Deep learning approach for the prediction of postpartum hemorrhage in vaginal birth

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Disclosure of Conflict of Interest

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I have no COI
with regard to our presentation.

Summary

- Postpartum bleeding (PPH) is a major cause of maternal morbidity and it is still difficult to predict PPH in vaginal deliveries. If PPH can be predicted before delivery, high-risk pregnant women can be managed at a tertiary hospital before delivery, and maternal mortality can be improved. We studied a deep learning model for prediction of postpartum bleeding, using 4960 vaginal deliveries with clinical data. The model achieved AUC of 0.67. Fetal weight, maternal age and weight had the biggest impact on the prediction.

日本語要約

- 産科危機的出血（PPH）は周産期死亡の第一の原因であるが、経腟分娩症例におけるPPHの発症予測は難しい。分娩前にPPHを予測できれば、出血リスクの高い妊婦を分娩前から三次病院で管理することができ、妊産婦死亡率を改善することができる可能性がある。今回我々は、4960症例の経腟分娩の臨床データを使用して、1000ml以上の分娩時出血となった症例を予測するDeep learningモデルを構築した。予測モデルの予測精度は0.67であり、予測へ寄与する因子は児体重、母体年齢、母体体重の影響が強かった。

Introduction

- Postpartum bleeding(PPH) is a major cause of maternal morbidity. Although endovascular treatment and surgical treatment have progressed in recent years, it is still difficult to manage unexpected PPH.

- If PPH can be predicted before delivery, high-risk pregnant women can be managed at a tertiary hospital before delivery, and maternal mortality can be improved.

- Clinical prediction of PPH remains difficult, especially for vaginal delivery. We studied a deep learning model for predicting postpartum bleeding in vaginal birth.

Method①: Enrollment/Variables

[Enrollment] 4,960 cases, including 128 patients (2.5%) of PPH

Inclusion criteria: vacuum/foceps, breech vaginal deliveries

Exclusion criteria: cesarean section(including the failure of vaginal delivery)

[Features] 25 clinical factors (as shown below)

[Labels] PPH cases (defined as blood loss greater than 1000 mL)

1	Age	8	Smoking	15	DBP on adimission	22	Breech delivery
2	Height	9	Alcohole	16	SBP on adimission	23	Vacuum/forceps delivery
4	Weight (on admission)	10	Infertility	17	BT on adimission	24	Oxytosin use
3	BMI (before pregnancy)	11	Hb during pregnancy	18	Proteinuria on adimission	25	Prostaglandin use
5	Gravity	12	Fetal BPD	19	Fetal weight		
6	Parity	13	Gestational week of delivery	20	Sex of the baby		
7	Maternal blood type	14	Gestational day of delivery	21	Induction		

Method②　Implementation

[Implement]　Python 3.6.3, Keras/tensor flow/Pandas/ Numpy/ Scikit-learn

[Machine learning models]

logistic regression/support vector machine/random forest/boosting tree/decision tree

[Evaluation]

k-fold cross-validation,

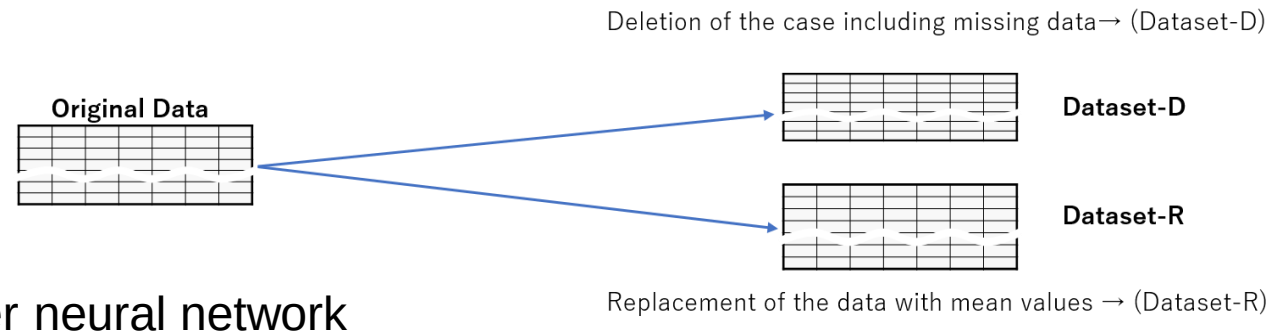
Area under the curve of the receiver operating characteristic (AUC)

Accuracy of the performance

Method③　Model construction

[Data procession]

