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Improve Interval Optimization of FLR Using Auto-speed Acceleration Algorithm

Yusuf Priyo Anggodo, Imam Cholissodin
Department of Informatics/Computer Science, Brawijaya University, Malang, 65145, Indonesia
*Corresponding author, e-mail: anggodoyusuf1950@gmail.com, imamcs@ub.ac.id

Abstract
Inflation is a benchmark of a country's economic development. Inflation is very influential on various things, so forecasting inflation to know on upcoming inflation will impact positively. There are various methods used to perform forecasting, one of which is the fuzzy time series forecasting with maximum results. Fuzzy logical relationships (FLR) model is a very good in doing forecasting. However, there are some parameters that the value needs to be optimised. Interval is a parameter which is highly influence toward forecasting result. The utilizing optimization with hybrid automatic clustering and particle swarm optimization (ACPSO). Automatic clustering can do interval formation with just the right amount. While the PSO can optimise the value of each interval and it is providing maximum results. This study proposes the improvement in find the solution using auto-speed acceleration algorithm. Auto-speed acceleration algorithm can find a global solution which is hard to reach by the PSO and time of computation is faster. The results of the acquired solutions can provide the right interval so that the value of the FLR can perform forecasting with maximum results.

Keywords: Inflation, Forecasting, Fuzzy logical relationship, Interval optimization, Auto-speed acceleration algorithm

1. Introduction
Macroeconomics is the viewpoint of an economy in general in the country and was benchmarked for economic development. Macro economy has a big influence on the business cycle in General [1],[2]. The price of oil imports is affected by the value of the macroeconomic [3], when the price of oil is not stable then it will affect the prices of basic necessities and others. In addition, the impact of the increases of the macroeconomic value is the price of the project [4],[5]. Based on that, the macroeconomic in one country have a big effect on the development of economic in a country. There is some factor that affecting the macroeconomic, inflation is the most influential factor to macroeconomic. It is supported by several studies which show that the form of inflations trend has a major influence toward the growth of macroeconomic [6]-[8]. It is caused the inflation has a large effect on economic growth [9], [10]. The inflation control needs to be done to keep the inflation steady and to decrease the inflation value [11]. There are some approaches and policies undertaken to achieve a decrease and stability of the inflation value [12],[13]. However, based on studies of Kumar et al (2015) showed that the inflation target is incompatible with the purposes for which it has been planned [14]. The various approaches and policies that are used are still not able to degrade the value of inflation so that the inflation forecast is the necessity. Forecasting inflation has some positive impact like planning the industrial production [15], Government decision making in the face of the rising of inflation [4]. Inflation is important because it can impact on many fronts so it needs a proper approach for inflation forecasting.

The forecasting is usually done by a specific method. The right method is useful to give a good forecasting and can be beneficial [16]. There are some method to do the forecasting such as support vector regression [17], optimization of regression model [18], Bayesian model [19], statistic model [20], network based fuzzy inference system model [21], and neural network model [19]. Some of that research is used to do an inflation forecasting. However, the forecasting model proposed by Cheng et al (2016), Chen and Jian (2017) showed that the use of fuzzy time series method can deliver a maximum result with lower error value in a stock forecasting case [22], [23]. Fuzzy time series is very helpful in doing a forecasting due to it can

overcome the uncertainty and deliver high accuracy. This research will use the inflation dataset on 2003-2017 from Indonesian Bank. The previous study has been done by Sari et al (2016) about inflation forecasting using neural network model [24]. That model will be compared with fuzzy time series forecasting model which is proposed by Anggodo and Mahmudy (2017) which have succeeded to do the forecasting of the minimum income of life [25]. In that research is done forecasting using FLR method and to optimise the forecasting result is done optimization of interval value using ACPSO. The optimization of FLR interval value is helpful to get the right forecasting of value point, so that can obtain a high accuracy result. Hybrid ACPSO is the right combination. Automatic clustering can form the right amount of intervals [26], [15], [27]. While the PSO can optimise the interval limit value so that can be obtained the flexible interval so that it can deliver results forecasting that has a high degree of accuracy [21], [28], [29].

