Supplemental Table 1. All antepartum and intrapartum variables included for analysis for feature selection

|  |  |
| --- | --- |
| **Antepartum Variabels** | **Intrapartum Variables** |
| Activeherpes: Active genital herpes | Accrete: Placenta accrete |
| Admreason: Admission to L&D: Admission reason | Activeherpes: Active genital herpes |
| Alcohol: Prenatal History: Alcohol during  pregnancy | AdmBishop: Admission to L&D: Bishop score |
| Anteabruption: Prenatal History: Abruptio placentae | Admcervpos: Admission to L&D: Cervical position |
| Anteanemia: Prenatal History: Prenatal anemia | Admconsistency: Admission to L&D: Consistency |
| Anteasthma: Prenatal History: Prenatal asthma | Admcontract: Admission to L&D: Number of  contractions per 10 minutes |
| Antebleed3: Prenatal History: Bleeding in the 3rd Trimester | AdmDBP: Admission to L&D: Diastolic BP (mmHg) at admission |
| AnteCHBP: Prenatal History: Chronic hypertension | Admefface: Admission to L&D: Effacement |
| Prenatal History: Antepartum chorioamnionitis | Admpresent: Admission to L&D: Presentation |
| Antefetaldth: Prenatal History: Antepartum fetal death | Admreason: Admission to L&D: Admission reason |
| Antefetdistress: Prenatal History: Antepartum fetal distress | AdmSBP: Admission to L&D: Systolic BP (mmHg)  at admission |
| AnteGBS: Prenatal History: Antepartum Group B  Strep | Alcohol: Prenatal History: Alcohol during pregnancy |
| AnteGDM: Prenatal History: Gestational diabetes | Analgesia: Labor and delivery summary: Labor Analgesia |
| Antehospital: Prenatal History: Antenatal hospital admission | Anteabruption: Prenatal History: Abruptio placentae |
| AnteLGA: Prenatal History: Large for GA | Anteanemia: Prenatal History: Prenatal anemia |
| Anteprevia: Prenatal History: Placenta previa | Anteasthma: Prenatal History: Prenatal asthma |
| AnteSGA: Prenatal History: Intrauterine growth restriction | Antebleed3: Prenatal History: Bleeding in the 3rd Trimester |
| AnteSTD: Prenatal History: Sexually transmitted  disease infection | AnteCHBP: Prenatal History: Chronic hypertension |
| Antesteroid: Prenatal History: Antenatal Steroids | Antechorio: Antepartum chorioamnionitis |
| Antethrombo: Prenatal History: Thromboembolic  disorder | Antefetaldth: Prenatal History: Antepartum fetal  death |
| Antethyroid: Prenatal History: Prenatal thyroid disease | Antefetdistress: Prenatal History: Antepartum fetal distress |
| AnteUTI: Prenatal History: Antepartum UTI | AnteGBS: Prenatal History: Antepartum Group B  Strep |
| ART: Pregnancy by ART or drugs | AnteGDM: Prenatal History: Gestational diabetes |
| Cerclage: Cerclage | Antehospital: Prenatal History: Antenatal hospital admission |
| ChronicHBP: Chronic Hypertension | AnteLGA: Prenatal History: Large for GA |
| CPD: CPD | Anteprevia: Prenatal History: Placenta previa |
| CS\_Elect: C Section - Elective | AnteSGA: Prenatal History: Intrauterine growth restriction |
| CS\_Fetanom: C Section – Fetal indication or anomaly | AnteSTD: Prenatal History: Sexually transmitted  disease infection |
| CS\_Fetmac: C Section – Fetal macrosomia | Antesteroid: Prenatal History: Antenatal Steroids |
| CS\_HIV: C Section – HIV, Herpes active infection | Antethrombo: Prenatal History: Thromboembolic disorder |
| CS\_HTNdis: C Section – Hypertensive Disease | Antethyroid: Prenatal History: Prenatal thyroid disease |
| CS\_HxShoulder: C Section – Hx of Shoulder dystocia | AnteUTI: Prenatal History: Antepartum UTI |
| CS\_Mult: C Section - Multiple gestation | ART: Pregnancy by ART or drugs |
| CS\_Uscar: C Section - Previous uterine scar | Augment: Labor and Delivery summary: Method of labor augmentation |
| depression\_comb: maternal chronic disease: Depression | BESTGA: Admission to L&D: Best estimate GA  (week) |
| Diabetes: Medical History: Pre-existing diabetes | Breech: Derived variable from chart: Breech  presentation |
| DMControl: Prenatal History: Most serious diabetes control | breech9: Maternal ICD9 collection: Breech  presentation (ICD-9 code 652.2) |
| Druguse: Prenatal History: Recreational drugs  during pregnancy | Cerclage: Prenatal History: Cerclage |
| Eclampsia: Prenatal History: Eclampsia | Chorio: Chorioamnionitis (ICD-9 code 658.4) |
| ECV: Prenatal History: External cephalic version | chorio9: Chorioamnionitis (ICD-9 code 658.4) |
| Education: Maternal demographic: Highest level of  education | ChronicHBP: Medical History: Chronic  hypertension |
| GestHBP: Prenatal History: Prenatal gestational hypertension | CPD; Prenatal History: CPD |
| gest\_diab: Derived variable: Gestational diabetes (GDM) | CS\_Breech: C Section - Breech or other  malpresentation |
| gest\_htn: Gestational hypertension | CS\_Chorio: C Section - Chorioamnionitis |
| gi\_disease9: Maternal ICD9 collection: maternal chronic disease Gastrointestinal disease (ICD-9 codes 555, 556, 557, 558) | CS\_Elect: C Section - Elective |