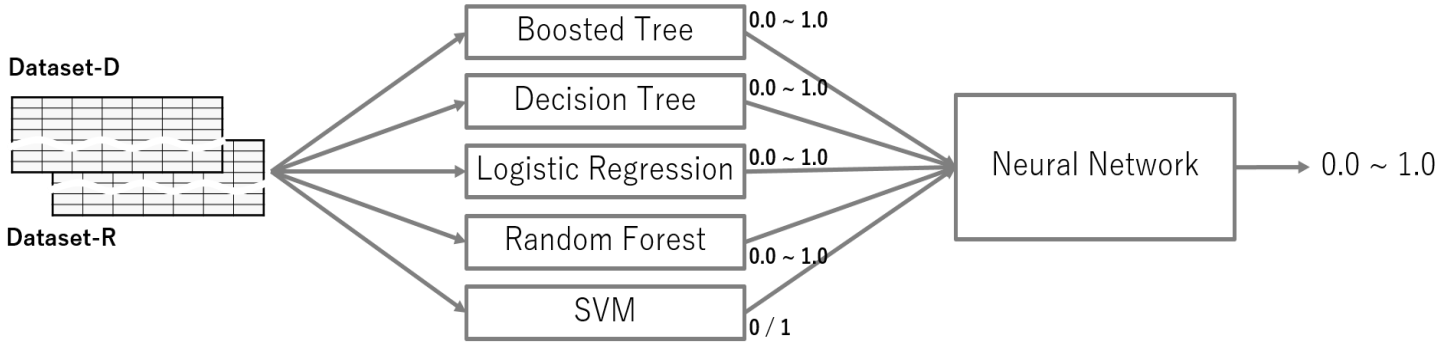
Missing values were processed in replacement with the median values or deletion of the cases.



[Model]