Interval optimization using ACPSO has given good results. However, it is still insufficient and the computational needs a long time. The process of finding the interval value with PSO is often get a trouble, especially in the process of finding the global solution because of PSO are too focused on the process of finding the solution in their local area. Moreover, the process of finding the solution with PSO with maximum results needs some great parameter value so that the computational process is long enough [25]. It is the main problem to be solved first the problem of long computing time, second the search for a interval solution that has not been maximized. The more complex the value of forecasting it will be more difficult in finding the maximum interval solution and also to get the maximum interval solution definitely takes a long time computing. In this research is proposed the improvement of interval optimum to solve the problem of finding the broader solution and the computational is relatively shorter with new method that is auto-speed acceleration algorithm. The proposed method hopes to solve the problem i.e. finding a solution of the interval that is maximum and the computation time is fast. Auto-speed acceleration algorithm is a new method in swarm intelligence or interval optimization that has never been proposed in any paper [22], [30-33].

Auto-speed acceleration algorithm was inspired by the concept of one-dimensional motion on classical physics developed by Galileo Galilei and Issac Newton [34],[35]. The motion of one dimension is a particle that moves from one position to another position, where the displacement is very influenced by the acceleration. The acceleration of the particles can affect the speed of the particle so that it can control the range of particle displacement. Auto-speed acceleration algorithm settings can control the displacement of the particle to find solutions that are more optimal. Based on this it is proposed new method with the name of auto-speed acceleration algorithm. Besides the managing of the particle displacement right, the determination of particle movement is also very influence toward the process of finding the solution to get out from the local finding area so that can find the maximum solution. Auto-speed acceleration algorithm settings can find a solution quickly because it can set the range of particle displacement. Auto-speed acceleration algorithm developed in a simple and in just a few lines of code of computer programs. In addition to the simple process of each auto speed acceleration process, the algorithm requires only a few primitive mathematical operators from fundamental kinematic motion in one dimension. Focus of auto-speed acceleration algorithm is doing the automatic settings on the acceleration of motion of each particle acceleration process. the change will affect changes in speed, direction, and distance [36]. This research will show the results of the implementation of the auto-speed acceleration algorithm for improvement of optimization model of hybrid ACPSO interval submitted by Anggodo and Mahmudy (2017) [25] on the issue of inflation forecasting.

2. Fuzzy Logical Relationships

This section will discuss on forecasting method of fuzzy logical relationships and optimise the value of interval using the hybrid ACPSO. There are several stages of doing forecasting time series data using fuzzy logical relationships [22], [29].

Step 1: the first stage does optimization using interval value hybrid ACPSO and do the calculation of the middle score of each interval.

Step 2: once the retrieved value interval $R_1, R_2, R_3, ..., R_n$ next do the formation of fuzzy Ti set, It was labelled as follows:

$$T_1 = 1/R_1 + 0.5/R_2 + 0/R_3 + 0/R_4 + ... + 0/R_{n-1} + 0/R_n,$$

$$T_2 = 0.5/R_1 + 1/R_2 + 0.5/R_3 + 0/R_4 + \ldots + 0/R_{n-1} + 0/R_n,$$

$$T_3 = 0/R_1 + 0.5/R_2 + 1/R_3 + 0.5/R_4 + \ldots + 0/R_{n-1} + 0/R_n,$$

.

.

.

$$T_n = 0/R_1 + 0/R_2 + 0/R_3 + 0/R_4 + \ldots + 0.5/R_{n-1} + 1/R_n.$$

Step 3: in this stages do the fuzzy process in each datum, if it is included in R_i interval a set of fuzzy T_j should be formed.

Step 4: these stages form the fuzzy logical relationship of a fuzzy set from each datum in the time series data, so it will be formed datum year t and $t+1$ become the fuzzy logical relationships $T_t \rightarrow T_{t+1}$. Once formed the next step is doing the grouping based on the same current state.

Step 5: the last stage is doing the forecasting, by doing some forecasting principles as follows:

Principles 1: when the value of fuzzy year t is T_A and there is the current state of the fuzzy logical relationships groups $T_A \rightarrow T_B$ than to do forecasting of year $t+1$ or M_B, which is obtained from P_B which is the midpoint of this R_B interval.

