CLASSIFICATION OF MODES OF CHILD BIRTH USING FEATURE SELECTION AND MACHINE LEARNING MODELS

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Abstract – The mode of delivery is a crucial determinant for ensuring the safety of both mother and child. The current practice for predicting the mode of delivery is generally the opinion of the physician in charge, but choosing the wrong method of delivery can cause different short-term and long-term health issues for both mother and baby. The purpose of this study was twofold: first, to reveal the possible features for determining the mode of childbirth, and second, to explore machine learning algorithms by considering the best possible features for predicting the mode of childbirth (vaginal birth, cesarean birth, emergency cesarean, vacuum extraction, or forceps delivery). An empirical study was conducted, which included a literature review, interviews, and a structured survey to explore the relevant features for predicting the mode of childbirth, while five different machine learning algorithms were explored to identify the most significant algorithm for prediction based on 6157 birth records and a minimum set of features. The research revealed 32 features that were suitable for predicting modes of childbirth and categorized the features into different groups based on their importance.

Index terms – Feature extraction, Machine learning, classification, Prediction.

I. INTRODUCTION

At the end of pregnancy, one or more babies leaves the womb through normal delivery or by cesarean section. Overall, the most common mode of childbirth is natural delivery, while others are cesarean section, emergency cesarean section, vacuum extraction, and forceps delivery. All these types of births have pros and cons, and the chosen mode of delivery may not suit with the characteristics of the mother. Choosing the wrong mode of delivery may pose different risks, such as fetal termination, excessive bleeding, breathing problems for the baby, and the like.

Although natural delivery is the most common procedure, this can cause complications for symptomatic mothers, such as mothers who are older than 35 years, suffering from diseases such as diabetes or preeclampsia, or carrying more than one fetus. Cesarean section, also known as C-section, or cesarean delivery, is often necessary when a normal delivery might place the baby or mother at risk. It can be a lifesaving procedure for both mother and infant if, for example, a baby is in an awkward position in the womb or labor is not progressing as it should, even though cesarean section might not be the best alternative to normal delivery. Apart from these concerns, the rates of cesarean section around the world are rapidly. According to the World Health Organization (WHO), the number of babies born through cesarean section almost doubled between 2000 and 2015—from 12% to 21% of all births . The overall maternal mortality rate was 6 to 22 deaths per 100 000 live births, with approximately one third to one half of maternal deaths following cesarean delivery . This situation is worse in developing and underdeveloped countries; for example, in Bangladesh, the avoidable cesarean section rate increased by 51% during 2016–2018 and 77% of all cesarean sections in 2018 were medically unnecessary. In Bangladesh during 2017, the maternal mortality rate was 173 deaths per 100 000 live births, which was higher than for most developed countries; in the same year thematernal mortality rate in the United States was 17 deaths per 100 000 live births. Furthermore, according to the Institute of Public Health Nutrition's National Low Birth Weight Survey Bangladesh, 2015, the cesarean section rate was 35.5% which exceeded the WHO's recommended range of 10–15%. Compared to normal delivery, maternal mortality and morbidity increase to approximately twice the rate for cesarean delivery. Cesarean section may cause various health issues for mothers, such as blood loss, injury to an organ, infection, complications in future pregnancies, and similar. Sometimes, the surgical cesarean section procedure is urgently needed due to immediate concerns for the health of mother and/or baby and is known as emergency cesarean section. Despite its similarity to classic cesarean section, emergency cesarean section carries a higher risk of surgical injury and infection.

II. LITERATURE SURVEY

Four major hormonal systems are active during labor and birth. These involve oxytocin, the hormone of love; endorphins, hormones of pleasure and transcendence; epinephrine and norepinephrine, hormones of excitement; and prolactin, the mothering

hormone. These systems are common to all mammals and originate in our mammalian or middle brain, also known as the limbic system. For birth to proceed optimally, this part of the brain must take precedence over the neocortex, or rational brain. This shift can be helped by an atmosphere of quiet and privacy, with, for example, dim lighting and little conversation, and no expectation of rationality from the laboring woman. Under such conditions a woman intuitively will choose the movements, sounds, breathing, and positions that will birth her baby most easily. This is her genetic and hormonal blueprint.

The purpose of this study was to obtain a better understanding of women who demand a cesarean section when obstetricians do not think it is necessary. Thirty-three pregnant women were interviewed about their reasons for the demand. The 28 parous women referred to previous childbirth experiences and feared mainly for intractable labor pain and for the life and health of the child. The most prevalent fear of the five nulliparae was for vaginal rupture. According to their wishes and prerequisites the women received counselling or short-term psychotherapy by a psychotherapeutically trained obstetrician. At term 14 women chose vaginal delivery and 19 had elective cesareans, three on obstetric indications and 16 at their own choice.

