Applying Data-Driven APO Algorithms for Formative Assessment in English Language Teaching

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***Abstract*—This study proposes an innovative approach for improving the accuracy and efficiency of formative assessment in English language teaching. The method integrates the Artificial Protozoa Optimization (APO) algorithm with the Kernel Extreme Learning Machine (KELM) to overcome limitations such as local optima in traditional models. The study utilizes data from five university-level English courses, consisting of 327 samples divided into a training set (70%), validation set (15%), and test set (15%). The APO-KELM model is constructed by optimizing the KELM parameters using the APO algorithm. Comparative analysis is conducted against other models, including ELM, KELM, WOA-KELM, PPE-KELM, and AOA-KELM, in terms of accuracy (RMSE), MAPE (Mean Absolute Percentage Error), and convergence speed. The result shows that the APO-KELM model demonstrates superior performance with a Root Mean Square Error (RMSE) of 0.6204, compared to KELM (0.7210), WOA-KELM (0.6934), PPE-KELM (0.6762), and AOA-KELM (0.6451). In terms of MAPE, APO-KELM achieves 0.48, outperforming KELM (0.55), WOA-KELM (0.52), PPE-KELM (0.51), and AOA-KELM (0.49). Additionally, the APO-KELM model converged within 300 iterations, showing faster convergence compared to other models. The integration of the APO algorithm with the KELM significantly enhances the accuracy and efficiency of formative assessment in English language teaching. The APO-KELM model is more accurate and faster than traditional models, making it a valuable tool for improving assessment systems. Future research should focus on refining the APO algorithm for broader applications in educational assessments.**

Keywords*—Big data technology; APO algorithm; formative assessment in English language teaching; nuclear limit learning machine

I. Introduction

The implementation of education evaluation reform in China is increasingly gaining support from scholars and frontline teachers. This reform aims to achieve a comprehensive integration and effective connection between teaching evaluation and disciplinary parenting. It also seeks to establish a teaching evaluation index system that promotes students' physical and mental well-being, as well as their all-round development [1]. The development of a rigorous and efficient teaching evaluation index system is essential for conducting high-quality teaching evaluations. Additionally, the establishment of a comprehensive and systematic English teaching evaluation model not only facilitates the improvement of teaching evaluation practices and enhances disciplinary education outcomes, but also aligns with the contemporary goal of fostering moral values and educating individuals in the new era [2]. The use of big data technology to extract crucial information for the development of assessment methodologies has emerged as a future trend in teaching evaluation, owing to the growing volume of data generated by students and instructors throughout the teaching and learning process [3].

Currently, the study on formative assessment of English teaching using big data technology focuses mostly on two areas: the development of a teaching evaluation system and the creation of a teaching evaluation model. The objective of studying the English teaching evaluation system is to create an index system by analyzing the English teaching process, identifying the elements that influence the quality of teaching, and using appropriate algorithms to determine the final evaluation indexes [4]. Huang [5] develops teaching evaluation criteria based on the principles of effectiveness, differentiation, acceptability, and practicality. Assia and Samira [6] identify primary criteria from five aspects, including teachers, students, teaching content, teaching resources, and teaching media, to establish an English teaching evaluation system. Khodamoradi et al [7] divide the evaluation criteria for cultural teaching in senior high school English classrooms and constructs dimensions for the framework of the evaluation system. Chen and Yi [8] construct an evaluation system for secondary school English classrooms by examining and analyzing teaching plans, teaching methods, teaching attitudes, and classroom performance. The study on English teaching evaluation model mostly uses data-driven algorithms to develop the mapping link between English teaching evaluation indicators and evaluation scores [9]. The primary approaches used for teaching assessment include comprehensive fuzzy analysis [10], random forest [11], decision tree [12], extreme learning machine [13], neural network [14], and other similar techniques. The literature presents various approaches for evaluating English teaching. One study [10] suggests using an integrated fuzzy logic method, while another [11] utilizes random forest to establish the relationship between evaluation values and factors. Additionally, a high school English evaluation model is proposed [13], which is based on the extreme learning machine and tested using different datasets. Lastly, Shehu and Henay [14] propose a college English teaching evaluation model using a neural network. As the amount of data and the complexity of evaluation indexes increase, traditional machine learning algorithms may get stuck in local optima and fail to find the optimal evaluation model. To address this issue, intelligent optimization algorithms are employed to enhance the training process and improve the accuracy of the evaluation model. Furthermore, the English evaluation process lacks depth, resulting in an incomplete evaluation system and reduced efficiency. To overcome this

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limitation, a more comprehensive evaluation system is utilized to enhance the accuracy of the evaluation model [15].

This paper addresses the limitations of the current English teaching evaluation method, which uses the Extreme Learning Machine algorithm [13]. These limitations include getting stuck in local optimal solutions, low evaluation accuracy, and time-consuming evaluations. To overcome these challenges, the paper proposes a formative assessment method for English teaching based on the APO-KELM model, which combines the Intelligent Optimization Algorithm with the Nuclear Extreme Learning Machine [16]. The primary contributions of this paper include: (1) analyzing the issue of formative assessment in English teaching using big data, and identifying comprehensive, scientific, effective, and quantifiable evaluation criteria for English teaching; (2) integrating the Artificial Protozoan Optimizer algorithm and the Kernel-Limit Learning Machine to develop a formative assessment approach based on an efficient data-driven algorithm for English teaching; (3) validating the effectiveness and robustness of the proposed method by utilizing formative data from English teaching in various colleges and universities.

II. Analysis of Formative Assessment Issues

A. *Research Ideas on Formative Assessment in English Teaching*

This work utilizes the research approach of problem identification, problem analysis, solution proposal, solution implementation, and solution validation [17] to investigate the issue of formative assessment in English education. The particular research concept is shown in Fig. 1.