Principles 2: when the value of the Fuzzy year t is T_j and there is a current state in fuzzy logical relationships groups $T_{i(x1)} \rightarrow T_{B1(x1)}, T_{B2(x2), \ldots,} T_{Bp(xn)}$ then to do the forecasting of year t+1 as follows:

$$\frac{x_1 \cdot M_{B1} + x_2 \cdot M_{B2} + \ldots + x_n \cdot M_{Bp}}{x_1 + x_2 + \ldots + x_p}, \tag{1}$$

Principles 3: when the value of Fuzzy year t is T_i and there is a current state in fuzzy logical relationships group $T_j \rightarrow \#,$ then for the forecasting of year $t+1$ is the M_j, which is the midpoint of the interval R_j.

2.1. Interval Optimization

Maximum result is an important thing to achieve in doing forecasting. On fuzzy logical relationships, there are several parameters that affect the results of forecasting, interval is one of the thing which has big influence because of the taking of forecasting value of fuzzy logical relationships is retrieved from interval midpoint. Hybrid ACPSO is an optimum interval which has maximum forecasting result [25]. Automatic Clustering is used to find the right distribution of interval value so that can find the best forecasting value [26] [37], [38]. While the particle swarm optimization is used to make the boundary of each interval optimum so that can find the most maximum interval boundary while doing the forecasting [39], [28], [29]. The first step is doing the clustering with automatic clustering method, and then makes the interval value optimum with particle swarm optimization. The step of automatic clustering as follows:

Step 1: the first step is sort ascending the time series data $S_1, S_2, \ldots, S_n.$ and then calculate the average data value avg_diff, as follows:

$$avg\_diff = \frac{\sum_{i=0}^{n}(S_{i+1} - S_i)}{n-1}, \tag{2}$$

Step 2: The second stage is forming the cluster from time series data. The researcher should form the first datum become the new cluster and the next datum follow the principle as follows:

Principles 1: assume that there are cluster and datum $\{S_1\}, S_2, S_3, \ldots, S_i, \ldots, S_n.$ if the value $S_2 \leq avg\_diff$ then input the S_2 into the cluster that consist of S_1. If not then create a new cluster.

Principles 2: assume that there are cluster and datum $\{S_1\}, \ldots, \{\ldots, S_i\}, \{S_j\}, S_k, \ldots, S_n.$ if the value $S_k - S_j \leq avg\_diff$ and $S_k - S_j \leq S_j - S_i$ then input the S_k into cluster that consist of S_j. if it does not like that then create a new cluster with S_k.

Principles 3: assume that there are cluster and datum $\{S_1\}, \ldots, \{\ldots\}, \{\ldots, S_i\}, S_j, \ldots, S_n.$ if the value $S_j - S_i \leq avg\_diff$ and $S_j - S_i \leq clus\_diff$ then input the S_j into cluster that consist of S_i. if does not like that create a new cluster with S_j datum. $clus\_diff$ is average value in every cluster, which is obtained as follows:

$$clus\_diff = \frac{\sum_{i=0}^{n}(S_{i+1} - S_i)}{n-1}, \tag{3}$$

Step 3: the third stage is adjust the contents of each cluster in accordance with the following principles:

Principles 1: If in one cluster there are more than two data then preserve the smallest and largest datum.

Principles 2: If in one cluster there are two data preserve all the data.

Principles 3: If in one cluster there is *a* datum S_j delete it and add the datum S_j - *avg_diff* and S_j+*avg_diff* in accordance with the following situations:

Case 1: If the first cluster, then replaces the datum S_j - *avg_diff* with datum S_j.

Case 2: If the last cluster, then replaces the datum S_j+*avg_diff* with datum S_j.

Case 3: If the value of the datum S_j - *avg_diff* smaller than the attendance cluster then **principles 3** does not apply.

Step 4: assuming there is a cluster as follows:

$\{S_1, S_2\}, \{S_3, S_4\}, \{S_5, S_6\}, ..., \{S_r\}, \{S_s, S_t\}, ..., \{S_{n-1}, S_n\}$.

Do the changes the cluster be the intervals in accordance with the following principles:

4.1 First changes the cluster $\{S_1, S_2\}$ into the interval $[d_1, d_2)$.

4.2 If the current interval $[d_i, d_j)$ and *current cluster* $\{d_k, d_l\}$, then:

(1) if $d_j \geq d_k$, then the interval form is $[d_j, d_l)$. Interval $[d_j, d_l)$ then now the fcurrent interval and next cluster is $\{d_m, d_n\}$ becomes the current cluster.

