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Citation: **1782**, 040019 (2016); doi: 10.1063/1.4966086
View online: http://dx.doi.org/10.1063/1.4966086
View Table of Contents: http://aip.scitation.org/toc/apc/1782/1
Published by the American Institute of Physics

A Standard Deviation Selection in Evolutionary Algorithm for Grouper Fish Feed Formulation

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Abstract. Malaysia is one of the major producer countries for fishery production due to its location in the equatorial environment. Grouper fish is one of the potential markets in contributing to the income of the country due to its desirable taste, high demand and high price. However, the demand of grouper fish is still insufficient from the wild catch. Therefore, there is a need to farm grouper fish to cater to the market demand. In order to farm grouper fish, there is a need to have prior knowledge of the proper nutrients needed because there is no exact data available. Therefore, in this study, primary data and secondary data are collected even though there is a limitation of related papers and 30 samples are investigated by using standard deviation selection in Evolutionary algorithm. Thus, this study would unlock frontiers for an extensive research in respect of grouper fish feed formulation. Results shown that the fitness of standard deviation selection in evolutionary algorithm is applicable. The feasible and low fitness, quick solution can be obtained. These fitness can be further predicted to minimize cost in farming grouper fish.

INTRODUCTION

Global marine waters as in fishery production was 82.6 million tonnes in year 2011 and 97.7 million tonnes in year 2012 as recorded in [1]. It is obvious that 18 major countries caught at least one million tonnes per year, which consists of at least 76 percent of the global marine catches. Malaysia is one of the major producer countries, which is ranked at number 15 [1] and 12.5% of the global fish contribution is grouper fish [2]. This carnivorous grouper fish is selected in this study because of its current trend of demand in restaurants [2] [3], its high price compared to other species of fish ([4] [5] [6] [2] [3]) and desirable taste ([5] [7] [2]).

Currently, farming grouper fish is gaining importance in the market due to its high demand. Moreover, the amount of farmed grouper fish is more than the wild catch grouper. This ensures its supply has remained uninterrupted. However, there is a need to have an overview on the nutrients requirement but it is difficult to search the relevant data since there are no exact data available ([8] [3]).

In this study, data come from two sources: Data sources (1) are from 30 manufacturers' grouper fish feed meal. Data sources (2) are from the journal papers, researchers and view from experts. These are summarized and discussed as in the study of [3]. An overview on the priority of nutrients in feeding the grouper fish is adopted as in the study of [3] to further study in formulating fish feed by using evolutionary algorithm (EAs). EAs are algorithms that perform optimization or learning tasks with the ability to evolve ([9] [10] [11] [12] [13]).

Subsequently, this paper presents EAs approach with the application in a fish feed formulation. In applying the proposed approach, the grouper fish feed formulation is taken as a case study. Hence, the model for the fish feed formulation and the EAs approach are described in the next section, followed by data analysis and discussion. Concluding remarks are drawn in the last section.

The 4th International Conference on Quantitative Sciences and Its Applications (ICOQSIA 2016)
AIP Conf. Proc. 1782, 040019-1–040019-5; doi: 10.1063/1.4966086
Published by AIP Publishing. 978-0-7354-1444-0/$30.00

Development of the Proposed Evolutionary Algorithm

The models for the fish feed formulation and the EAs approach are described in this section. The function of EAs is to find the optimization or near-optimization solution where heuristics lead to unsatisfactory results. A basic evolutionary algorithm is adopted from [11]. The original evolutionary algorithm is adapted into this sophistically evolutionary algorithm model as in Figure 1.