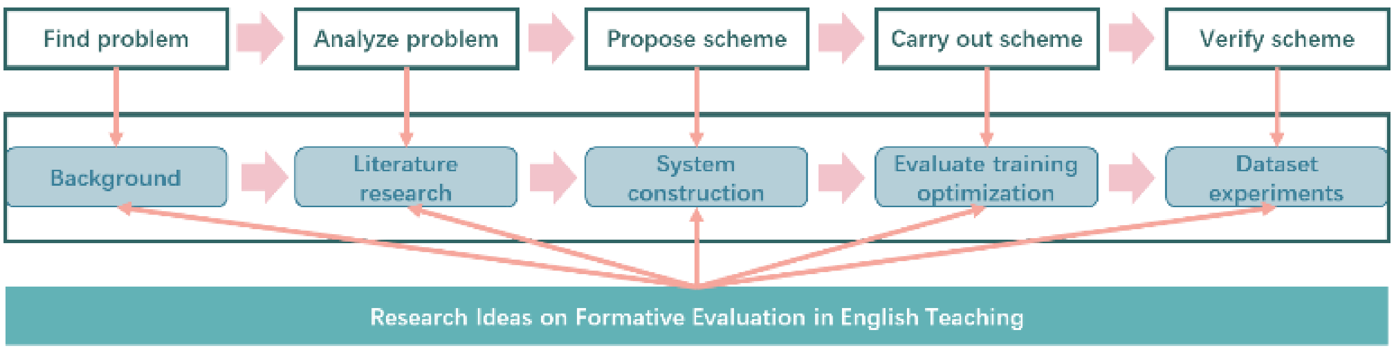


Fig. 1. Schematic diagram of the research idea.

The research ideas of this paper, as shown in Fig. 1, are as follows: 1) Identify the problem of formative assessment in English teaching by examining the background of formative assessment in English teaching; 2) Analyze the formative process of English teaching and identify the formative assessment indicators through literature research; 3) Develop the formative assessment indicator system for English teaching using data preprocessing and correlation analysis, while also proposing 4) Constructing a formative assessment model for English teaching by combining various machine learning algorithms and optimizing training for formative assessment of English teaching; 5) Validate the effectiveness and reliability of the proposed evaluation method using different datasets and data extraction methods.

Based on the analysis provided above, this paper conducts research on the problem of formative assessment in English teaching. The research includes the discovery and analysis of the problem, the establishment of an index system for formative assessment, the construction of a formative assessment model for English teaching, and the validation of the model's application. The specific key technologies are illustrated in Fig. 2.

B. *Analysis of the Problem*

The teaching evaluation issue revolves on the teaching evaluation index system, which involves examining and extracting the value of teaching evaluation indices. Machine learning techniques are then used to establish the mapping relationship between the index value and the evaluation value [18]. The issue of formative assessment in English teaching involves determining the teaching process by examining relevant literature, conducting analysis, and integrating the English curriculum, student development requirements, and English teaching evaluation practices. This process leads to the extraction of a formative assessment index system for English teaching. Furthermore, a data-driven algorithm is employed to construct a formative assessment model for English teaching. The specific problem analysis is illustrated in Fig. 3.

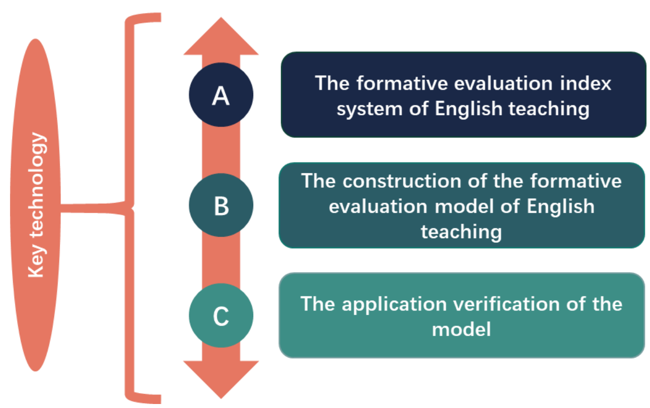


Fig. 2. Key technology content.

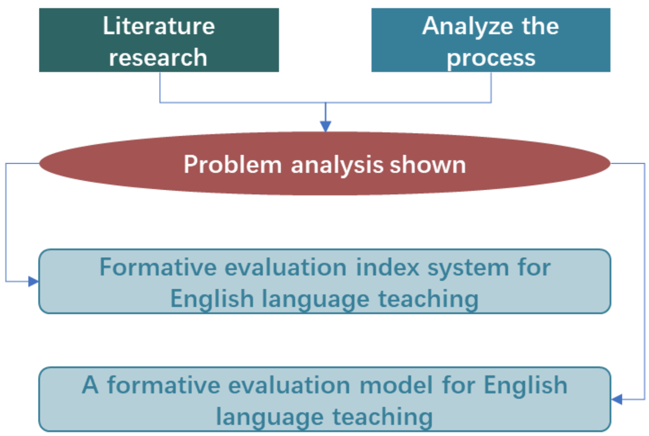


Fig. 3. Schematic diagram of the problem analysis.

C. Evaluation System Construction

The formative assessment problems in English teaching were analyzed to develop students' comprehensive language application ability. The focus was on the leading role of students' teaching evaluation and the diversity of evaluation methods and system construction. The teaching objectives, contents, methods, and effects were set as the first-level indicators, following the principles of human nature, scientific approach, developmental approach, systematic approach, and operability. The formative indicator system of English teaching was obtained through the use of the Delphi method questionnaire survey, deletion, and adjustment [19], as shown in Table I.

D. Analysis of Evaluation Models

The essence of the formative assessment problem of English teaching is a complex regression prediction problem, with the index value in the formative index system of English teaching as the input and the evaluation score as the output, the specific evaluation model is constructed as follows:

$$Y_{score} = F_{eval}\left(X_{index}\right) \tag{1}$$

Where Y_{score} is the evaluation score; F_{eval} is the evaluation model; X_{index} is the index value. In this paper, a data-driven algorithm is used to construct the formative assessment model of English teaching, as shown in Fig. 4.

TABLE I. EVALUATION INDICATOR SYSTEM

No.	Data set	Goal
1	A Teaching and Learning Objectives	A1 Developing students' language skills A2 Expanding Students' Cultural Awareness A3 Developing the quality of students' thinking A4 Improving Student Learning
2	B Teaching content	B1 English Language Knowledge B2 English Language Skills B3 Knowledge of English Culture B4 English Learning Strategies
3	C Teaching methods	C1 Inquiry-based teaching C2 Contextualised Teaching C3 Thematised Teaching
4	D Teaching Effectiveness	D1 Teaching effectiveness of teachers D2 Student Learning Outcomes

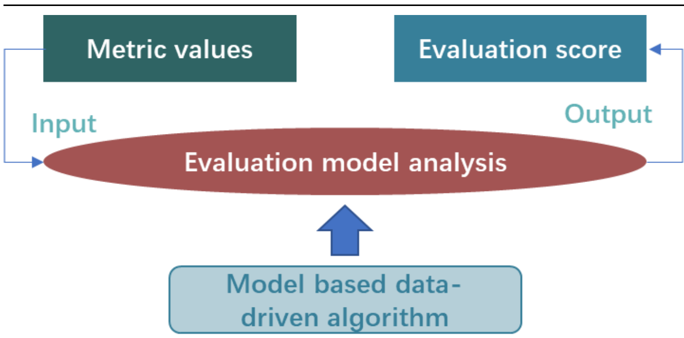


Fig. 4. Evaluation model analysis.

