Artificial Intelligence Research and Development
A. Cortés et al. (Eds.)

doi:10.3233/FAIA220327

Predicting Personalized Quality of Life of an Intellectually Disabled Person Utilizing Machine Learning

Gaurav Kumar Yadav [a,d,1], Benigno Moreno Vidales [b], and Sara Dueñas [b] and Mohamed Abdel-Nasser [c] and Hatem A Rashwan [a] and Domenec Puig [a] and G. C. Nandi [d]

[a] *Universitat Rovira I Virgili, Tarragona, Spain*
[b] *Instituto the Robótica Para la Dependencia, Sitges, Barcelona, Spain*
[c] *Department of Electrical Engineering, Aswan University, Egypt*
[d] *India Institute of Information Technology Allahabad, India*

Abstract. This work aims to enhance dependent persons' quality of life (QOL) by examining various aspects of their lives and providing the required assistance to enhance each aspect of their QOL. We employ machine learning methods to evaluate the eight aspects of QOL and forecast the corresponding index value. Machine learning algorithms input eight aspects of QOL and predict the QOL index value. The QOL Index value says the requirement of the support to a person, and it depends on eight aspects of the QOL. We use our dataset to train the machine learning model. Dataset is collected using the GENCAT scale tool, which takes 69 items and provides the score value for each aspect of the QOL. We apply many linear and nonlinear machine learning regression algorithms. The multiple linear regression algorithm results show better performance for root mean squared error (1.4729) and R^2 score (0.9918).

Keywords. Quality of Life, Intellectual and Developmental Disability, Priority of Care, Support Paradigm, and Machine learning.

1. Introduction

The perspective of society has been changed in the current decades toward the rights of intellectually disabled (ID) people. This situation became possible due to adopting the international convention on the right of a person with a disability (CRPD) in 2006. One hundred eighty-five countries ratified it [1] including Spain in 2008, showing their commitment to providing dignity, equality, and freedom to the dependent people. CRPD contains 50 articles, out of the twenty-six, obligate the state to provide legal rights to dependent people in every aspect of life, including social, personal, judicial, Etc. [2]. This work is motivated to improve the quality of life of elderly and intellectually disabled people. We are developing a quality of life support model (QOLSM) that combines the aspects of QOL to support and show the method to implement this concept. With this

[1] E-mail: gauravkumar.yadav@urv.cat

motivation, we started to effectuate this idea to provide uninterrupted support to intellectually disabled people using the current development of machine learning techniques. We interviewed 26 beneficiaries individually and recorded their response on a four-point frequency scale. Beneficiaries were asked 69 questions that covered every necessary aspect of people with ID. We used the GENCAT scale [3] tool to convert these 69 question responses into eight aspects of QOL score value and an index value corresponding to the eight aspects value. The paper has the following contributions:

- We apply current machine learning technologies, analyze the eight aspects of QOL of intellectually impaired people and forecast the need for help.
- Using our own recorded dataset to train a machine learning model and provide a method to assist ID personnel.
- Proposed a machine learning-based model to predict person needs support or not to improve their QOL.

2. Methodology

2.1. Dataset

We have the Newton-One dataset, a private dataset collected by us. This dataset contains data of 26 beneficiaries, of which 14 are female and 12 are male. The age range of these recipients is from 65 to 90 years old. This dataset is compiled in the year 2021. It has eight aspects value and corresponding index values, so the original shape of the dataset is 26,9. The eight aspects of the QOL are Emotional Well-being, Personal Development, Physical well-being, Self-determination, Interpersonal relation, Social Inclusion, Material well-being, and Rights. The dataset contains a QOL Index value corresponding to the eight aspects value for each beneficiary. For collecting this dataset, a professional asked 69 questions during the interview of each beneficiary. They recorded the response to these questions on a four-point frequency scale. Further, these questionnaires answer inputting to the GENCAT scale, giving the eight aspects value and corresponding Index value for support. The value of each aspect of QOL varies between 68 to 130.

2.2. ML Techniques

In the Newton-One dataset, the input consists of eight dimensions of quality of life, and the output is the associated index value. Output is continuously dependent on the eight aspects of the QOL, so it is a regression task; therefore, regression algorithms perform well on this dataset. Initially, we do not know the nature of the dataset, so we use both linear and nonlinear regression algorithms. We use multiple linear algorithms, support vector regressor, decision tree, random forest, and gradient boosting algorithms. We have imported these models from scikit-learn and trained them using our dataset.

2.3. Steps of the Proposed Method

Figure 1 shows the fundamental steps of our work. We started our work by collecting a dataset. Professionals interviewed the intellectually disabled people and asked sixty-nine questions, covering all the eight aspects of the QOL of a dependent person. We record

