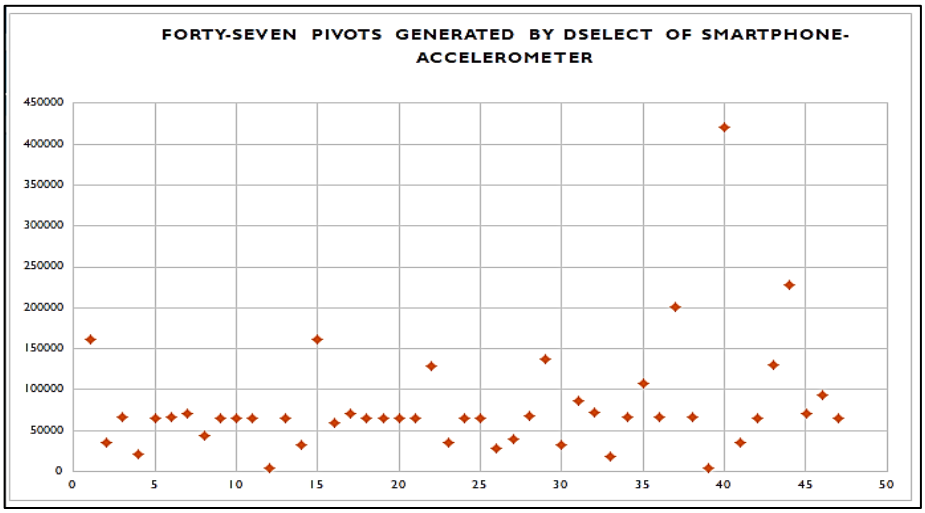

Fig. 5. Forty-Seven Pivots generation by Dselect related to Smartwatch- Accelerometer

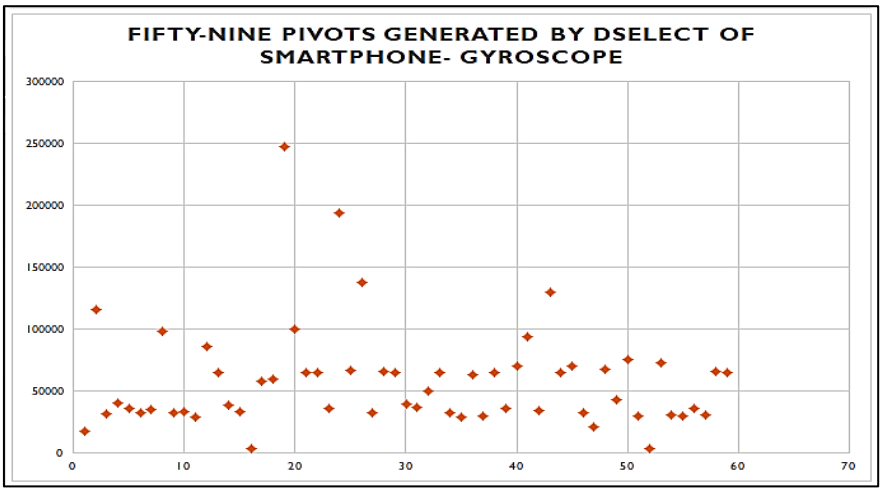

Fig. 6. Fifty-nine Pivots generation by Dselect related to Smartwatch- Gyroscope

Table 2. the main result gets by Dselect into four sensors.

	Result of DSA			
	Phone		Watch	
	gyroscope	accelerometer	gyroscope	accelerometer
#SG	50	65	59	47
#Nodes	3608635	4804403	3440342	3777046

4.2.4. Results of ALO algorithm.

. In this section, we will explain the main results get by ALO, where in that algorithm using the parameters shown in table (3). the input of that algorithm is output of Dselect (i.e., number of pivots and number of nodes related to that pivots) while the output is optimal subgraph for each dataset (i.e., smartphone Accumulator, smartphone Gyroscope, smartwatch Accumulator and smartwatch Gyroscope).