III. APO-KELM ALGORITHM

In order to solve the problem of formative assessment in English language teaching, this section uses the artificial protozoan optimiser algorithm to improve the kernel-limit learning machine for the construction of formative assessment model in English language teaching.

A. APO Algorithm

1) Principle of APO algorithm: Swarm intelligence optimization system Artificial Protozoa Optimizer (APO) [20] is inspired by natural phenomena. The method introduces a new Artificial Protozoa Optimizer (APO) that is inspired by protozoa. APO imitates the foraging, quiescent, and reproductive behaviors of protozoa in order to replicate their survival strategies. From a practical perspective, the method is employed to resolve five common engineering design challenges in continuous environments with constraints. Moreover, the method is employed to perform multilevel picture segmentation in a discrete space while adhering to specific constraints.

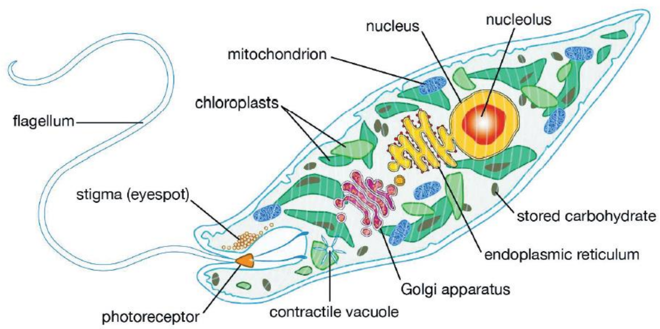


Fig. 5. Representation of protozoan behaviour.

Microorganisms have a unique advantage, as evidenced by research on a variety of biological processes. As microorganisms, bacteria, algae, and protozoa execute functions that are comparable to those of organelles in higher plants and animals. Specialized structures known as "organelles" execute these functions. Metabolism, reproduction, genetic continuity, adaptability to environmental stimuli, and variability are fundamental life features of microorganisms. Because of their simple and low-complexity structure, microbial beings are often more successful than larger organisms. Researching the principles of behavioral processes such as reproduction, dormancy, and foraging, the APO algorithm is employed. Fig. 5 shows representation of protozoan behavior.

a) Foraging

i) Self-supporting model: By generating carbohydrates via their chloroplasts, protozoa may provide nourishment. The protozoan will migrate away from its current location and towards a specific spot if it is subjected to extreme light intensity. When the light intensity around the protozoan is low, the protozoan relocates to a different position (Fig. 7). The autotrophic model may be described by the following particular model:

$$X_i^{new} = X_i + f \cdot \left(X_j - X_i + \frac{1}{np} \cdot \sum_{k=1}^{np} \omega_a \cdot \left(X_{k-} - X_{k+} \right) \right) \odot M_f \tag{2}$$

$$X_i = \left[x_i^1, x_i^2, \cdots, x_i^{\dim} \right]$$
$$X_i = sort\left(X_i \right) \tag{3}$$

$$f = rand \cdot \left(1 + \cos\left(\frac{iter}{iter_{\max}} \cdot \pi \right) \right) \tag{4}$$

$$np_{\max} = \left\lfloor \frac{ps-1}{2} \right\rfloor \tag{5}$$

$$\omega_a = e^{-\left| \frac{f(X_{k-})}{f(X_{k+})+eps} \right|} \tag{6}$$

$$M_f\left[di\right] = \begin{cases} 1 & randperm\left(\dim, \left\lceil \dim \cdot \frac{i}{ps} \right\rceil \right) \\ 0 & otherwise \end{cases} \tag{7}$$

where X_i^{new} denotes the updated protozoan position; X_i denotes the current protozoan position; X_{k-} denotes the randomly selected neighbourhood-1 protozoan; X_{k+} denotes the randomly selected neighbourhood+1 protozoan; f denotes the foraging factor; np denotes the individual of the neighbourhood pairs; $x_i^{\dim}$ denotes the dimensional position of the ith protozoan; $iter$ denotes the number of iterations; $iter_{\max}$ denotes the maximum number of iterations; ps denotes the population size; $f(\cdot)$ denotes the formula for calculating the fitness value; eps denotes the minimal value, which is generally taken as 2.2204e16; denotes the dimension index; denotes the fitness value; and denotes the mapping vector. The general value is 2.2204e-16; M_f is the mapping vector; di is the dimension index (see Fig. 6).

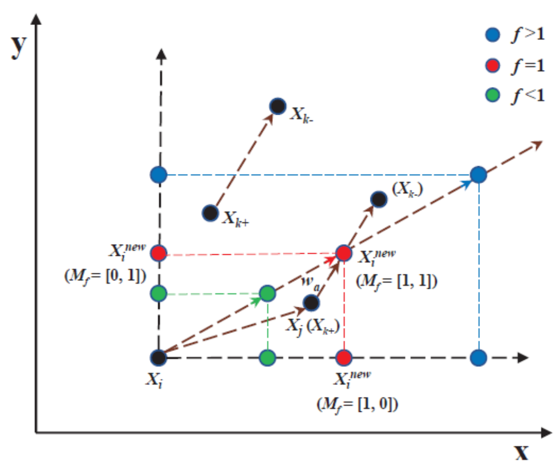


Fig. 6. Self-supporting model.

ii) Heterotrophic model: Protozoa are able to acquire nourishment by absorbing organic substances from their environment while under darkness. If X is a nearby location with abundant food, protozoa will travel towards it. The precise model of the heterotrophic model is as follows:

$$X_i^{new} = X_i + f \cdot \left(X_{near} - X_i + \frac{1}{np} \cdot \sum_{k=1}^{np} \omega_h \cdot \left(X_{i-k} - X_{i+k} \right) \right) \odot M_f \tag{8}$$

$$X_{near} = \left(1 \pm Rand \cdot \left(1 - \frac{iter}{iter_{\max}} \right) \right) \odot X_i \tag{9}$$

$$\omega_h = e^{-\left| \frac{f(X_{i-k})}{f(X_{i+k})+eps} \right|} \tag{10}$$

$$Rand = \left[rand_1, rand_2, \cdots, rand_{\dim}\right] \tag{11}$$

where X_{near} denotes the neighbourhood position; X_{i-k} and X_{i+k} are the i-kth and i+kth neighbourhood positions, respectively; ω_h is the weight of the heterotrophic pattern; and $Rand$ is a random vector.