(2) if $d_j < d_k$ then change the current cluster $\{d_k, d_l\}$ becomes interval $[d_k, d_l)$ and create a new interval $[d_j, d_k)$. Then now $[d_k, d_l)$ becomes current interval and $\{d_m, d_n\}$ becomes current cluster. If now the current interval $[d_i, d_k)$ and current cluster $\{d_f\}$, then create the interval $[d_i, d_f)$.

4.3 Repeat steps 4.1 and 4.2 until the whole cluster becomes the interval.

Step 5: changes the intervals become *p* sub-interval, where p ≥ 1.

To get optimal results the value of *p* then the researcher have to do testing.

fter completing the formation of intervals the next step is optimise the value of each interval using the PSO. PSO is a method of meta-heuristics which aims at seeking the best solution [40]. The particle is represented in the form of real code, where a particle is the value of the bottom and top boundary from the entire interval. Every solution quality is represented in the form of cost, when the cost getting smaller and then the solution will be the better to use and vice versa. Cost is the error value of a solution which is obtained from the root mean sequence error (RMSE) [24]. RMSE compares the actual data with the data of forecasting using fuzzy logical relationships with interval values represented in the particle.

$$RMSE = \sqrt{\frac{\sum_{t=0}^{n}(forecst_t - actual_t)}{n-1}}, \tag{4}$$

PSO work by spreading each particle to the entire search space randomly, then the particles will move to search solutions. The movement of the PSO are influenced by the speed; there is a wide variety of modelling in calculation speed. The research proposed Eberhart and Shi (2000) provide maximum results with give an attention to local and global search [41].

$$v_{t+1} = w.v_t + c_1.rand().(pBest - x_t) + c_2.rand().(gBest - x_t), \tag{5}$$

The speed of v_t of each dimension in each particle is influenced by the inertial weight value, the local value of each best particle in *pBest,* and the best global value in entire particle in *gBest.* Inertia Weight (w) value is a model proposed by Ratnaweera et al (2004) to get a more precise result, inertia weight do the calculation for each iteration [42].

$$w = (w_{max} - w_{min}).\frac{(Iterasi_{max} - Iterasi_t)}{Iterasi_{max}} + w_{min}, \tag{6}$$

The value of w_{max} and w_{min} is the largest and smallest inertia weight parameter while the values of *Iteration_{max}* and *Iteration_t* is the maximum iteration value which have been specified and much looping right now. The using of this inertia weight will be very helpful in searching solutions with

better results [43]. After the retrieved value v_{t+1}, then do the change position of each particle in each dimension.

$$x_{t+1} = x_t + v_{t+1}, \tag{7}$$

The process of calculation of the value of cost begins, calculation speed, change the position of the particle will continue to be repeated until the iterations done. So that the output of the PSO is the *gBest* value that is the best solution to use the interval value fuzzy logical relationships in doing forecasting.

3. Motion in One Dimension

The movement is the displacement of the particle from one point to another; the distance of the displacement which is achieved by the particle is influenced by the speed [43]. Every movement in the concept of one dimension is always bounded, does the particle move to the right or to the left [44]. Therefore, the speed is made of from the distance of displacement particle position per time unit which is taken [35]. When the particle velocity is constant then the distance of movement of particles are not changes. In a movement usually changes the speed and size, that usually called the acceleration [45], so the acceleration *a* is a change of the speed divided with the time difference.

$$a = \frac{v_1 - v_0}{t}, \tag{8}$$

When the speed of the particle changes higher than the previous time, it called that the acceleration is positive, so is otherwise when the particle's speed decreased, it called to be negative acceleration [45]. The concept of gravitational acceleration conducted by Galileo showed that all objects on Earth have the same acceleration [46]. In addition, the application of Newton's II laws of motion in one dimension indicates that the acceleration is not constant or changes [41]. Whereas the movement of an object in the concept of one dimension has the same concept, so the same acceleration is when the object is moving from time *t=0* until a certain time *t* [44]. When acceleration is constant then use equations 8, it is written as follows.

$$v_1 - v_0 = at$$

The movement of the object starts with speed v_0 and stops in a speed of v_1 and the movement of the objects move during *t.* with a value of a constant acceleration *a* then formed equation to find speed in last time [44].

$$v_1 - v_0 = at$$
$$v_1 = v_0 + at, \tag{9}$$

When there is a change of speed at a time, then the average speed is obtained from a number of initial and final speeds divided with how long the time taken. Therefore, the average speed of $\tilde{v}$ as follows.

$$\tilde{v} = \frac{v_1 + v_0}{2}, \tag{10}$$

The displacement of a particle is the average speed multiplied by time in constant acceleration [35], so the equation is formed as follows.

$$s = \tilde{v}t$$
$$s = \frac{v_1 + v_0}{2} . t, \tag{11}$$

Based on equation 11 can be lowered into three general equations commonly used in a motion of one dimension.