Table 3. The Main Parameters of ALO

Parameter	Value
Maximum number of iterations (Max-it)	500
SearchAgents_no(Population)	200
Upper Boundary (ub)	100
Lower Boundary(lb)	-100
Dimintions(dim)	4
Objective Function-Linear (OBJ#1)	$\text{sum}(x.\hat{}2 - 10 * \cos(2 * \text{pi}. * x)) + 10 * \text{dim}$
Objective Function-SIGMID (OBJ#2)	-20*exp(-.2*sqrt(sum(x.^2)/dim))-exp(sum(cos(2*pi.*x))/dim)+20+exp(1)
Type of selection Method	Deterministic selection method

The best sub-graph is No. (51), where the value of the first objective function for it during iterations No. (500) is (80.849) and the value of the second objective function for the same iteration is (6.136). As explain in figures (7-8). Therefore, that sub-graph is passed to Evaluation stage.

The best sub-graph is No. (9), where the value of the first objective function for it during iterations No. (500) is (96.089) and the value of the second objective function for the same iteration is (1.778). As explain in figures (9-10). Therefore, that sub-graph is passed to Evaluation stage.

The best sub-graph is No. (39), where the value of the first objective function for it during iterations No. (500) is (72.219) and the value of the second objective function for the same iteration is (5.427). As explain in figures (11-12). Therefore, that sub-graph is passed Evaluation stage.

The best sub-graph is No. (1), where the value of the first objective function for it during iterations No. (500) is (96.307) and the value of the second objective function for the same iteration is (1.807). As explain in figures (13-14). Therefore, that sub-graph is passed Evaluation stage

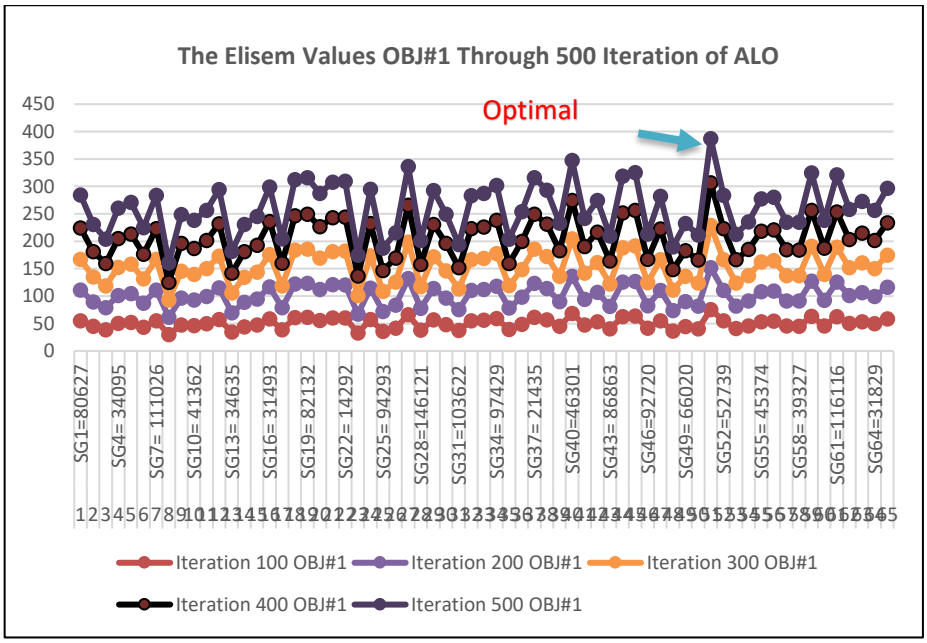

Fig. 7. the value of objective function number one (OBJ#1) of sixty-five Subgraph related to Smartphone- Accelerometer

