Implementasi Metode Whale Optimization Algorithm Support Vector Machine (WOA-SVM) dalam Klasifikasi Derajat Cedera Akibat Kecelakaan Kerja di Industri Pertambangan Bawah Tanah = Implementation of the Whale Optimization Algorithm Support Vector Machine (WOA-SVM) Method in the Classification of Injury Severity from Workplace Accidents in the Underground Mining Industry

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Abstrak

Industri pertambangan merupakan salah satu sektor pekerjaan paling berbahaya di dunia karena memiliki tingkat kecelakaan kerja yang tinggi, terutama kecelakaan fatal. Dalam 23 tahun terakhir, industri pertambangan mencatat 30.327 kecelakaan, dengan 357 berakhir dengan kematian pekerja. Machine learning dapat digunakan untuk memecahkan permasalahan dunia nyata yang kompleks, termasuk klasifikasi derajat cedera akibat kecelakaan kerja di industri pertambangan bawah tanah. Penelitian ini menggunakan metode machine learning Whale Optimization Algorithm Support Vector Machine (WOA-SVM), dengan Whale Optimization Algorithm (WOA) berperan sebagai optimizer untuk parameter model Support Vector Machine (SVM). Derajat cedera dibagi menjadi tiga kelas berdasarkan pengaruhnya terhadap produktivitas pekerja, yaitu no days away from work (NDAFW), days away from work (DAFW), dan disability or fatality (DF). Data yang digunakan berasal dari Mine Safety and Health Organization milik pemerintah Amerika Serikat sebanyak 28.520 kejadian kecelakaan dalam rentang 1 Januari 2000 hingga 31 Desember 2023. Sebelum mengimplementasikan model machine learning, dilakukan data preprocessing yang meliputi pembersihan data, transformasi data, sampling data, encoding data, penyeimbangan data, dan seleksi fitur. Kinerja model WOA-SVM dievaluasi menggunakan metrik akurasi, presisi, recall, dan F1-score dengan berbagai proporsi splitting data train dari 50% hingga 90%, serta mempertimbangkan waktu komputasi. Setelah itu dilakukan komparasi model WOA-SVM dengan model SVM tanpa optimisasi. Hasil komparasi menunjukkan bahwa model WOA-SVM lebih unggul dibandingkan model SVM, dengan keunggulan pada metrik konfusi, akurasi, presisi, recall, F1-score, serta memiliki waktu komputasi yang lebih cepat. Model WOA- ix Universitas Indonesia SVM memiliki nilai akurasi, presisi, recall, dan F1-score tertinggi pada proporsi 70:30, masing-masing sebesar 82,4153 %, 82,1255%, 82,4153%, dan 82,0812%.

.....The mining industry is one of the most dangerous employment sectors in the world due to its high rate of workplace accidents, particularly fatal ones. Over the past 23 years, the mining industry has recorded 30,327 accidents, with 357 resulting in worker fatalities. Machine learning can be employed to address complex real-world problems, including the classification of injury severity resulting from workplace accidents in the underground mining industry. This study utilizes the Whale Optimization Algorithm Support Vector Machine (WOA-SVM) method, with the Whale Optimization Algorithm (WOA) acting as an optimizer for the parameters of the Support Vector Machine (SVM) model. The severity of injuries is divided into three classes based on their impact on worker productivity: no days away from work (NDAFW), days away from work (DAFW), and disability or fatality (DF). The data used comes from the Mine Safety and Health Organization's, managed by the U.S. government, encompassing 28,520 accident incidents from January 1, 2000, to December 31, 2023. Before implementing the machine learning model, data preprocessing was

conducted, including data cleaning, data transformation, data sampling, data encoding, data balancing, and feature selection. The performance of the WOA-SVM model was evaluated using accuracy, precision, recall, and F1-score metrics with various train data splitting proportions ranging from 50% to 90%, while also considering computational time. A comparison was then made between the WOA-SVM model and the non-optimized SVM model. The comparison results indicated that the WOA-SVM model outperformed the SVM model, with superiority in confusion metrics, accuracy, precision, recall, F1-score, and having the fastest computational time. The WOA-SVM model has the highest accuracy, precision, recall, xi Universitas Indonesia and F1-score values at a 70:30 ratio, which are 82.4153%, 82.1255%, 82.4153%, and 82.0812%, respectively.