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# Water Quality Autoregression Prediction Model Based on Markov-Switching Theory Using Crow Search Algorithm

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Water quality prediction is an important technical means for preventing and controlling water pollution and is crucial in the formulation of reasonable water pollution prevention and control measures. The time series structure of natural water quality is complex and heteroscedastic, so it is difficult for the traditional prediction model to reflect the actual situation well. Hence, Markov-switching (MS) theory is applied to a water quality autoregression (AR) prediction model (MSAR) in this paper. Further, MSAR is improved by introducing the crow search algorithm to obtain model parameters (CSA-MSAR). Then existing water quality time series for $COD_{Mn}$ was selected as the data for the CSA-MSAR model after a normality test and the Box–Cox normality transformation. The results show that the CSA-MSAR model for $COD_{Mn}$ with (s, p) values of (3, 5) has the best performance. The improvement degree for selection criteria compared with AR model is as follows: Akaike information criterion for MSAR is 32.020% and 31.611% for CSA-MSAR; Bayesian information criterion for MSAR is 10.632% and 13.464% for CSA-MSAR; likelihood value for MSAR is 40.016% and 40.801% for CSA-MSAR; C for MSAR is 63.559% and 64.968% for CSA-MSAR. Moreover, the results show that the average prediction precision of the first- to fifth-order prediction is raised by 89.016% for MSAR and 89.340% for CSA-MSAR compared with AR, indicating that the introduction of MS makes the CSA-MSAR and MSAR models conform to the smoothness of the mean and variance in each state. The results also indicate that the introduction of CSA into the maximum likelihood estimation to obtain the parameters raise the model prediction precision (the average prediction precision of CSA-MSAR is higher than MSAR by 5.231% excluding the fifth-order prediction) and the CSA-MSAR model is scientifically valid and reasonable for water quality prediction.