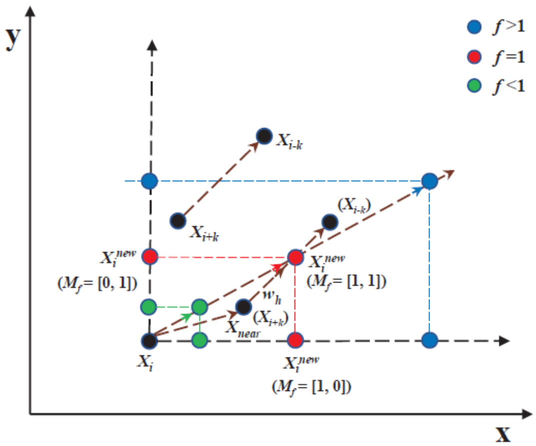


Fig. 7. Self-supporting model.

b) Dormancy: Every element of a single solution vector is multiplied by a random value selected from a Gaussian distribution to create a new offspring. The Gaussian random variable influences the number of interruptions introduced to the parent vector, aiding the algorithm in eliminating local optima. The offspring produced by the Gaussian variation at generation *m* is defined for every parent solution vector:

$$X_i^{new} = X_{\min} + Rand \odot \left(X_{\max} - X_{\min}\right) \tag{12}$$

$$\begin{aligned} X_{\min} &= \left[lb_1, lb_2, \cdots, lb_{\dim}\right] \\ X_{\max} &= \left[ub_1, ub_2, \cdots, ub_{\dim}\right] \end{aligned} \tag{13}$$

where $X_{\min}$ and $X_{\max}$ denote the lower and upper bound vectors, respectively, and lb and ub denote the lower and upper bound variables, respectively (Fig. 8).

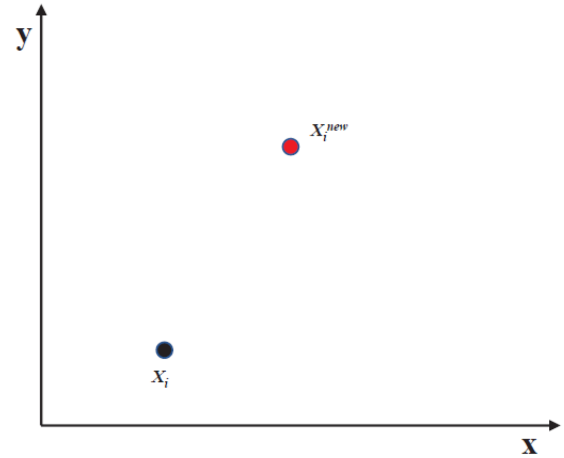


Fig. 8. Diagram of hibernation.

c) Reproduction: Protozoa are capable of asexual reproduction when they reach the appropriate age and are in good condition. In theory, this process of reproduction results in the protozoan dividing into two identical progeny. This behavior is simulated by creating a duplicate protozoan and analyzing a perturbation. The mathematical representation of reproduction is as follows:

$$X_i^{new} = X_i \pm rand \cdot \left(X_{\min} + Rand \odot \left(X_{\max} - X_{\min}\right)\right) \odot M_r \tag{14}$$

$$M_r\left[di\right] = \begin{cases} 1 & randperm\left(\dim, \lceil \dim \cdot rand \rceil\right) \\ 0 & otherwise \end{cases} \tag{15}$$

where $\pm$ denotes interference forward or backward, and M_r denotes reproduction mapping relationships (see Fig. 9).

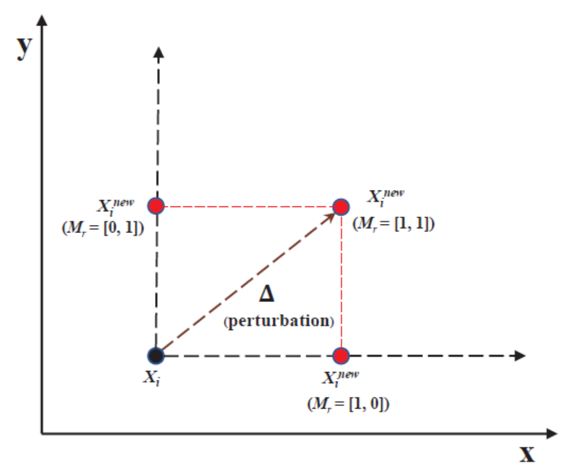


Fig. 9. Diagram of reproduction.

d) Other parameter settings: The other parameters of the APO algorithm are set as follows:

$$pf = pf_{\max} \cdot rand \tag{16}$$

$$p_{ah} = \frac{1}{2} \cdot \left(1 + \cos\left(\frac{iter}{iter_{\max}} \cdot \pi\right)\right) \quad (17)$$

$$p_{dr} = \frac{1}{2} \cdot \left(1 + \cos\left(\left(1 - \frac{i}{ps}\right) \cdot \pi\right)\right) \quad (18)$$

Where pf denotes the dormancy ratio parameter, $pf_{\max}$ is the maximum ratio parameter, p_{ah} is the conversion probability between autotrophic and heterotrophic modes, and p_{dr} is the conversion probability between dormancy and reproduction. The conversion probability is mainly used to balance the conversion of exploration and exploitation operators, as shown in Fig. 10.

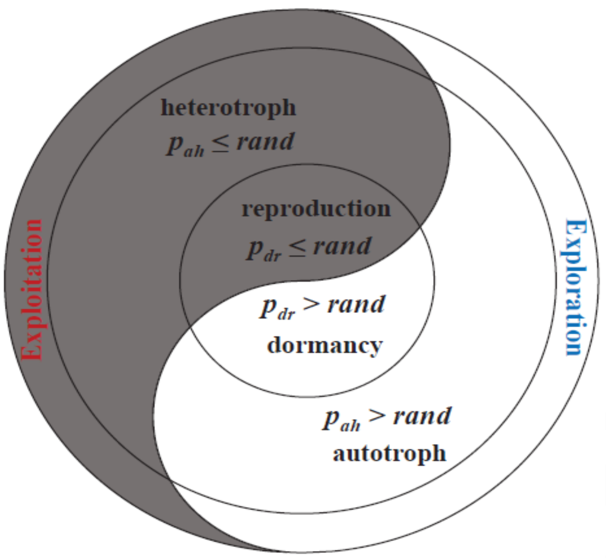


Fig. 10. Schematic diagram of the behavioural transition between development and exploration.