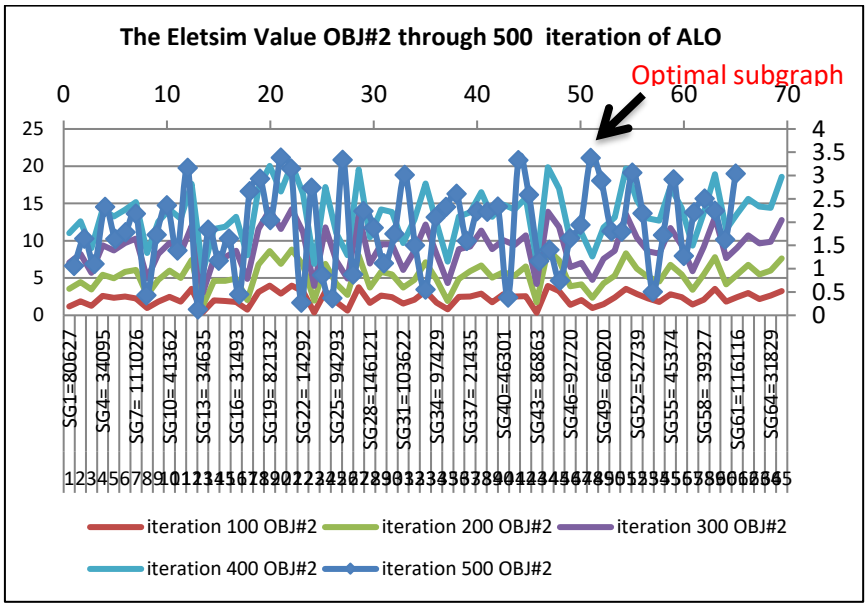

Fig. 8. the values of objective function number two (OBJ#2) of sixty-five Subgraph related to Smartphone- Accelerometer

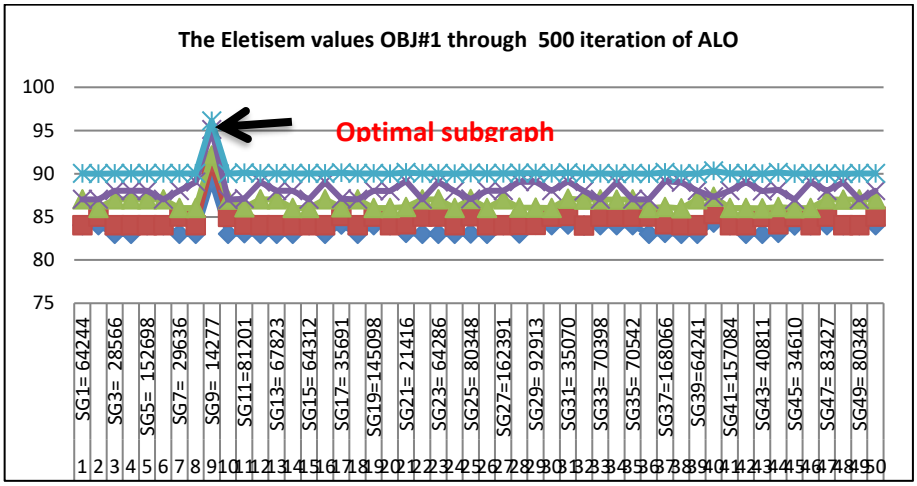

Fig. 9. the values of objective function number one (OBJ#1) of Fifty Subgraphs related to Smartphone- Gyroscope

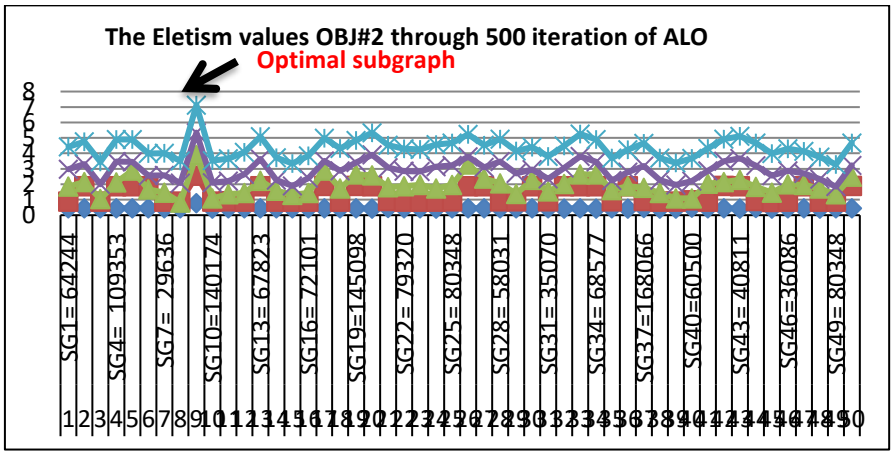

Fig. 10. the values of objective function two (OBJ#2) of Fifty Subgraphs related to Smartphone-Gyroscope