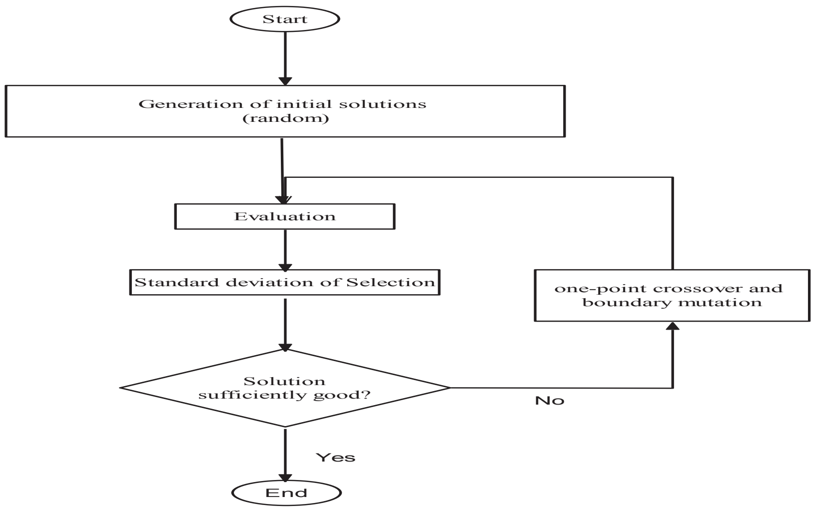

FIGURE 1. Proposed Standard Deviation Selection in Evolutionary Algorithm

Generation of initial solutions: In this first step, the population size needs to be determined but not necessary be kept constant. They can be variable numbers. Most of the early experimental studies involved only a small population size. Experimental studies recommend the values of genetic parameters as population size 20-30 which is as recommended by [14]. [15] mentioned that a population size of between 30 and 100 is usually recommended. Thus, initial solution in this proposed evolutionary algorithm is random. The initialization of the population would have 30 samples of individuals' chromosomes.

Standard deviation selection: In this step, common selections are roulette wheel selection, tournament selection and ranking selection. Since our grouper ingredients are represented by real valued alleles in the chromosome of the EA, an alternative new selection as standard deviation operator similar to tournament selection is deemed necessary for exploration to improve the performance of the whole EA process.

The tournament selection procedure is whereby *k* individuals are picked randomly with replacement and compare it with the fitness values of these *k* individuals. The best one wins the tournament and is selected into the mating pool. Thus, our new standard deviation selection procedure is whereby 2 individuals are picked randomly with their standard deviation and compare it with the fitness values of these 2 individuals. The pair of these 2 individuals with big dispersed one wins the tournament and is selected into the mating pool.

One-point crossover: In this step, one-point crossover is to select the crossover point within a random chromosome and interchange the two parent chromosomes to yield two new offspring. One-point crossover adopted by [13] is as shown in Figure 2.

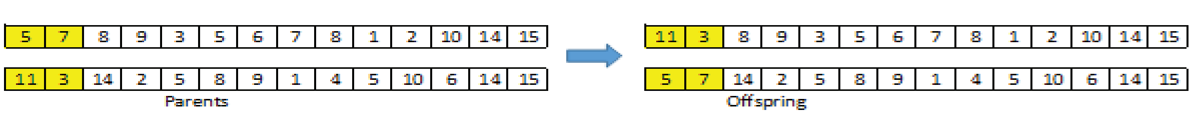

FIGURE 2. One-point Crossover

Boundary mutation: In this step, Power mutation is the improvement of uniform mutation designed based on a random concept and is making use of the lower and upper bounds of constraints. Boundary mutation is adopted as depicted in Figure 3.

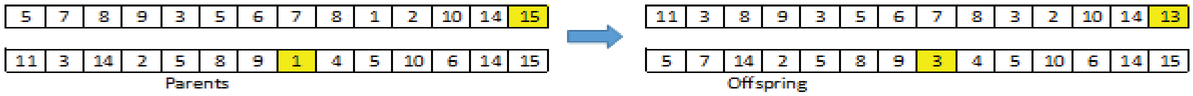

FIGURE 3. Boundary mutation

Data Analysis and Discussion

In this present study, SPSS is used to perform the fitness of 30 samples. In this study, quantitative descriptive statistics include the coefficient of data which comes from variance (CV), mean, standard deviation, range of sample, maximum and minimum sample. These are depicted as in Table 1. All the 30 samples are based on the fitness values which are less than 1.0. In other words, the smaller the value of the CV of fitness, the residuals to the predicted value are. It is an indication of a good variable. Therefore, it can be concluded that these are good suggestive nutrients.