2) APO algorithm pseudo-code: According to the optimisation strategy of APO algorithm, the pseudo-code of APO algorithm is shown in Table II.

TABLE II. APO ALGORITHM PSEUDO-CODE

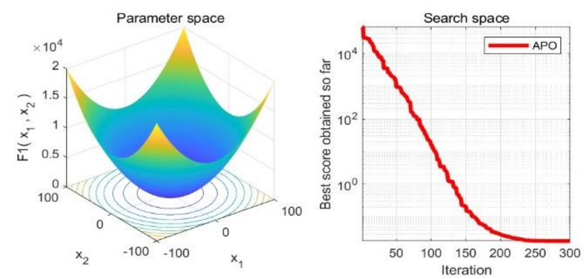
Algorithm 1: Artificial Protozoa Optimisation Algorithm (APO)
Initialise the parameters ps, dim, np, pfmax and MaxFEs;
Protozoan populations were randomly generated and fitness values were calculated;
While FEs<MaxFEs
Sort(Xi), calculating the scaling parameter, calculating the conversion probability
For i=1:ps do
If i in Drindex do
Individual positions are updated using either the dormant behaviour operator or the reproduction behaviour operator;
Else
Individual positions were updated using either the autotrophic behaviour operator or the heterotrophic behaviour operator;
End if
Calculate fitness values and compare updated populations;
End for
Output optimal protozoan individuals;
FEs = FEs + ps;
End while

3) Performance analysis of APO algorithm optimisation: In order to verify the convergence of the APO algorithm, this paper chooses F1-F8 test functions (see Table III) [21] to analyse the performance of APO, and the specific results are shown in Fig. 11.

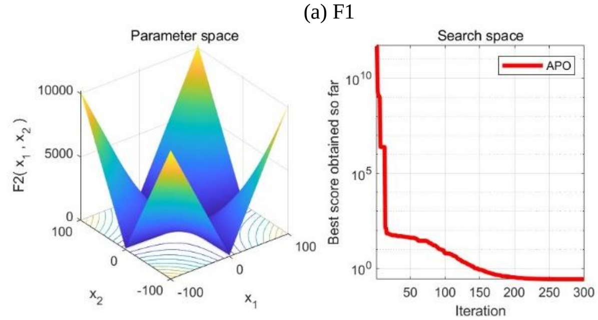
TABLE III. TEST FUNCTION SETTINGS

serial number	name (of a thing)	n	realm
1	F1	30	[-100,100]
2	F2	30	[-10,10]
3	F3	30	[-100,100]
4	F4	30	[-100,100]
5	F5	30	[-30,30]
6	F6	30	[-100,100]
7	F7	30	[-1.28,1.28]
8	F8	30	[-500,500]

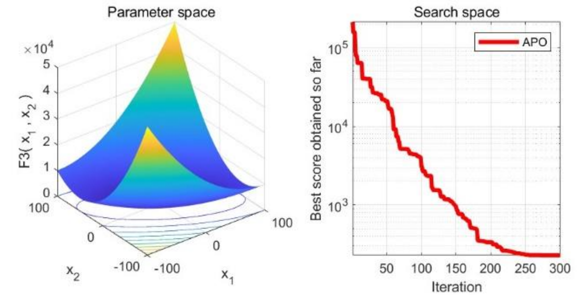
As can be seen from Fig. 11, the APO algorithm can converge to a certain accuracy and achieve a better optimal solution in the F1 to F8 function tests.



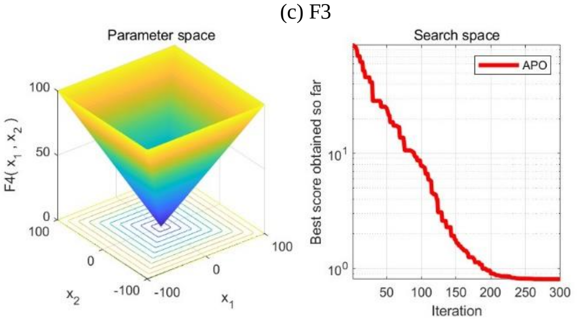
(a) F1



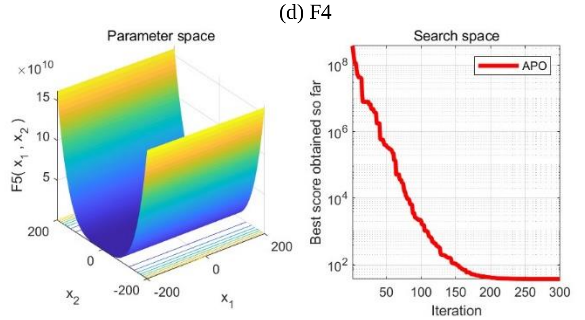
(b) F2



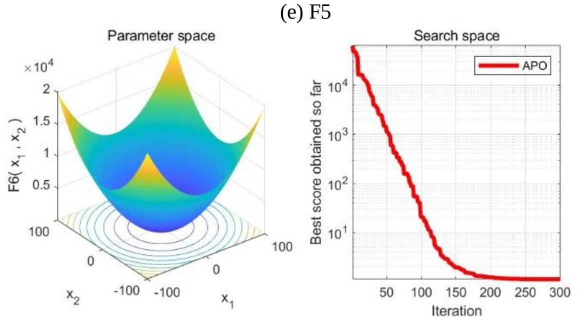
(c) F3



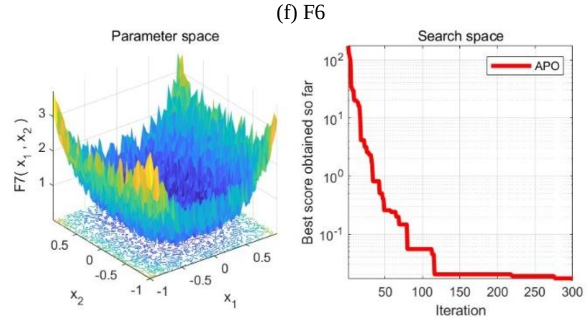
(d) F4



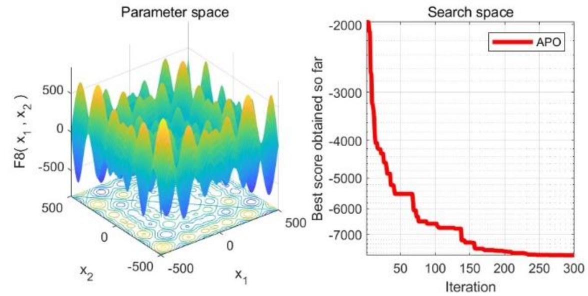
(e) F5



(f) F6



(g) F7



(h) F8

Fig. 11. APO optimisation performance test results.