Deep learning model consisting of a two-layer neural network

following ensemble learning of five machine learning classifiers



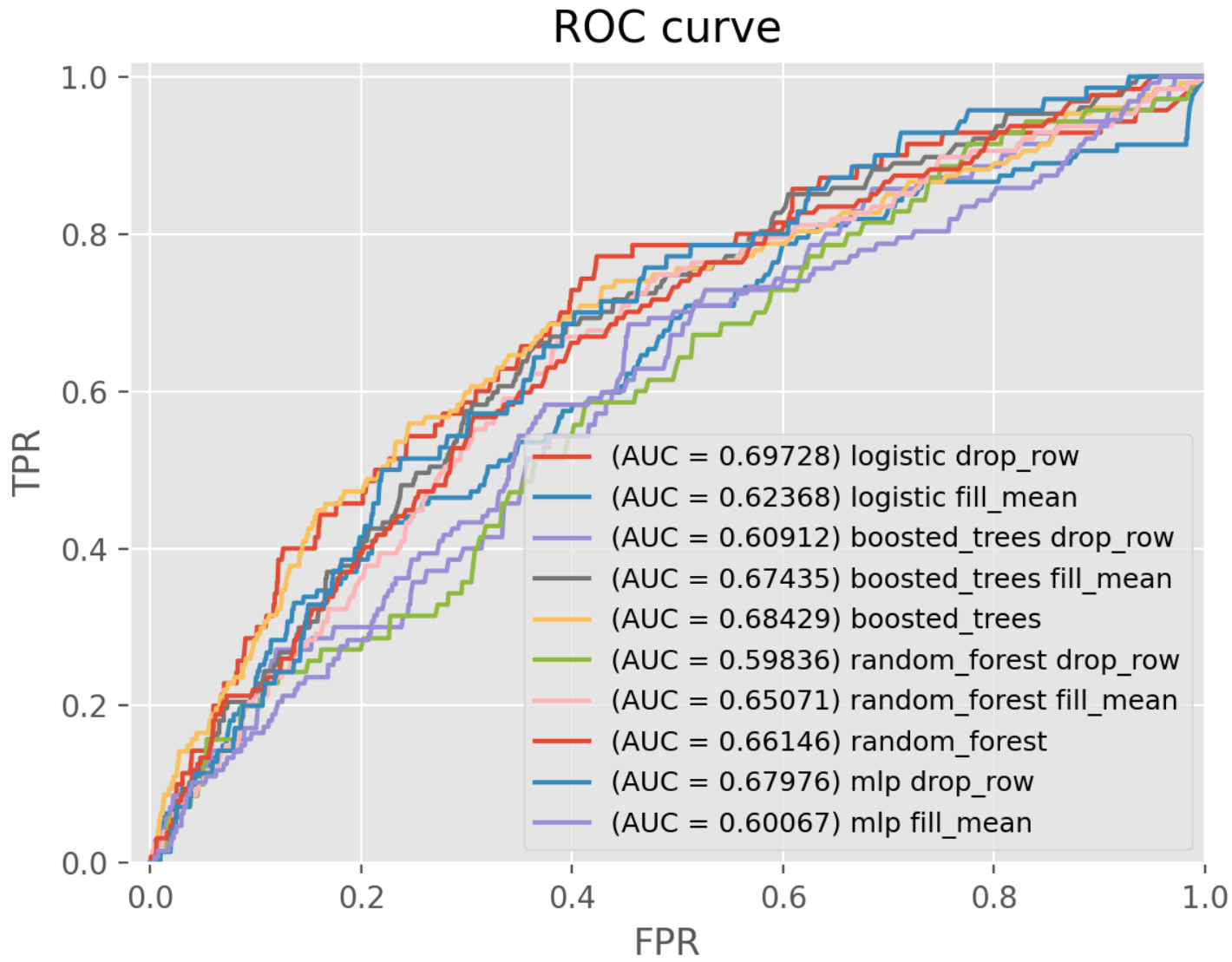
Result①

	1) Deletion of missing data		2) Replacement by mean-value	
Model	AUC	accuracy	AUC	accuracy
Deep learning	**0.679**	**0.744**	**0.601**	**0.757**
Logistic regression	0.697	0.734	0.623	0.711
Random forest	0.598	0.830	0.650	0.805
Boosted trees	0.609	0.902	0.674	0.878
SVM	-	0.703	-	0.683