TABLE 1. Coefficient of Variance of Samples for Grouper Fish

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	CV
sample_1	4	26.45	75.91	102.36	90.0091	11.02775	0.123
sample_2	4	21.54	76.24	97.78	84.8472	10.15861	0.120
sample_3	4	21.23	79.74	100.97	85.9473	10.10405	0.118
sample_4	4	22.37	65.06	87.43	79.3245	9.88108	0.125
sample_5	4	27.84	66.37	94.22	82.5067	11.66298	0.141
sample_6	4	6.94	78.83	85.76	82.1699	2.88935	0.035
sample_7	4	11.87	76.89	88.76	83.0637	6.17829	0.074
sample_8	4	15.10	71.65	86.76	78.4752	6.31505	0.080
sample_9	4	50.62	57.34	107.97	80.6236	21.83849	0.271
sample_10	4	28.43	56.44	84.87	67.4003	12.56811	0.186
sample_11	4	41.34	58.00	99.35	82.3994	17.48226	0.212
sample_12	4	19.41	85.34	104.75	94.2501	7.97915	0.085
sample_13	4	17.37	75.50	92.88	84.3357	7.77613	0.092
sample_14	4	54.29	50.37	104.66	80.1681	23.21413	0.290
sample_15	4	14.85	76.87	91.73	84.7972	6.10869	0.072
sample_16	4	22.40	70.74	93.14	81.0445	9.82669	0.121
sample_17	4	33.34	64.12	97.46	83.8802	14.65743	0.175
sample_18	4	16.77	79.73	96.50	85.8926	7.96734	0.09
sample_19	4	40.14	54.12	94.26	75.5231	16.62319	0.220
sample_20	4	9.17	82.98	92.15	87.3222	3.76524	0.043
sample_21	4	9.50	73.61	83.11	77.3040	4.24204	0.055
sample_22	4	19.11	73.70	92.81	83.0826	9.67505	0.116
sample_23	4	21.90	74.46	96.37	85.2734	9.97750	0.117
sample_24	4	17.46	62.52	79.98	73.2072	7.49372	0.102
sample_25	4	16.42	75.70	92.12	83.0228	8.46153	0.102
sample_26	4	19.29	72.73	92.02	84.0806	8.12802	0.097
sample_27	4	29.40	74.21	103.61	91.8645	12.84601	0.140
sample_28	4	13.73	78.39	92.12	87.6602	6.25738	0.071
sample_29	4	1.62	83.60	85.22	84.6279	.73387	0.009
sample_30	4	.72	83.35	84.07	83.7923	.32019	0.004
Valid N (listwise)	4						

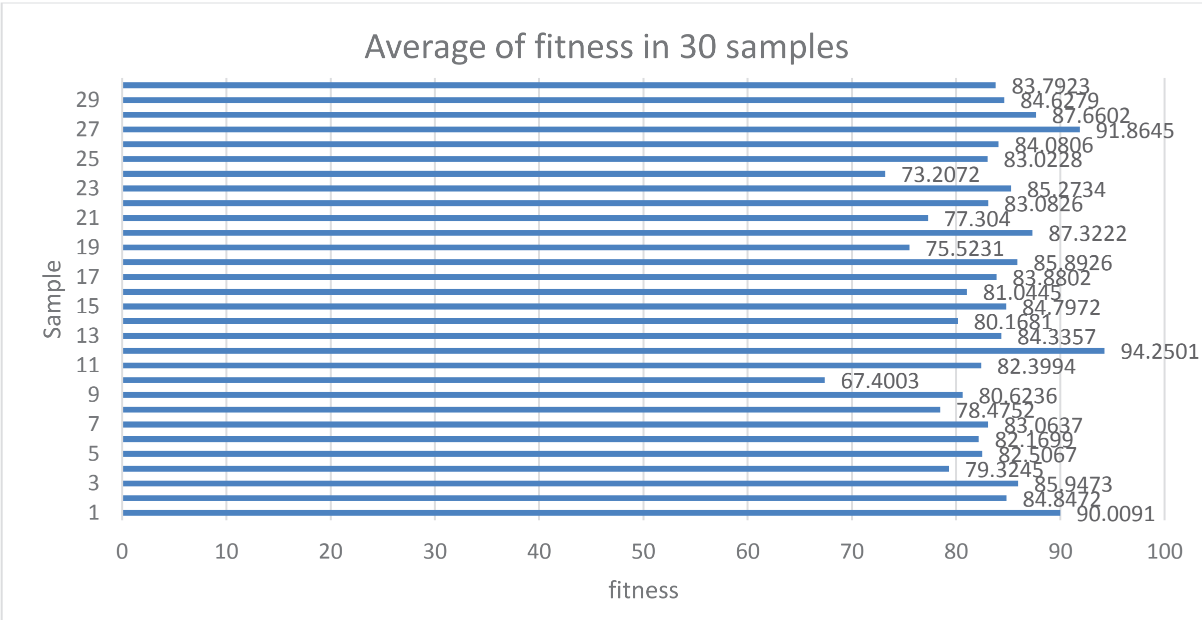

FIGURE 4. Average of fitness in 30 samples

Then, the average of fitness in 30 samples is represented as in Figure 4. The lowest fitness is sample 10 which is 67.4003. The second lower fitness and third lowest fitness are sample 24 and 19, which are 73.2072 and 75.5231 respectively. The highest fitness is sample 12 which is 94.2501. The second higher and third higher fitness are sample 27 and 1, which are 91.8645 and 90.0091, respectively. The range for the highest fitness and lowest fitness is 26.8498. The average minimum fitness is 71.817 while the average maximum fitness is 93.5063.

However, the lowest fitness which is fulfils the priority of nutrients in feeding the grouper fish is adopted as in the study of [3] which is 78.3912 and the chromosome as illustrated in Figure 5. The cost of this solution is RM638.59 as shown in Table 2.