In this Series paper, we describe the frequency of, trends in, determinants of, and inequalities in caesarean section (CS) use, globally, regionally, and in selected countries. On the basis of data from 169 countries that include 98·4% of the world's births, we estimate that 29·7 million (21·1%, 95% uncertainty interval 19·9–22·4) births occurred through CS in 2015, which was almost double the number of births by this method in 2000 (16·0 million [12·1%, 10·9–13·3] births). CS use in 2015 was up to ten times more frequent in the Latin America and Caribbean region, where it was used in 44·3% (41·3–47·4) of births, than in the west and central Africa region, where it was used in 4·1% (3·6–4·6) of births. The global and regional increases in CS use were driven both by an increasing proportion of births occurring in health facilities (accounting for 66·5% of the global increase) and increases in CS use within health facilities (33·5%), with considerable variation between regions. Based on the most recent data available for each country, 15% of births in 106 (63%) of 169 countries were by CS, whereas 47 (28%) countries showed CS use in less than 10% of births. National CS use varied from 0·6% in South Sudan to 58·1% in the Dominican Republic. Within-country disparities in CS use were also very large: CS use was almost five times more frequent in

births in the richest versus the poorest quintiles in low-income and middle-income countries; markedly high CS use was observed among low obstetric risk births, especially among more educated women in, for example, Brazil and China; and CS use was 1·6 times more frequent in private facilities than in public facilities.

III. PROPOSED SYSTEM

The research was conducted in two phases. The objective of the rst phase was to explore and prioritize the features necessary for predicting modes of delivery. This phase included a literature review, structured interviews, and a mini survey. The results of these methods were synthesized and analyzed to identify all possible features and their importance/priorities in predicting modes of childbirth. The purpose of the second phase was to develop several machine learning models to effectively predict modes of delivery using an optimal number of features. In this phase, different predictive machine learning models were developed using five supervised learning algorithms: DT, SVM, KNN, RF, and SC. For applying the machine learning algorithms, an open access data set was used, which contained 6157 birth records for 2014 from four public hospitals located in three different autonomous communities of Spain. The features found in Phase I were used to develop and test the models. All possible subsets of features based on their priority/ importance were separately tested, and the effectiveness of each algorithm for each of the subsets was explored. The outcome of this phase revealed which algorithm best predicted the performance for a particular set of features.

The below figure shows system overview.

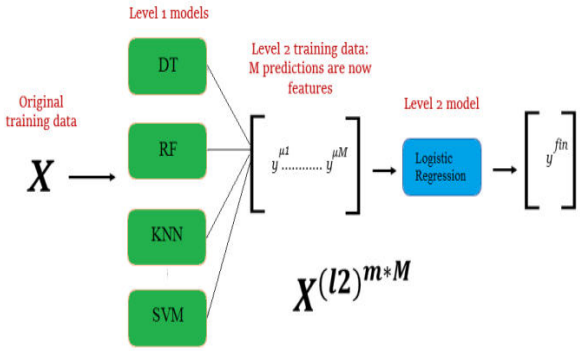

Fig. 1: System Model

Implementation Modules

- **Data collectionModule**
- To develop efficient prediction models, a data set consisting of diverse sets of features relating to pregnant women was used, as collected by Campillo-Artero and colleagues. The data set contained 6157 singleton birth records, with no exclusions, which occurred in 2014 at four public hospitals located in three different autonomous Spanish communities.

- **Data Preprocessing Module**
- In the second phase, the collected data were synthesized. First, irrelevant features were removed from the data set, and 32 important features out of 153 features were selected for further analysis based on a feature exploration study, which was briefly discussed in the previous section. Second, duplicate instances were removed from the data set (18 out of 6157 instances). Third, null values were handled by applying likewise replacement techniques, where a particular numerical observation was replaced with a mean value and categorical observation was replaced with the most frequent value. Fourth, an adaptive synthetic (ADASYN) sampling approach was applied to the data to make the class distribution of the target feature uniform, since the data set had a class imbalance problem.
- **Classification Module**
- In this phase, different machine learning algorithms were chosen based on recent work relating to the prediction of childbirth methods which included DT, KNN, RF, and SVM, and these four different algorithms were then combined to develop a SC model. The models were developed using scikit-learn, which is a Python module integrated into a wide range of machine learning algorithms.

Implementation Algorithms

- **Support Vector Machine**
- Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.
- The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.
- SVM chooses the extreme points/vectors that help in creating the hyperplane.
- **Random Forest**
- Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem

and to improve the performance of the model.

- As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

- **Decision Tree**

- Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.

- In a Decision tree, there are two nodes, which are the Decision Node and Leaf Node. Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches.

- The decisions or the test are performed on the basis of features of the given dataset.