3.1. Auto-speed Acceleration Algorithm

The concept of auto-speed acceleration algorithm was inspired by the process of the movement of objects in the one dimension field. Where an object, in this case, is the particle moves in accordance with great speed that established. Speed is affected by acceleration and travel time. Yet, the acceleration is the most significant variable in shaping the value of speed. Based on this proposed a new method of auto-speed acceleration algorithm, with the concept of iteration such as heuristic methods in General. Focus on auto-speed acceleration algorithm for each iteration needs an acceleration managing that based on the condition.

The condition is seen from presents and previous of cost position value, the smaller cost value means that increasingly the solution was given. When the cost value is smaller, the decrease of acceleration value is needed. Whereas, when the cost value is greater, the upgrading of acceleration value is needed. In the first condition the reduction of acceleration is needed to decrease the speed value, this thing is identified because of the position with small cost value typically has a tendency of neighbors who have similar properties.

The second condition is done to the particle can be out of the premises so that the position can do a global search for a position that has smaller cost so that it can provide solutions that are more optimally. Those two condition auto-speed acceleration algorithm is a balanced condition in searching. The decrease of speed value in reducing the speed values so that the particle can exploit the local area. While the upgrade of acceleration value is followed by speed value so that the particle can exploit the entire searching area. On Figure 1 shows the stages of the auto-speed acceleration algorithm starts from the process of initialization particles and some parameters in auto-speed acceleration algorithm.

```
initialization
while (stop condition) {
  update velocity
  update distance
  update position
  evaluation
  if (c₁ > c₀) then
      a = a + (a /q)
  else then
      a = a - (a /q)
}
```

Figure 1. Procedure of auto-speed acceleration algorithm

The initial position of the particle that is raised is used as the starting point of the movement in the search for solutions. Whereas the parameters initialized, such as: the value of the acceleration a, initial speed v_0, iteration, the time t, the conditional q, and the direction of the particle. The value of the acceleration is getting from the upper and lower limit of the particle dimensions and divided as much as r, where r is a variable which is affecting the determining of acceleration value a. The initial speed v_0 is initialized with 0. Iterations are assigned in advance to limit how long the particles doing the movement. The time here is time which is used to determine the speed used by the particles. While the direction of the particle is used to determine the direction of particle movement. The movement is direction is resurrected in opposite direction from the initial position, it is to be able to maximise the search solution. So that the direction of p movement is obtained from particle conditions x_p as follows.

if (x_{pi} > 0) then
    p_i=1
else then
    p_i=-1

from these conditions will be obtained a value direction which is turning back from early position. After the resurrected parameter auto-speed acceleration algorithm is done, then input in iteration stage. The repetition is done until the condition is stop; there are two conditions for the looping stopped. The first condition when the repetition is as many as the iterations. The second condition is when the final speed value v_1 is less than and equal to zero is the main process.

There is some auto-speed acceleration algorithm in repetition. First, do the calculation of the value of the speed in each particle. The speed of each dimension in a particle is obtained using the equation 9, where the variable of the acceleration r and the number of time t defined in advance, but to get the maximum results need to do testing. In addition, there is initial velocity value v_0 which is initialized equal with zero. After the velocity of dimension of each particle is retrieved then the changing of the distance value which is resurrected from the equation is done (11). Change the position of each particle dimension by doing the sums starting position with a distance that has been calculated. However, also consider the direction of movement from the beginning, as follows.

$$x_i = x_{0i} + p_i . s_i,$$ (12)

Based on these equations will be obtained a new position with the opposite direction with a starting position, this treatment is done so that the particles could be out of the local search so the researcher can find the positions that are more optimally. Then, do the evaluation of the new position of the particle X_P. Evaluation is doing the calculation on the value of cost c_1, where the value of the cost derived from the RMSE between actual data and forecasting results in equation 4. Forecasting results obtained from the results of the method of fuzzy logical relationships. After get the value of the cost the next step is the condition for the determination of the new acceleration value.