2	5	4	20	6	5	3	10	6	10	7	4	8	10

FIGURE 5. Chromosome with feasible solution

TABLE 2. Cost of ingredients

Ingredients	Price (RM/ Kg)	Kg	Total Price	Ingredients	Price (RM/ Kg)	Kg	Total Price	Ingredients	Price (RM/ Kg)	Kg	Total Price
1	0.21	2	0.42	6	3.13	5	15.65	11	1.51	7	10.57
2	0.73	5	3.65	7	2.27	3	6.81	12	0.93	4	3.72
3	0.6	4	2.4	8	0.011	10	0.11	13	3.51	8	28.08
4	0.89	20	17.8	9	1.07	6	6.42	14	51.91	10	519.1
5	3.36	6	20.16	10	0.37	10	3.7				638.59

Conclusion

The proposed standard deviation selection in evolutionary algorithm provides an applicable, feasible and low fitness, quick solution in terms of computational time and cost as compared to the manually trial and error method. These fitness can further predict the cost in farming grouper fish. As a conclusion, this model is an exploration into the alternative and improved methodology in the problem of fish feed formulation. This will unlock frontiers for extensive researchers for further development in respect of grouper fish feed formulation.

ACKNOWLEDGMENTS

Research on the work reported in this paper is supported by a grant of FRGS. We thank for the financial support on this piece of work. We also thank Dr Ahmad Daud bin Om from FRI Tg Demong and Dr Zainoddin bin Jamari from FRI Gelang Patah, Johor for their constructive comments.

REFERENCES

1. FAO, The state of word fisheries and aquaculture: opportunities and challenges, FAO Fisheries and Aquaculture Department. Food and Agriculture Organization of the United Nations, Rome, pp. 243 (2014).
2. C.-J. Soong, R. Razamin and A. R. Rosshairy, Fish consumption and track to a fish feed formulation, *2nd Innovation and Analytics Conference & Exhibition 2015 (IACE2015), Kedah.*
3. C.-J. Soong, R. Razamin and A. R. Rosshairy, Nutrients requirements and composition in a Grouper fish feed formulation, *International Soft Science Conference 2016 (ISSC2016), Langkawi, Kedah.*
4. I. B. Tuburan, E. B. Coniza, E. M. Rodriquez & R. F. Agbayani, Culture and economics of wild grouper (Epinephelus coioides) using three feed types in ponds, *Aquaculture*, 201, 229-240 (2001).
5. A. O. Daud, *Pembenihan dan pembiakan ikan Kerapu Harimau,* Kuala Lumpur: Dewan Bahasa dan Pustaka. (2012).
6. Q. Liu, T. Sakamoto, S. Kubota, N. Okamoto, H. Yamashita, M. Takagi, Y. Shigenobu, T. Sugaya, Y. Nakamura, M. Sano, S. Wuthisuthimethavee & A. Ozaki, A genetic linkage map of kelp grouper (Epinephelus bruneus) based on microsatellite markers, *Aquaculture*, 414-415, 63-81 (2013).
7. W. Y. Tseng & S. K. Ho, Grouper Culture, A Practical Manual. Chien Cheng Publisher, Kaohsiung, People's Republic of China, *Aquaculture*, pp. 134 (1988).
8. NRC, Nutrient Requirements of Fish and Shrimp, Board on Agriculture and Natural Resources, National Research Council (2011).
9. D. B. Fogel, The advantages of evolutionary computation, in D. Lundth, B. Olsson, & A. Naraganan, (eds.), Bio-computing and emergent computation, World Scientific Press, pp. 1-11 (1997).
10. H. P. Schwefel, Advantages (and disadvantages) of evolutionary computation over other approaches. in K. De-Jong, L. Fogel & H. P. Schwefel, (eds.). *Handbook of Evolutionary Computation (pp. 1-10), IOP Publishing Ltd and Oxford University Press,* (1997).
11. W. Banzhaf, P. Nordin, R. E. Keller & F. D. Francone, *Genetic Programming: An introduction on the automatic evolution of computer programs and its applications*, Dpunkt Verlag and Morgan Kaufmann Publishers, Inc. (1998).
12. C. Grosan & A. Abraham, *Hybrid Evolutionary Algorithm: Methodologies, Architectures, and Reviews*, Studies in Computational International (SCI) 75, 1-17 (2007).
13. X. J. Yu, & M. Gen, Introduction *to Evolutionary Algorithms,* Springer, Berlin Heidelberg New York (2010).
14. A. K. Bhatia, Applications of Genetic Algorithms in Agricultural Problems-An overview. *Journal of the Indian Society of Agricultural Statistics*, 67(1), 13-22 (2013).
15. S. Hurley, L. Moutinho, & N. M. Stephens, Solving marketing optimization problems using genetic algortihms. *European Journal of Marketing*, 29(4), 39-56 (1995).