Predicting The Mode Of Delivery

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ABSTRACT

Background: The C-Sec has started becoming a trend worldwide, Particularly India being a developing nation with changing trends and lifestyles of people is near to become the home for the largest number of cesarean births. With some inclined cesarean births, there is increased doctor recommend c-sec where it is not medically required.

Objective:
The aim of our study is to determine that machine learning algorithms could be used to predict the mode of deliveries.

Study Design:
Decision Tree Model and Logistic Regression Models can be applied to the selected biological and social features to develop a predictive training model, trained on the sample dataset which can be used to make predictions for new data in the future.

Keywords: C-Sec, Placenta Previa, Uterine Rupture, Placental abruption, Breech position, Cord prolapse, Fetal distress, Logistic Regression Models.

I. INTRODUCTION

There are many myths regarding the mode of delivery through pregnancy, Experts states that it is still a challenge to accurately predict the type of childbirth. However, Early prediction of the type of childbirth can be helpful to reduce the stress and awe during pregnancy. Primarily, the Mode of deliveries or the type of childbirth is categorized into two types: Normal Vaginal Delivery and Cesarean Delivery(C-Sec).

Cesarean Section(C-sec) is the surgical delivery of the baby which is done by an incision through the mother's abdomen (belly) and uterus(womb). It is recommended when normal delivery is not safer for the operand, baby or both. Some cesarean deliveries are planned and scheduled, while others may be done as a result of problems that occur during labor. In Maternity Care, it is essential to make a quick decision about the mode of delivery for patients. The advance prediction could help a family identifying if a woman actually needs a cesarean section, thus reducing unnecessary procedures and substantially increasing medical benefits.

A research states that the number of cesarean births has doubled during last decade. While the World Health Organisation(WHO) recommends that the rate of cesarean deliveries to be 10%-50%, India experienced a rate of 17.2% of C-Sec births during the period Jan 2015 to Dec 2016. Not only the Inclined cesarean births but a study from the Indian Institute of Management-Ahmedabad (IIM-A) revealed that 40.9% of the deliveries in the private sector are cesarean of which some were not required medically but performed in order to make profits of the admitted patient's family.