The first condition when the value cost c_1 for the current position is less than the cost c_0 of the previous position, then carried out a reduction in the acceleration value as much as the acceleration divided by q, where q is a parameter whose value has been set in advance. The cost value is smaller means that the present position is better than the previous position, so that the reduction of acceleration value aims to narrow the distance of displacement position. This treatment done, because of the position which has maximum solution value then its neighbors are likely has the maximum solution. While for the second condition when the cost value greater than the previous position then will be done the addition in acceleration value, this thing undertaken to make the distance of movement position wider. This treatment is intended to be able to get out of the local area so better solutions can be achieved. After that repeat the process of speed update, distance update, position update, evaluation and condition until the repetition condition stop or the speed v_1 is less than 0. The result from auto-speed acceleration algorithm process is a particle position which has better solution value.

3.2. Improve Interval Optimization
This research proposes improvement the interval value on fuzzy logical relationships. Previous research has been done using the interval value optimization ACPSO [25]. This research will do the improvement on each iteration of the particle value of PSO using auto-speed acceleration algorithm. This is because of the PSO is often stuck at local search so it is difficult to find a position that provides the maximum solution, so that it needs to do the improvements optimization model that focuses on global search. Auto-speed acceleration algorithm was very helpful in finding solutions through global search. Besides being able to get out of the local search auto-speed acceleration algorithm can also find a position on the best local area. Figure 2 shows the process to improve the optimization the interval of fuzzy logical relationships with auto-speed acceleration algorithm.

```
automatic clustering()
initialization
while (stop condition) {
    evaluation x
    update velocity
    update pbest & gbest
    update position
    auto-speed acceleration algorithm ()
}
```

Figure 2. Procedure of improve interval optimization

Auto-speed acceleration algorithm is performed in every iteration in the PSO. The first resurrected one particle at random from the entire PSO particle to do the process of auto-speed acceleration algorithm. So it will get a new position that provides a solution that is more optimally than before.

4. Results and Analysis
4.1. Best Parameter

The dataset used in this research is the inflation data during 2003-2017, the data obtained from Bank Indonesia. Data for the year 2003-2017 will be used as training data, except March 2008 to October 2009 because it becomes a testing data [24] shown in Figure 3.
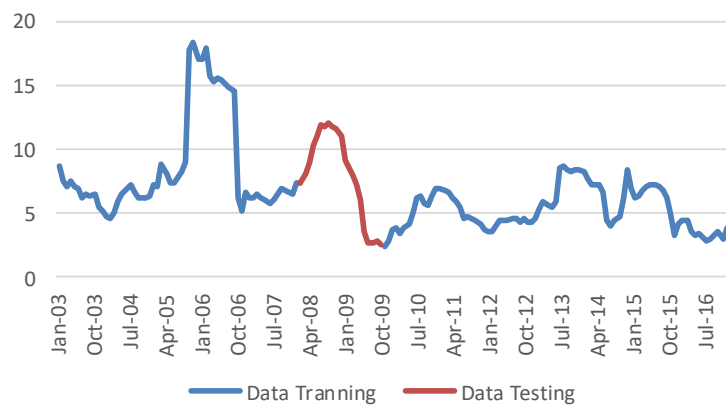
Figure 3. Dataset inflation

The value of interval training on the fuzzy logical relationships is conducted by doing forecasting in 2003-2014. In the first model the forecasting is done with interval optimization values using hybrid ACPSO [25] [26]. Based on the test results is obtained the smallest average value cost from the parameters of the PSO. The parameters which are tested such as the number of particles, the number of iterations, inertia weight, and control of each speed it is shown in Table 1.

Table 1. Best of Parameter PSO and Automatic Clustering

Population of particle	500
Number of iterations	450
Inertia weight (w_{min}, w_{max})	(0.4, 0.8)
Acceleration coefficient (c_1, c_2)	(1, 1)
Velocity control (v_{min}, v_{max})	(-0.8, 0.8)
Number of Sub interval	4

Based on the value of the parameter PSO and automatic clustering forecasting using fuzzy logical relationships is undertaken and obtained average value cost of 0.94036. The second model the improvement of interval optimization using the auto-speed acceleration algorithm to improve the solution is undertaken. Table 2 shows specified value of the parameter auto-speed acceleration algorithm.