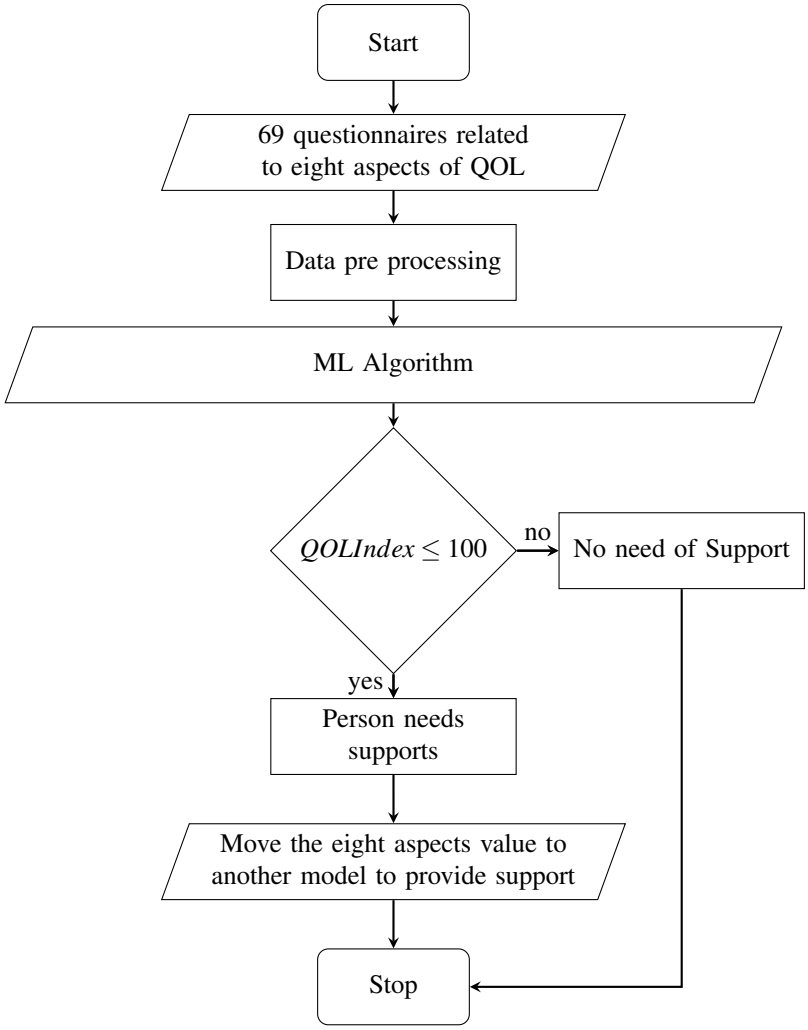

Figure 1. Flowchart of complete architecture of our Machine Learning Model

the answer on four points frequency scale. We build a tabular data which consists of eight columns corresponding to eight aspects of QOL and one column consisting of the Index value. We interview a total of twenty six-person. So the size of the dataset is 26, 9. Each score value of eight aspects and index value varies between sixty-eight to one hundred thirty. Where sixty-eight represent a poor score value, and one hundred thirty shows the best score value. The number of samples in the original dataset is only twenty-six, which is less to train the machine learning models. Therefore we use SMOTE-R [4] algorithm to augment our underfit data. Before augmenting the data, we split data into the train and test case because we want to test our trained model on original test data to validate our model. We split our dataset 80% (20) for training and 20% (6) for the testing set. Then after we augmented the training dataset from twenty to hundred forty-five, we trained each machine learning algorithm and calculated the mean absolute error, root mean square error value, and R^2 score value for train and test cases.

Table 1. Measuring matrices showing the performance of machine learning models trained on an augmented dataset for training and results for original test set dataset

Algorithms	MLR	DT	RF	GB	SVR
Matrices	Train ‖ Test	Train ‖ Test	Train ‖ Test	Train ‖ Test	Train ‖ Test
MAE	0.4902 ‖ 1.3504	0.0000 ‖ 8.5000	2.2340 ‖ 8.4383	0.1161 ‖ 6.0268	0.1000 ‖ 18.7400
RMSE	0.6350 ‖ 1.4729	0.0000 ‖ 10.8857	2.6883 ‖ 9.1498	0.1419 ‖ 7.4630	0.1000 ‖ 19.9124
R^2 Score	0.9981 ‖ 0.9918	1.0000 ‖ 0.5537	0.9676 ‖ 0.6847	0.9999 ‖ 0.7902	0.99995 ‖ -0.4931

3. Results

We present the findings as evaluation matrices. Table 1 displays the computed performance for the train and test instance. It shows the result for multiple linear regression algorithms (MLR), decision trees (DT), random forests (RF), gradient boosting (GB), and support vector regression (SVR) algorithms. The outcomes of the MLR algorithm are superior to those of other algorithms in terms of R^2 score value and root mean squared error value. The cause behind the MLR algorithm is that the data set is linearly dependent, and other algorithms are best for nonlinear datasets. In order to anticipate the QOL index value during the test case and for subsequent use, we finalized the MLR algorithm based on the RMSE value and R^2 score. By considering eight aspects of QOL, the MLR algorithm forecasts the value of the QOL Index. Finally, determine whether the person requires support based on the projected QOL Index value model.
It should be noted that the prediction results could be further improved by employing a metaheuristics algorithm like the stochastic whale optimization algorithm [5] to optimize the parameters of the regression techniques.

4. Conclusion

In this work, we analyzed the QOL of intellectually disabled people. We trained numerous machine learning regression methods, both linear and nonlinear. In order to estimate the QOL index value, algorithms take eight aspects of QOL. The evaluation matrices score shows that the performance of the MLR is outperforming the others. We finalized the MLR for further use to predict the QOL index value. The QOL Index value determines if a person needs assistance or not.

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