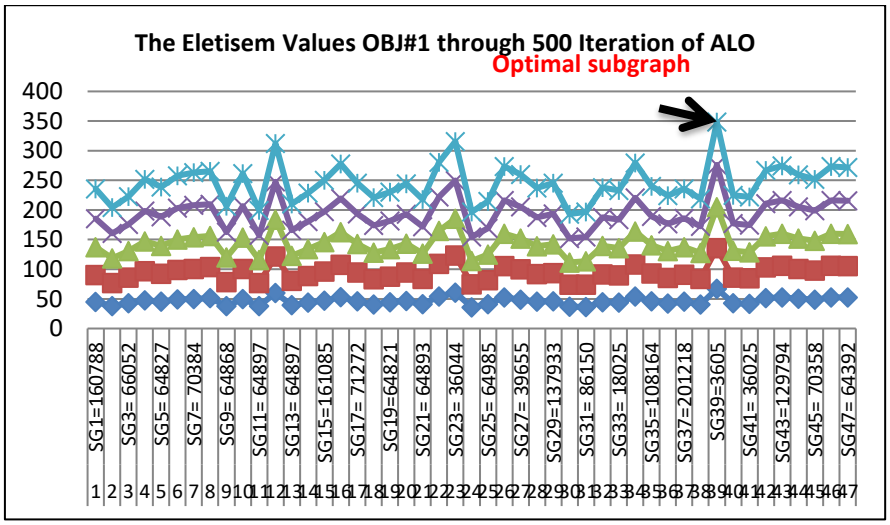

Fig. 11. the values of objective function number one (OBJ#1) of Forty-Seven Subgraphs related to Smartwatch- Accelerometer

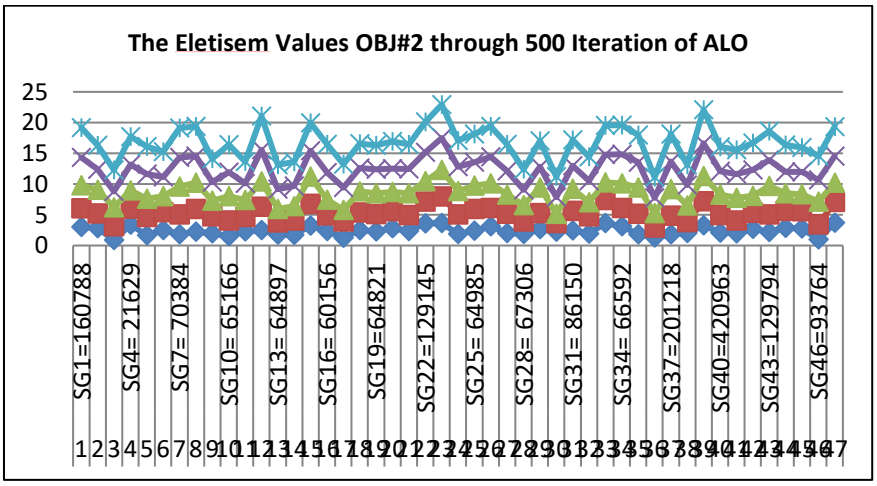

Fig. 12. the values of objective function number two (OBJ#2) of Forty-Seven Subgraphs related to Smartwatch- Accelerometer

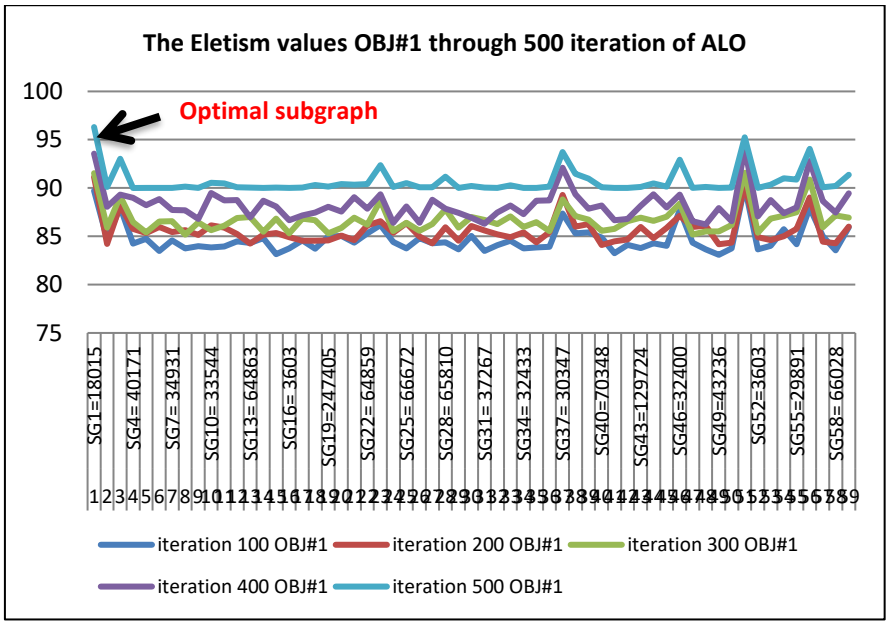

Fig. 13. the values of objective function number one (OBJ#1) of fifty-nine Subgraphs related to Smartwatch- Gyroscope