B. The KELM Model

Kernel Based Extreme Learning Machine (KELM) [22] is an extreme learning machine algorithm based on kernel functions, which achieves high-dimensional mapping of data through kernel functions, thus improving the performance of the model.KELM has better stability and generalisation capabilities when dealing with classification and regression problems compared to traditional Support Vector Machines (SVMs) and Extreme Learning Machines (ELMs) [23], which usually have better stability and generalisation capabilities. A key advantage of KELM is that it can directly handle multi-class classification problems and usually does not require complex weight adjustments as in traditional neural networks (see Fig. 12).

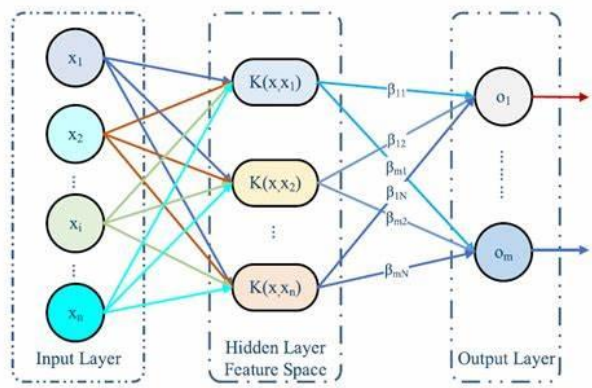


Fig. 12. KELM structure.

The KELM model is calculated as follows:

$$F(X) = \left[K(X, X_1); \cdots; K(X, X_n)\right]\left(\frac{I}{C} + \Omega_{ELM}\right)^{-1} L \tag{19}$$

Where, $(X_1, X_2, \cdots, X_n)$ is the given training sample, n is the number of samples, K is the kernel function, Ω_{ELM} is the kernel matrix and $F(X)$ is the learning objective function.

The steps of KELM are shown in Fig. 13 and described below:

- Determine the number of neurons in the hidden layer, randomly set the connection weights between the input layer and the hidden layer w and the bias of the hidden layer neurons b ;

- Choose an infinitely differentiable function as the activation function of the neurons in the hidden layer, and then calculate the hidden layer output matrix H ;
- Calculate the output layer weights.

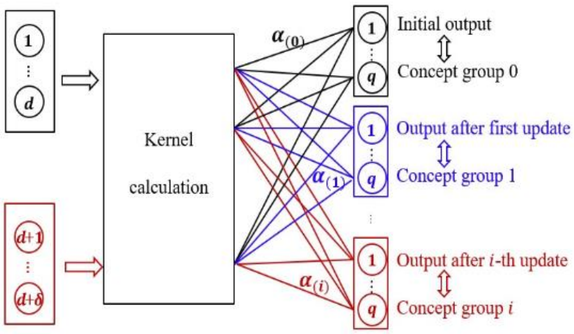


Fig. 13. KELM learning training steps.

The KELM model is mainly applied in the fields of data regression prediction, fault early warning, online data prediction, feature selection and parameter tuning, dealing with nonlinear and non-smooth data, and time series analysis [24], and the application schematic is shown in Fig. 14.

Fig. 14. KELM application.

C. APO-KELM Structural Steps

This paper utilizes the APO algorithm to optimize the parameters of the Kernel Extreme Learning Machine (KELM) model for constructing the formative assessment model of English language teaching. The objective is to enhance the evaluation accuracy and generalization of KELM. The specific optimization schematic can be seen in Fig.15. The APO method divides the decision variables into two parts [25] (Fig. 15): the first part consists of the weights and bias, and the second portion consists of the parameters of the activation function. The APO algorithm uses the RMSE function as the fitness function. Fig.16 displays the structure of the APO-KELM model, while Table IV presents the pseudo code.

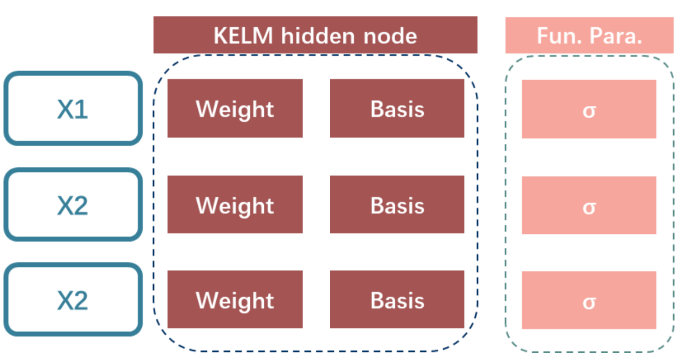


Fig. 15. Schematic diagram of APO-KELM optimisation variables.

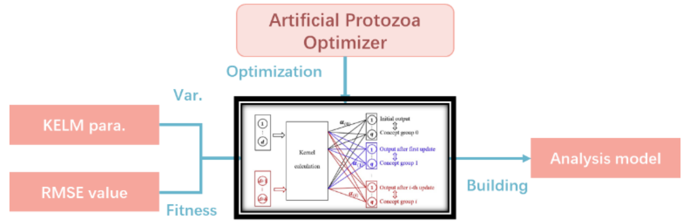


Fig. 16. Schematic diagram of APO-KELM structure.

TABLE IV. APO-KELM ALGORITHM PSEUDO-CODE

Algorithm 2: APO-KELM algorithm pseudo-code
Initialisation of the APO algorithm parameters, using real number encoding for the KELM model decision optimisation variables;
The RMSE was calculated as the fitness value to update the optimal KELM model parameters;
Whether the While iteration condition is satisfied
Behavioural stage transition probabilities were calculated and populations were updated using autotrophic, heterotrophic, dormant or reproducing behavioural operators;
Calculate the fitness value;
Updating Optimal KELM Network Parameters Individual;
End while
Output optimal KELM network parameters;
Construction of the APO-KELM evaluation model.

IV. MODEL APPLICATION

In this paper, the APO-KELM model is applied to the problem of formative assessment of English teaching, which mainly solves the problem of constructing the formative assessment model of English teaching, i.e., the APO-KELM model is used to learn to optimise the mapping relationship between the values of the formative assessment indexes and the evaluation scores of English teaching, so as to obtain the formative assessment model of English teaching based on the APO-KELM algorithm, and the method of its application is shown in Fig. 17, and the specific steps are shown in Table V.