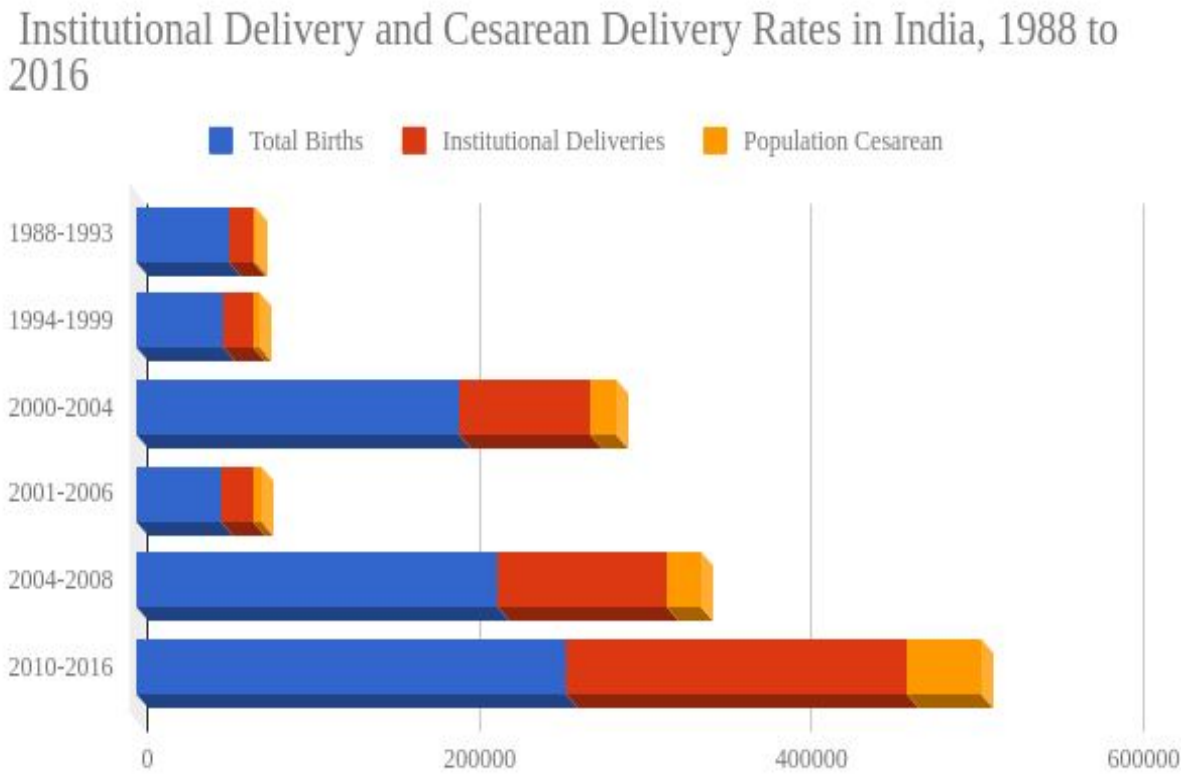


Fig. Increase in the rate of C-Sections

There are a number of complexities associated with the C-section births, As it could increase the rate of mortality by 3 to 4 times for the patient and her child. It is difficult for a woman to undergo vaginal delivery once she has given birth from C-Sec delivery as the scars are not too strong to hold together during labor contractions. It may not just harm the health of the mother, but could also have effects on the newborn's health.

With the changing trends and lifestyles of people in India, It has become an issue with great interest to determine the correct Mode of Delivery for a child. With Knowledge Engineering and Machine Learning, it is now possible to determine the mode of delivery just by looking into the biological and social factors that affect the pregnancy of a woman. The data collected from the patients can be classified and predictions can be made using the number of ML algorithms. The algorithm we used in our case study is the Logistic Regression Algorithm.

Logistic Regression Algorithm:

Logistic regression algorithm is a predictive analysis machine learning algorithm based on the concept of probability. Logistic regression algorithm uses a cost function known as “Sigmoid Function” or “Logistic Function”.
The hypothesis of Logistic regression tends to limit the cost function between 0 to 1.

$$0 \leq h_\theta(x) \leq 1$$

Logistic regression hypothesis expectation

1. **Sigmoid Function:**

A sigmoid function is used to map the predicted values to probabilities. The formula for the sigmoid function is as follows,

$$f(x) = \frac{1}{1+e^{-(x)}}$$

Formula of a sigmoid function | Image: Analytics India Magazine

The results of the hypothesis are expected to be between 0 to 1, As shown below,

$$h\theta(X) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X)}}$$

The Hypothesis of logistic regression

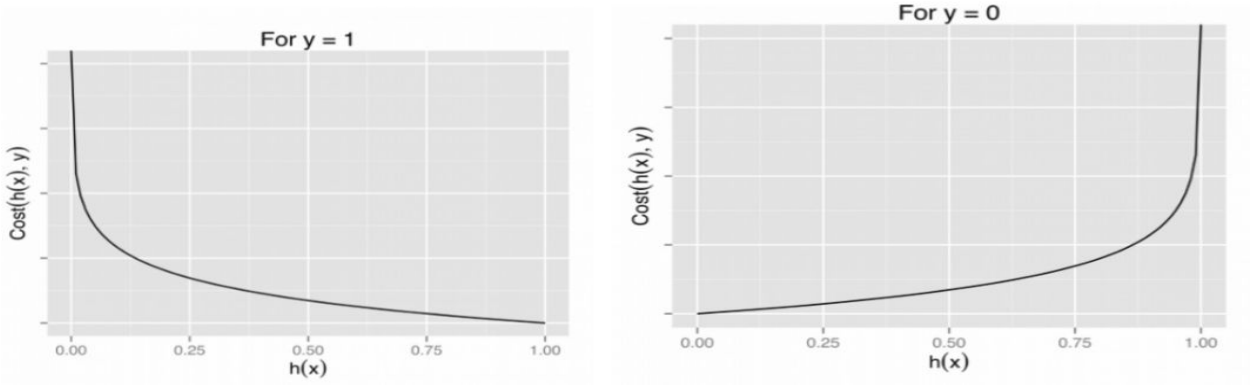
Cost Function for Logistic regression is as follows,

The cost function is the cost an algorithm pays to predict the value of hθ(x), while the actual label for the cost is y. Using the below function, the algorithm is granted with convexity, unlike a linear regression algorithm.

$$Cost(h_\theta(x), y) = \begin{cases} -log(h_\theta(x)) & \text{if } y = 1 \\ -log(1 - h_\theta(x)) & \text{if } y = 0 \end{cases}$$

Cost function of Logistic Regression

Consider y = 1, the cost to pay(output) approaches to 0 as hθ(x) approaches to 1. Conversely, the cost to pay grows to infinity as hθ(x) approaches to 0. Conversely, the same intuition applies when y = 0.



The above-mentioned cost function could be compressed into a single line expression, with some optimization it can be rewritten as,

$$J(\theta) = -\frac{1}{m}\sum \left[y^{(i)} \log(h\theta(x(i))) + \left(1 - y^{(i)}\right) \log(1 - h\theta(x(i))) \right]$$

Above functions compressed into one cost function

II. PROPOSED SYSTEM

Our objective is to predict the mode of delivery for a child by using the logistic regression algorithm for the classification of delivery as Normal or C-section. Our model is trained and tested on the dataset that we collected which includes different social and biological features collected from Blood and Urine Reports, Reports of obstetric ultrasonography through the nine months of pregnancy and face to face interviews.