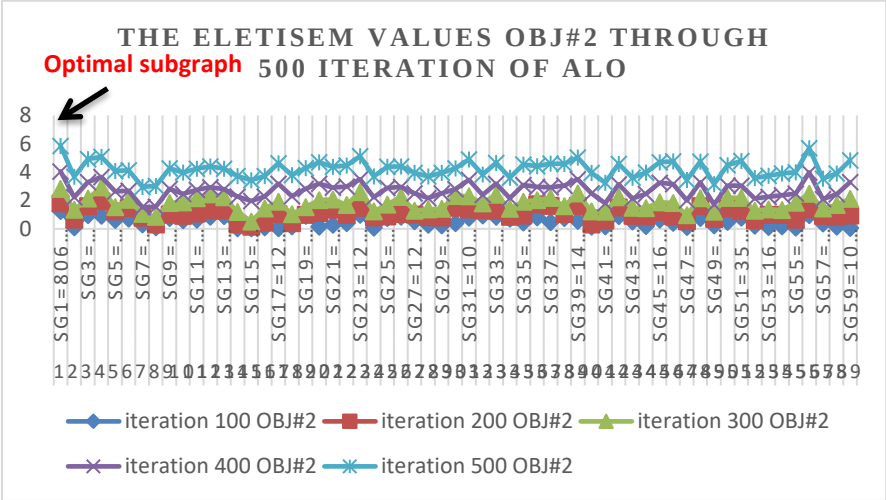

Fig. 14. the values of objective function number one (OBJ#2) of fifty-nine Subgraphs related to Smartwatch- Gyroscope

4.2.5 Evaluation

. The verification from the results of OMSPW-MLE we will use three evaluations measures, the first two measures determined the degree of connected nodes within optimal subgraph for each dataset while the other measure represent the connected of nodes between subgraphs. Finally using the modularity measures the result of all that measure shown in table (4)

Table 4. the value of Evaluation measures

#Seq	Optimal subgraph	connected		Modularity
		Between sub-graph	Within subgraph	
1	SP-A	87.12	12.88	0.27
2	SP-G	87.11	12.89	0.21
3	SW-A	87.10	12.90	0.23
4	SW-G	98.81	1.19	0.52

Finally, we extraction three levels of connection among the activity as explain in figure (3)