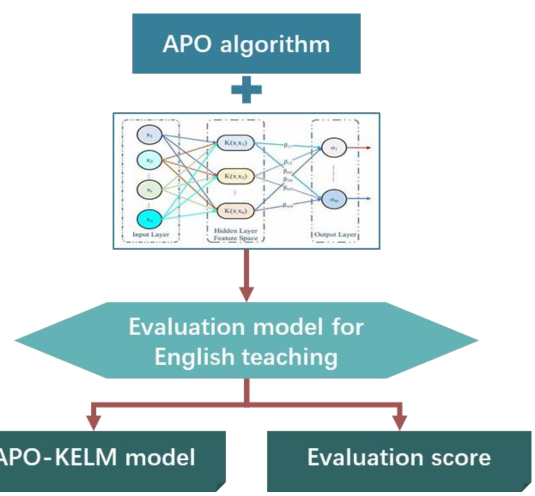


Fig. 17. APO-KELM applied in the formative assessment model of English language teaching.

TABLE V. APO-KELM ALGORITHM PSEUDO-CODE

Algorithm 3: Formative assessment Model Construction for English Language Teaching Based on APO-KELM Algorithm
Analysing evaluation problems in English language teaching and designing evaluation programmes;
Describe the process of English teaching, extract the evaluation indexes and construct the evaluation index system;
Data preprocessing and correlation analysis to construct a learning training set for formative assessment model of English language teaching;
Initialise the APO-KELM model;
The KELM model parameters were optimised iteratively using the APO algorithm optimisation strategy;
Obtain optimal KELM model parameters;
The APO-KELM model was retrained using the training set to obtain a formative assessment model for English language teaching;
Data validation analysis of the model.

V. VALIDATION ANALYSIS

A. Experimental Setup

1) Data setting: The research in this paper investigated five university English classes for questionnaires and obtained relevant data, which were divided into training set, validation set, and test set (as shown in Fig. 18), in which the ratio was 7:1.5:1.5, and the total number of sample sets was 327 groups, and only then did the questionnaire data were analysed with the SPSS 22.0 statistical software to obtain the final standardised data.

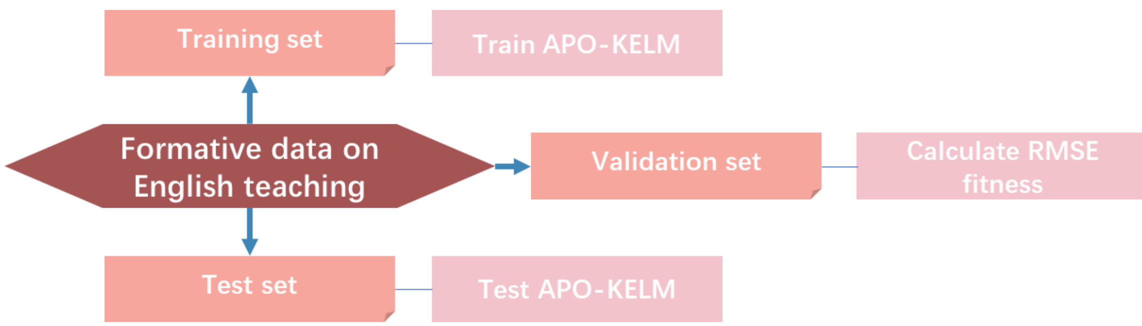


Fig. 18. Purpose of data set segmentation.

2) Algorithm parameter setting: In order to verify the superiority of comparing APO-KELM algorithms, ELM, KELM, WOA-KELM [26], PPE-KELM [27], and AOA-KELM [28] are used in this paper, and the specific parameter settings of each algorithm are shown in Table VI.

TABLE VI. COMPARISON ALGORITHM PARAMETER SETTINGS

No.	Arithmetic	Parameter settings	ELM/KELM Parameter Setting
1	ELM	No	The number of hidden layer nodes is 80
2	KELM	No	Hidden_node=80, kernel function is radial basis function
3	WOA-KELM	a=[2,0]	Refer to section 5.2 Analysis
4	PPE-KELM	a=1.1, c=0.2	Same settings as WOA-KELM
5	AOA-KELM	a=5, μ=0.5	Same settings as AOA-KELM
6	APO-KELM	np=1, pfmax=0.1	Refer to section 5.2 Analysis

3) Environmental settings: The simulation experiments in this paper are mainly executed on a laptop computer configured with Windows 11 operating system having 16GB RAM with Intel(R) Core(TM) i7-8750H CPU @2.20GHz 2.21GHz.The execution of each algorithm is analysed using Matlab2021a.

B. Analysis of Results

1) Parametric analysis: The CEC2022 standard function is used to analyze the size change of the APO algorithm's foraging factor in order to examine the influence of the foraging behavior factor with the number of iterations. The precise findings are shown in Fig. 19. The foraging factor diminishes as the number of iterations increases, causing the APO algorithm to choose exploration over exploitation.

This work examines the English evaluation accuracy under the APO algorithm population of 40, 50, 60, 70, 80, 90, 100, 110, 120, and 130 in order to investigate the effect of APO algorithm population on the evaluation performance of APO-KELM model. The precise findings are shown in Fig. 20.

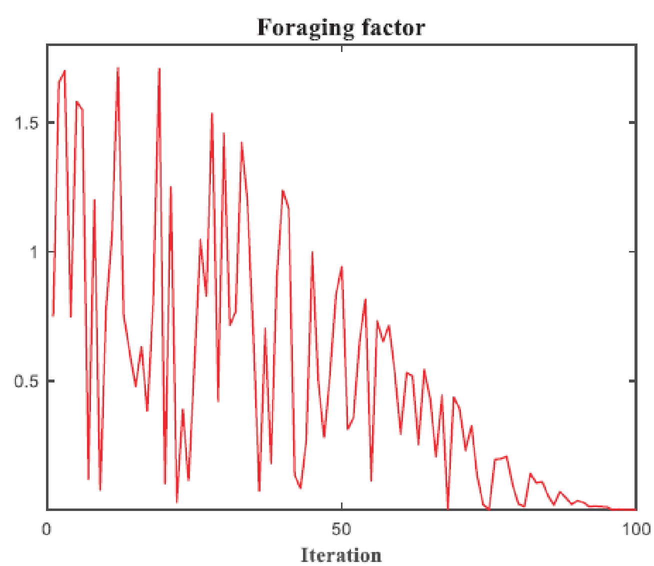


Fig. 19. Results of APO algorithm foraging factor change with increasing number of iterations.