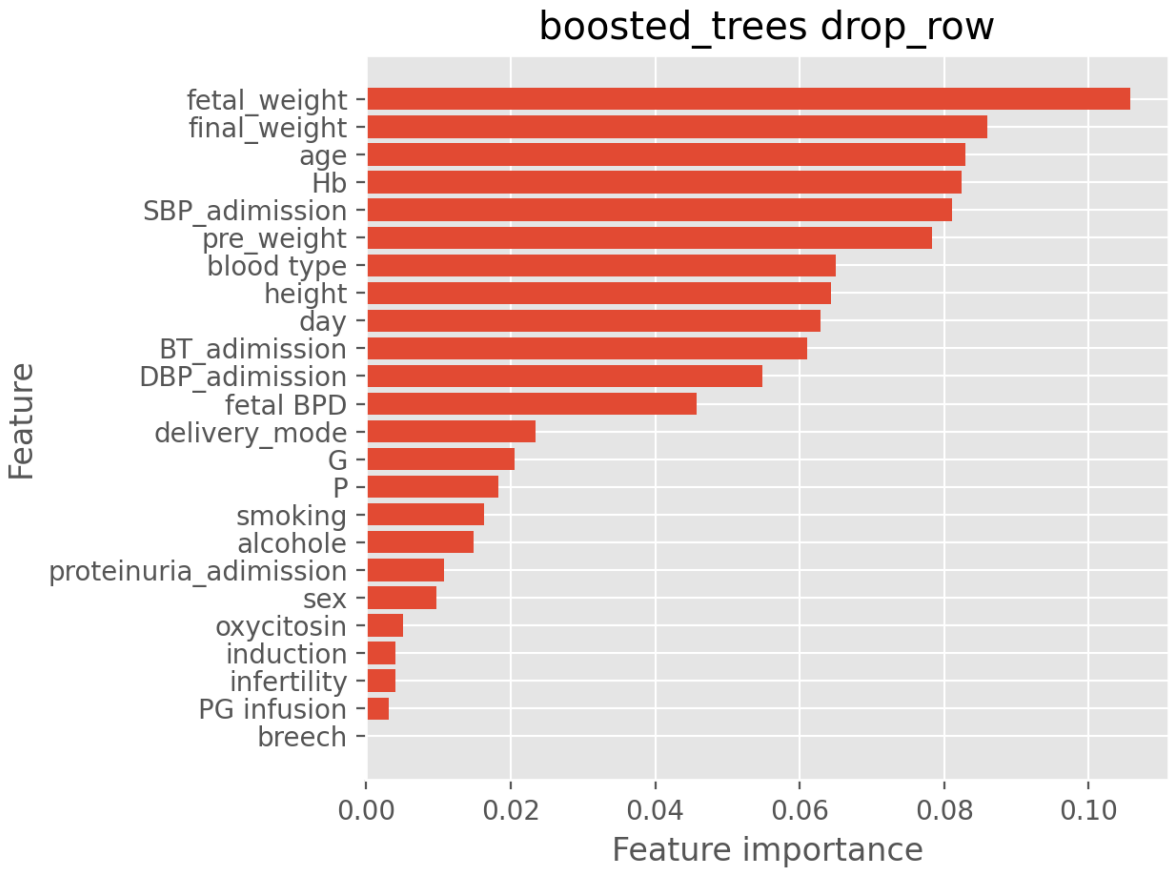
Result②

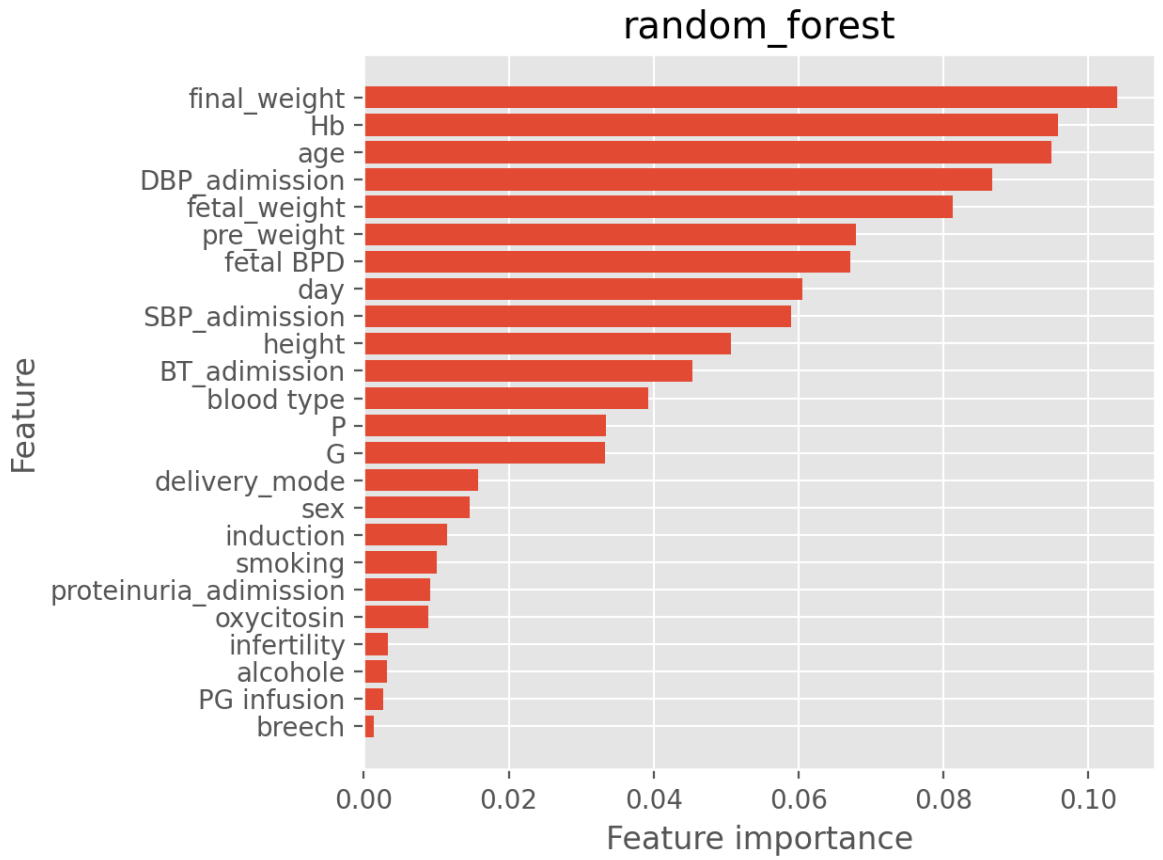
- Missing values were noted in the categories of tumor markers, and replaced with the median values or deletion of the cases.

- Boosted tree showed the best performance of prediction.



Result③: Feature Importances





Discussion

- In the systematic review of PPH prediction model, traditional logistic regression was used in all 14 studies.

BJOG. 2021;128:46–53

- In 2020, PPH prediction model by machine learning has been reported. With 150,000 cases of deliveries, the model performed the accuracy of 0.93. However, it contains many cases of Cesarean section, it is not just a study of vaginal delivery.

Obstet Gynecol. 2020;135:935–44.

Limitation

- The size of the dataset was small for machine learning. One million cases is desirable for the performance.
- Uneven distribution of PPH/non-PPH groups make the learning difficult.
- External validation should be conducted for the robustness.
- Importance of features should be analyzed.

Conclusion

The size of the dataset and the number of variables included were small to improve the performance of the deep learning model. Further research is needed to analyze the appropriate variables and prepare big data such as millions of cases.