- **Naïve Bayes**

- Naïve Bayes algorithm is a supervised learning algorithm, which is based on Bayes theorem and used for solving classification problems.

- It is mainly used in text classification that includes a high-dimensional training dataset.

- Naïve Bayes Classifier is one of the simple and most effective Classification algorithms which helps in building the fast machine learning models that can make quick predictions.

- It is a probabilistic classifier, which means it predicts on the basis of the probability of an object.

IV. RESULTS

Fig. 2: Welcome page

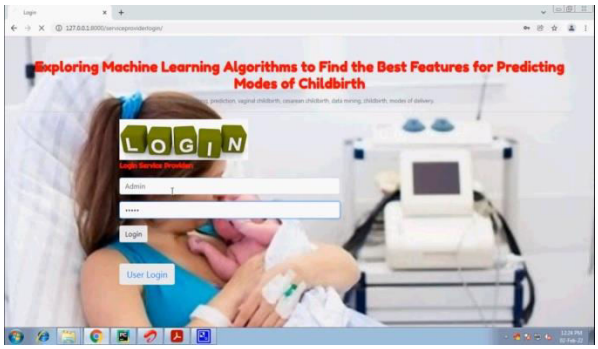

Fig. 3: Login page for service provider

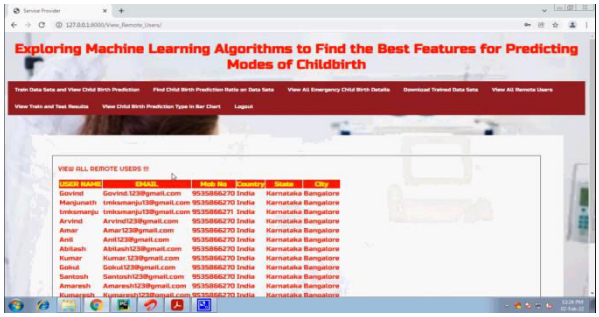

Fig. 5: Welcome page for service provider after login

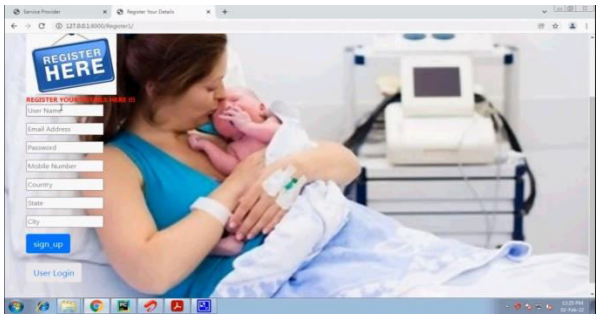

Fig. 6: Registration page for users

Fig. 7: Login page for users after registration

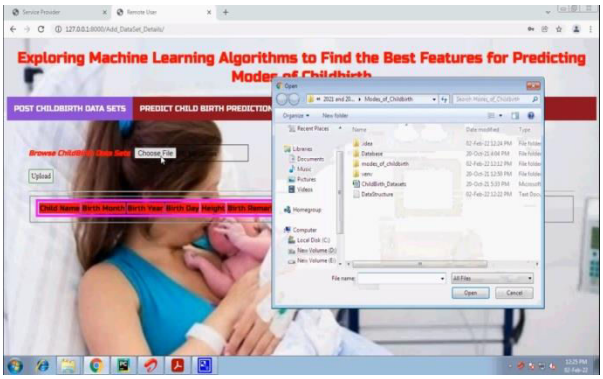

Fig. 8: Users welcome page after login and uploading data set

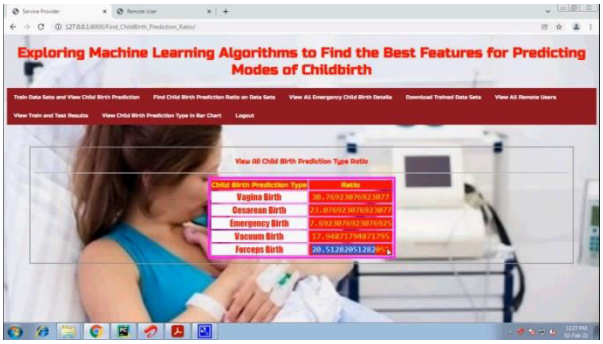

Fig. 9: Child Birth prediction type ratio

V. CONCLUSION

Choosing the most suitable modes of childbirth is vital for the safety of both mothers and infants, but the best sets of features to consider when taking such decisions remained to be explored. This study therefore examined all possible features and classified them into different categories by conducting an extensive empirical study, then applied a feature selection method of machine learning. Later, the results of applying five machine-learning algorithms to combinations of these categories (classes) were used to

determine the most appropriate algorithm for predicting the best childbirth model with the minimum number of features.

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