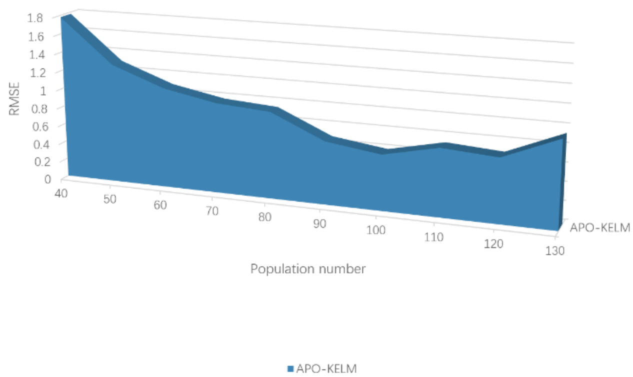


Fig. 20. Results of the effect of the number of populations of the APO algorithm on the performance of the APO-KELM model.

In order to explore the impact of the number of hidden layer nodes of KELM algorithm on the evaluation performance of APO-KELM model, this paper analyses the evaluation accuracy of English under the number of hidden layer nodes of KELM algorithm of 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, and 150, and the specific results are shown in Fig. 21.

2) Comparative algorithm analysis: This study utilizes ELM, KELM, WOA-KELM, PPE-KELM, AOA-KELM, and APO-KELM to develop the formative assessment model for English instruction. The performance results of these algorithms are compared and shown in Fig. 22 and Fig. 23.

Fig. 22 displays the convergence outcomes of WOA-KELM, PPE-KELM, AOA-KELM, and APO-KELM in ELT formative data. Fig. 22 shows that as the number of iterations increases, the WOA-KELM, PPE-KELM, AOA-KELM, and APO-KELM models converge with a decrease in fitness value. In terms of convergence accuracy, the KELM model based on the APO algorithm has the lowest convergence fitness value. In terms of convergence speed, APO-KELM converges the fastest, starting to converge within the first 300 iterations.

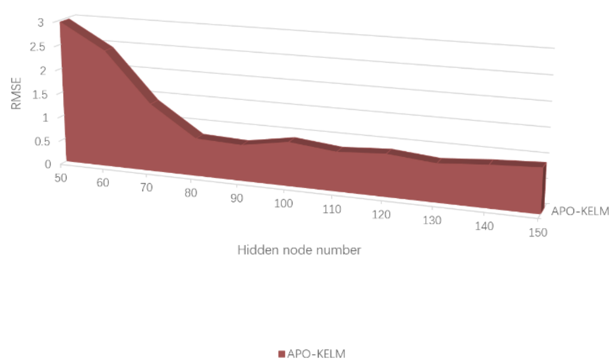


Fig. 21. Results of the effect of the number of KELM hidden layer nodes on the performance of the APO-KELM model.

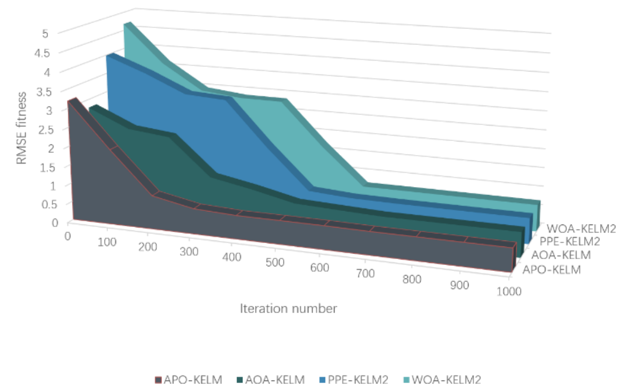
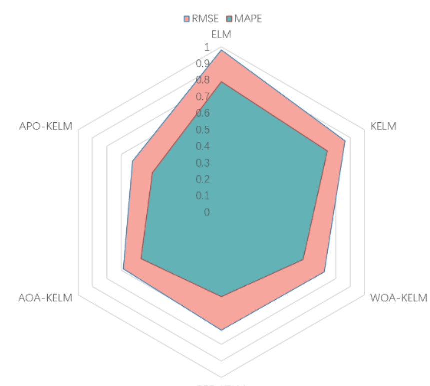
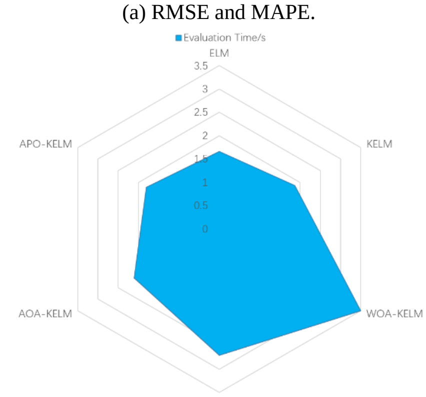


Fig. 22. Optimisation iteration process of KELM model with different optimisation algorithms.

Fig. 23 displays the performance comparison findings of ELM, KELM, WOA-KELM, PPE-KELM, AOA-KELM, and APO-KELM algorithms. The comparison is based on the performance of formative assessment models used in English language teaching and learning. The performance metrics considered are RMSE, MAPE, and elapsed time. Fig. 23 clearly demonstrates that the APO-KELM model outperforms the other models in terms of RMSE, with a value of 0.6204. Additionally, in terms of MAPE, the APO-KELM model is superior to the other models, with a value of 0.48. The ELM model outperforms other algorithms, including the KELM, APO-KELM, APOA-KELM, PPE-KELM, and WOA-KELM models, in terms of time efficiency.



(a) RMSE and MAPE.



(b) Time consuming.

Fig. 23. RMSE, MAPE, and elapsed time results for the comparison algorithm model.

VI. Conclusion

This research use the APO algorithm and Nuclear Limit Learning Machine to analyze and simulate trials related to the issue of formative assessment in English instruction. Firstly, it examines the issue of formative assessment of English teaching in the context of big data technology. It identifies evaluation criteria and establishes an index system for formative assessment of English teaching. Secondly, to address the challenge of constructing a formative assessment model for English teaching, it enhances the KELM using the APO algorithm. It introduces the method of formative assessment of English teaching based on the APO-KELM model. Lastly, it applies the APO-KELM model to multiple sets of data for formative assessment of English teaching. The simulation studies demonstrate that the screening approach suggested in this research has superior stability, merit-seeking ability, and convergence accuracy.

Future study should focus on enhancing the precision and speed of convergence of the APO algorithm, as well as expanding its application to a wider range of teaching assessment challenges.

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