Our model is designed in a way which takes in collected data, preprocess it and returns the formatted data on which the model could be trained. Below fig. shows the framework of our proposed system.

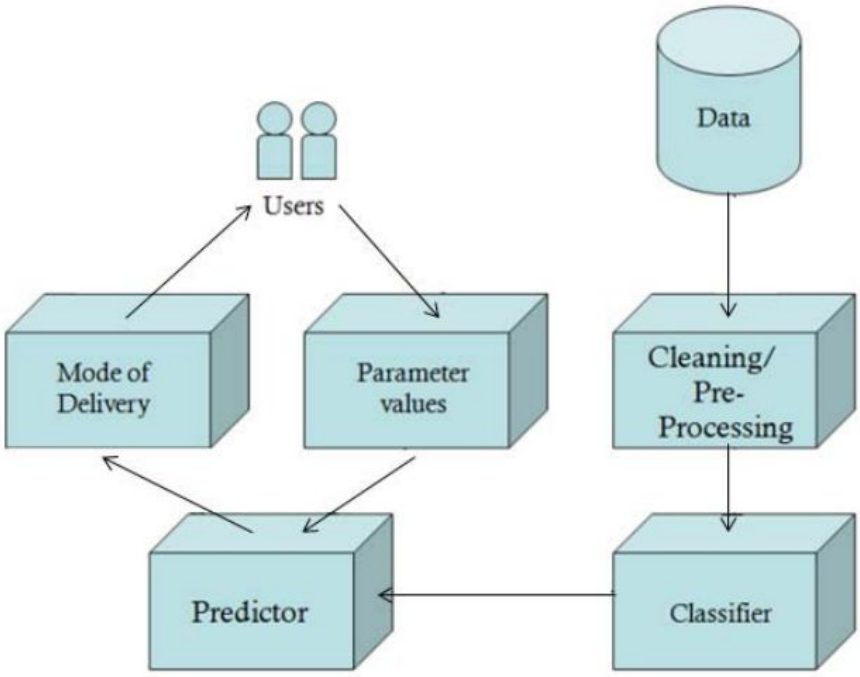


Fig. 1 Framework of our Proposed System

Each record in our dataset consisted of 80 different parameters including age, height, weight, glucose, fetal weight, fetal heart rate, cervical length, working, repeated c-sections, etc. Both the social and biological parameters were collected during the pregnancy. With all these factors, the medical history of the patient was also collected to be part of our dataset.

The following list shows all features included in the dataset that gives us detailed information about the conceiving woman and its child.

Fields	**Measurement Units**
Name	
Age	years
Height	cm
Weight	grams
Blood Group	
D BP	mm Hg
S BP	mm Hg

Hemoglobin (HB)	grams per deciliter (g/dl)
Glucose(Fasting)	mg/dL (milligrams per decilitre)
Glucose (Post Meal)	mg/dL (milligrams per decilitre)
Urine	
HBsAg	Negative / Positive
Thyroid	milliunits per liter (mU/L)
HIV	Negative / Positive
Sickling test	Negative/Positive
BPD	mm
HC	mm
AC	mm
FL	mm
Fetal weight	grams
Doppler	Normal
Fetal Heart Rate	beats per min [bpm]
Cervical Length	cm/mm
No. of Fetus	
Amniotic Fluid	
Gestational Age	In weeks and days

Table: Data Medical Features

With some medical information, we collected some social information about the conceiving woman which is tabularized as below;

Face to Face interview Questions	**Answer**
Maternal Age	Year
Height	In feets
Gestational Diabetes	Yes/No
High Blood Pressure	Yes / No
Asthma	Yes / No
Education	PG/HSC/SSC/Diploma/Bachelor's degree
Work type	
Occupation	
Drink	Yes / No
Smoke	Yes / No
Sugar	Yes / No
Breathlessness on exertion, palpitations	Yes / No
Operated Organ	Yes / No
Any Abortion	Yes / No
Regular Periods	Yes / No
Domestic violence	Yes / No
Limited Awareness	Yes / No
Dieting to look smart	Yes / No
Fear of Pain	Yes / No
Socio-economic Status	Yes / No