Table 2. Parameter Auto-speed Acceleration Algorithm

Variable of acceleration (r)	7
Number of time (t)	1
Variable of conditional (q)	10

Interval optimization improvements by using auto-speed acceleration algorithm deliver a more significant result by given the average cost value 0.467, the results of each iteration is shown in Figure 4.
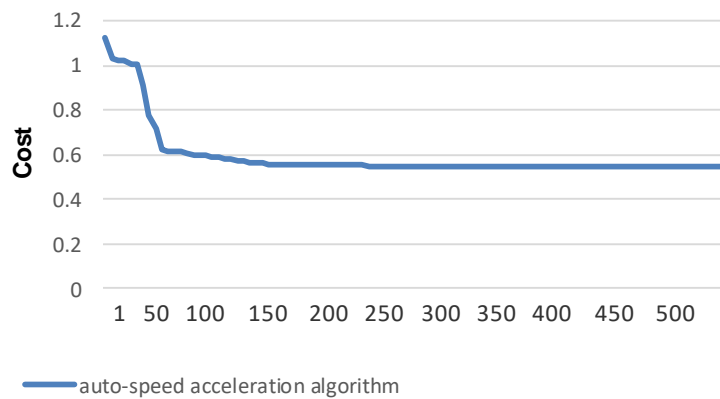

Figure 4 Result of cost auto-speed acceleration algorithm

Based on Figure 4 shows that in early iterations the premature convergence are already happen so that a new treatment is done on the value of the parameter of the PSO and automatic clustering, where population of particle of 10, number of iteration of 5, inertia weight for 0.4 and 0.8, velocity control for -0.8 and 0.8, variable of acceleration of 7, number of time of 1, and variable of conditional of 10. With the new value in the PSO, the improvement of optimization is undertaken with auto-speed acceleration algorithm so that the average of cost value is obtained 0.467. In addition getting the maximum interval value by performing optimization using hybrid ACPSO and auto-speed accelerate algorithm needs a testing of sub intervals on automatic clustering which is shown in Table 3. Table 3 shows that the interval division into p sub-interval very influential towards the results of the retrieval of more accurate forecasting.

Table 3. Result of Experimental of *p*

Number of *p*	Result of Cost					
	1st simulation	2th simulation	3rd simulation	4rd simulation	5rd simulation	Average
1	0.591211441	0.720663673	0.737593734	0.603191512	0.68461244	0.66745456
- - -	- - -	- - -	- - -	- - -	- - -	- - -
13	**0.259013015**	**0.267060462**	**0.254073903**	**0.261033924**	**0.249326836**	**0.25810162**
14	0.254063746	0.261794058	0.261292075	0.252989863	0.262431558	0.25851426
15	0.324219161	0.329085733	0.295316124	0.322589322	0.298875311	0.31401713

5. Comparison Works

Based on some of the tests the best parameter values obtained from automatic clustering, PSO, and auto-speed acceleration algorithm. In addition the testing on the dataset starting in 2015 through 2017 and compared with earlier research raised by Sari and Mahmudy (2016) about inflation forecasts uses fuzzy logic approach and the neural network shown in Table 4.

Table 4. Comparison of Method

Method	Cost of Testing	Computation Time
FIS Sugeno [24]	0.269437532	-
Neural Network [24]	0.203961692	-
Hybrid FLR using ACPSO [25]	0.179394200	77.441 s
Proposed Method	**0.106263822**	**1.245 s**

Based on the comparisons that have been done shows the model proposed in this study provide maximum results. This is because of the combination of the proper interval optimization. Automatic clustering can form the number of the corresponding interval. While the PSO and auto-speed acceleration algorithm can find the value of the interval which gives maximum results. Search interval that is balanced, where PSO focused on searching the local area while auto-speed acceleration algorithm focused on the global search. Otherwise it can provide result with a fast computing time.

5. Conclusion

The study was submitted interval optimization improvements on FLR using the new method of auto-speed acceleration algorithm. On the previous interval optimization model is used the searching interval using ACPSO. The test results show that its auto-speed acceleration algorithm is very helpful in doing repair search solution so that it can find a solution more quickly at maximum.

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