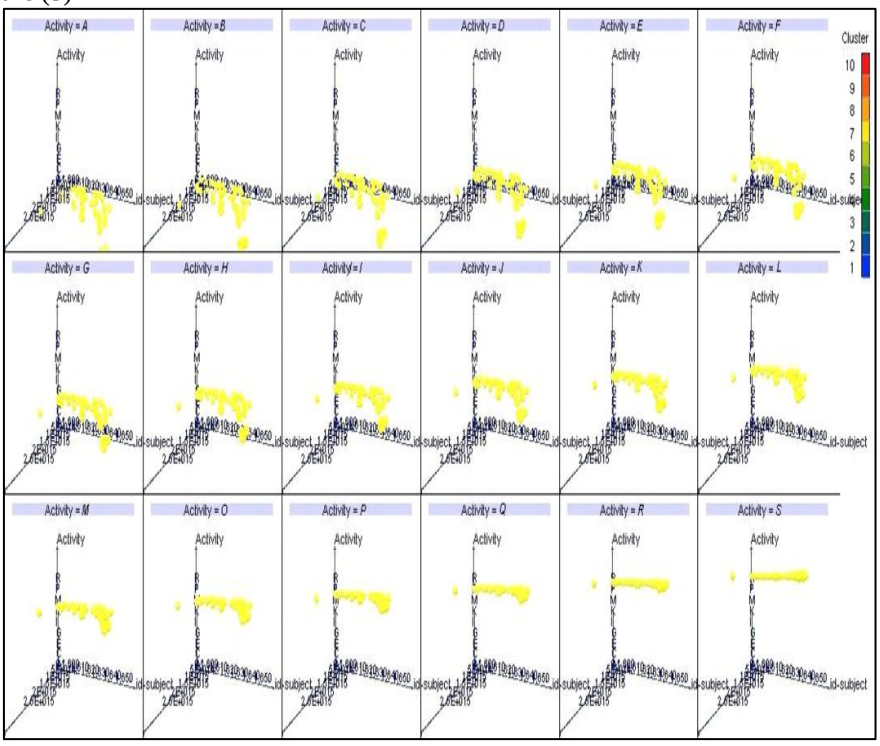

Fig. 15. relationship among time, activities and coordination

As a result, we found correlation among activities (A, B,C,D,E,F) as explain in Level one of figures (15), among activities(G,H,I,J,K,L) as explain in Level two of figures (15) and among activities(MO,P,Q,R,S) as explain in Level Three of figures (15) .

Discussion

The world has witnessed the rapid development of the internet and smart environments and devices, which have become widely applicable to various areas, including medicine and other industries. In this research, we attempt to find a way to generate optimal graph to distinguish human activities by using a deep learning technique (Dselect and ALO). Data from four sensors were collected in real time. The data obtained were preprocessed and converted into a graph. The optimal pivots for each subgraph were then identified using the DSA algorithm. Then, the ALO was applied to find the optimal subgraph among the dynamic number of subgraphs. From the apply ALO, on the sixty-five subgraphs related to smartphone- Accelerometer find the optimal subgraph number (51) and the value of object function one is (80.849) and the value of object function two is (6.136), the value of between subgraph is (87.12), the value of with-in subgraph is (12.88) and the value of modularity is(0.27).

on the Fifty subgraphs related to smartphone- Gyroscope find the optimal subgraph number (9) and the value of object function one is (96.089) and the value of object function two is (1.778), the value of between subgraph is (87.11), the value of with-in subgraph is (12.89) and the value of modularity is(0.21).

on the Forty-seven subgraphs related to smartwatch- Accelerometer find the optimal subgraph number (39) and the value of object function one is (72.219) and the value of object function two is (5.427), the value of between subgraph is (87.10), the value of with-in subgraph is (12.90) and the value of modularity is(0.23).

on the fifty-nine subgraphs related to smartwatch- Gyroscope find the optimal subgraph number (1) and the value of object function one is (96.307) and the value of object function two is (1.807), the value of between subgraph is (98.81), the value of with-in subgraph is (1.19) and the value of modularity is(0.52). As a result, three levels of interdependence were reached between the activities through the relationship between time, activity and the ID of the person, where the first level linked the six activities represented (A, B, C, D, E, F), while the second level Linking activities between (G, H, I, J, K, L) and the last (third) level, also linking six other types of activities, namely (M, N, O, P, Q, S) as we explained previously in Figure number (15)

Conclusions and Recommendation of Future Works

In this section, we can summarize the main benefit point to explain them in the future also the entire wall to attempt to avoid it in the future:

The sensors of smart phones and smart watch are one of the most important devices that can provide us with a torrent of big data that can be used to characterize human activities as well as to diagnose some disease cases. It is a rich field of knowledge that is characterized by the accuracy of the data obtained through it.

Decision making process of huge data is very important matter due to the continuous growth in data volumes and advancement of technology. Therefore, the combination of two techniques of deep learning proposed in this thesis in its two strategies, was the stage of finding the best point to divided the complex networks into set of subgraphs, then finding the best subgraph for each network on the bases of which the interconnectedness between the activity is determined as a constructive solution and its effectiveness was followed by the results we have reached, with its three levels,

The Dselect is prove highly and effective performance in dividing huge dataset, as it divided the four-complex network into a different number of important points (pivots) and each pivot belongs to it a different number of points. Therefore, it is recommended to use it in many applications due to its dependence on the principles of division, arrangement and selection continuous to reach the best division points.

Using the elitism principle inside the ALO give a pragmatic result based on the both activation functions used inside it. Add to that, the linear and sigmoid functions prove ability to deal with different number of subgraphs to choose the optimal from them.

The three-evaluation measure used give new trend to analyze the characterized of graph in addition, it gives idea of complex network and how can analysis the activities based on the multilevel of elitism.

The following points may be good ideas for future work;

It is possible to perform another objective function for other Deep Learning (DL) algorithm, such as the Long Short-Term Memory (LSTM) algorithm or the CapsNet algorithm.

It is possible to build a recommendations system based on one of the mining methods such as the gSpan algorithm for optimal subgraph.

Other types of sensors can be used to distinguish other types of activities.

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