Psychological pressure	Yes / No
Over Fattening food for a healthy baby	Yes / No
Infection	Yes / No
Poverty	Yes / No
Menstrual History	Regular / Not Regular
Exercise	Yes / No
Ask her about the Nausea and vomiting/ Heartburn/Constipation/Increased Frequency of Urination	Yes / No
Chronic cough, blood in the sputum, prolonged fever(tuberculosis)	Yes / No
Renal disease(Kidney failure)	Yes / No
Fever	Yes / No
Persistent Vomiting	Yes / No
Abnormal vaginal discharge/itching	Yes / No
Palpitations, easy fatigability	Yes / No
Breathlessness at rest/ on mild exertion	Yes / No
Generalized swelling of the body, puffiness of the face	Yes / No
Severe headache and blurring of vision	Yes / No
Passing Smaller amount of urine and burning sensation during	Yes / No

micturition(the action of urinating.)	
Vaginal bleeding	Yes / No
Leaking of watery fluid per vagina(p/v)	Yes / No
Thyroid	Yes / No
Bleeding	Yes / No
Swelling of Legs	Yes / No
Reason of C-section	
Mode of Delivery	Normal / C-sec

Table: Data Social Features

From the selected features, is a feature "Reason of C-section" which could have multiple values/reasons so it is necessary to study the reasons lead to choosing c-sec delivery above normal. These reasons are nothing but the complications that occur in the course of pregnancy. Some of which are listed below.

1. **Placenta previa:** This occurs when the placenta lies low in the uterus and partially or completely covers the cervix.
2. **Placental abruption**: This is the separation of the placenta from the uterine lining that usually occurs in the third trimester. Approximately 1% of pregnant women will experience placental abruption.
3. **Uterine rupture:** the uterus tears during pregnancy or labor. This can lead to hemorrhaging the mother and interfere with the baby's oxygen supply. This is a reason for immediate cesarean.
4. **Breech position:** When a baby is in the breech position, a cesarean delivery is often the only option. Breech position is referred to happen when the baby is positioned with the legs rather than its face closer to the birth canal.
5. **Cord prolapse:** Cord prolapse occurs when the umbilical cord slips through the cervix and protrudes from the vagina before the baby is born. This could result in a trap of a cord against the fetal body.
6. **Fetal distress:** It rarely happens when the fetus does not receive enough oxygen during labor.

From, the above-collected features we used selected features to train our model, The preprocessing was done on the following collected data.

- **Preprocessing and Cleaning of Data:**

  All the collected data was in raw format, thus it was needed to be converted into a format that could be used by an ML algorithm to train. The data was clarified by deleting some records which contained maximum missing or erroneous and irrelevant values. After deleting such records the values for the selected features were transformed in numerical format for enhancing the process of classification. The Transformation process was performed by our preprocessing system which outputted the data in a numerical format and assigned to our second level for the further process.

- **Classification and Prediction**

  This section could be considered as the brain of our system, the second level which is responsible to make us a decision as normal or C-sec. This section takes in the preprocessed data converts it into the training and testing set with the use of library functions checks for the relationship between the fed features and the type of delivery. Once the relationship is found the model is ready to be trained. The model maps all the features with the corresponding output and is trained on the training set, once training is complete the model parameters are saved with its corresponding weights, which is later loaded and used to make a decision on the test data for the validation purpose.

III. RESULT ANALYSIS

With all the collected data our system has performed well in predicting the mode of delivery with the scores as mentioned below for each training and test set.

Train Accuracy	**1**
Test Accuracy	**0.75**

Table: Accuracy Matrix

For the test data, our system has managed to achieve the accuracy of 0.75% when tested on some records with new data our predicted values and original values for the data were as follows:

Mode_of_Delivery	Prediction	Accuracy
1	1	1
0	0	1

Table: Predicted Results

IV. LIMITATIONS AND FUTURE SCOPE

Our System tends to fail in some specific conditions, where all the readings from the conceiver and baby are okay but the patient's family has decided to get baby on certain special day or date as anniversary, or someone's birthday. Mother while in labor refuses a normal delivery due to the fear of pain and any other myths she heard. Medical emergency with the baby or the mother and some other conditions.

Also, the system can be enhanced by using more classification algorithms as only a logistic regression algorithm is used for simplification purposes. More Data could be collected in the coming future as the Machine learning algorithm works much better when there is a large amount of data information available. New features such as financial background, Type of hospital where treatment is going on could be used to make the system better.

V. CONCLUSION

With the use of machine learning algorithms such as Logistic regression, it is now possible to predict the mode of delivery considering the social and biological and medical features of the woman and the fetus. Early prediction of the mode of delivery could be useful as people would not have to blindly believe the doctor to go with the cesarean delivery. Our system works like the predictor for the mode of delivery which predicts the most likely delivery type, namely; Normal or C-Sec delivery. Even though it is not a full-proof predictor, It can be used to make early predictions and reduce agitation and stress during pregnancy.

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