| GI\_disease\_comb: maternal chronic disease: Gastrointestinal disease | CS\_Emerg: C Section - Emergency |
| Heart\_disease\_comb: maternal chronic disease, heart disease | CS\_Fetanom: C Section - Fetal indication or anomaly |
| high\_Age | CS\_Fetmac: C Section - Fetal macrosomia |
| high\_BMI | CS\_Fforceps: C Section - Failed trial forceps or  vacuum |
| high\_Gravidity | CS\_Finduct: C Section - Failed induction |
| high\_height | CS\_FTP: C Section - Failure to progress/  cephalopelvic disproportion |
| HIV: Medical History: HIV | CS\_FVBAC: C Section - Failed VBAC |
| HospElectCS: Elective C-Section prior to 41 weeks | CS\_HIV: C Section - HIV, Herpes active lesions |
| HospElectInd: Elective induction prior to 41 weeks | CS\_HTNdis: C Section - Hypertensive disease |
| Hostype: Type of hospital | CS\_HxShoulder: C Section - Hx of Shoulder  dystocia |
| Hxanemia: Medical History: Anemia | CS\_Mult: C Section - Multiple gestation |
| Hxasthma: Medical History: Asthma | CS\_NRFHT: C Section - Non-reasurring fetal  testing/Fetal distress |
| Hxcsection: Reproductive history: Hx of Prior C-Section | CS\_Other: C Section - Other |
| Hxdepression: Medical History: Depression | CS\_Shoulder: C Section - Shoulder dystocia |
| HxGIdis: Medical History: Gastrointestinal disorder | CS\_Uscar: C Section - Previous uterine scar |
| Hxheartdis: Medical History: Heart disease | Dehiscence: Labor and Delivery summary:  uterine dehiscence |
| Hxmacrosomia: Reproductive history: Hx of Macrosomia | Delfetalpos: Labor and Delivery summary:  Fetal position |
| HxnumCS: Reproductive history: Prior C-Sections | Delmode: Labor and Delivery summary:  Mode of Delivery |
| Hxpreterm: Reproductive history: Hx of Preterm Birth | depression\_comb: Derived variable, maternal  chronic disease: Depression |
| Hxrenaldis: Medical History: Renal disease | Diabetes: Medical History: Pre-existing diabetes |
| Hxseizure: Medical History: Seizure | Dilat\_lst: Repeated Measures: Dilation of 1st exam |
| HxSTD: Medical History: STD | DMControl: Prenatal History: Most serious diabetes control |
| Hxstillbirth: Reproductive history: Hx of Prior Still  Births | Druguse: Prenatal History: Recreational drugs during pregnancy |
| Hxthyroid: Medical History: Thyroid | Eclamp: Derived variable: Eclampsia |
| Hypertyro: Maternal hyperthyroidism (ICD-9 codes 242) | Eclampsia: Prenatal History: Eclampsia |
| Hyp\_ace: Hypertensives: ACE Inhibitors | ECV: Prenatal History: External cephalic version |
| Hyp\_alpha: Hypertensives: Alpha-blockers | Education: Maternal demographic: Highest level of  education |
| Hyp\_beta: Hypertensives: Beta-blockers | Episiotomy: Labor and Delivery summary:  Episiotomy |
| Hyp\_meth: Hypertensives: Methyldopa (Aldomet) | FSE: Labor and Delivery summary: Fetal Salp  electrode |
| iatro\_hypo: Maternal iatrogenic hypothyroidism (ICD-9 codes 243, 244.0-244.3) | Gamethod: Admission to L&D: Method to  determine GA |
| ImposedPE: Prenatal History: Pre/eclampsia  superimposed on hypertension | GestHBP: Prenatal gestational hypertension |
| Incompetence: Prenatal History: Cervical  incompetence | gest\_diab: Derived variable: Gestational diabetes (GDM) |
| Ind\_anomaly: Indication for labor induction: Fetal  anomaly | gest\_htn: Gestational hypertension |
| Ind\_Chorio: Indication for labor induction:  Chorioamnionitis | gi\_disease9: maternal chronic disease Gastrointestinal disease (ICD-9 codes 555, 556, 557, 558) |
| Ind\_elect: Indication for labor induction: Elective  induction | GI\_disease\_comb: maternal chronic disease: Gastrointestinal disease |
| Ind\_Fcomp: Indication for labor induction: Fetal  compromise | Heart\_disease\_comb: maternal chronic disease, heart disease |
| Ind\_Fmacro: Indication for labor induction:  Suspected fetal macrosomia | high\_Age |
| Ind\_HTN: Indication for labor induction: Maternal  hypertensive disorders | high\_BMI |
| Ind\_Hxfetal: Indication for labor induction: Previous  history of fetal indications | high\_Gravidity |
| Ind\_HxMat: Indication for labor induction: History of  maternal indications | high\_height |
| Ind\_Mcond: Indication for labor induction: Maternal  condition | HIV |
| Ind\_Postdate: Indication for labor induction:  Postdate (as determined by physician) | HosEpiNurse: Epidural anethesia: Use of anesthesia nurse |
| Ind\_Still: Indication for labor induction: Stillbirth | HosEpitype: Epidural anethesia: Type of epidural |
| Ind\_Vbleed: Indication for labor induction: Vaginal  bleeding | HospElectCS: Elective C-Section prior to 41 weeks |
| Insurance: Maternal demographic: Insurance type | HospElectInd: Elective induction prior to 41 weeks |
| iufd9: Intrauterine fetal death (ICD-9 code 656.4) | Hostype: Type of hospital |
| Marital: Maternal demographic: Marital status | Hxanemia; Medical History: Anemia |
| momrace\_new: Maternal race, some missing data  replaced with data from repeat pregnancies | Hxasthma: Medical History: Asthma |
| MthInd\_Mec: Method of induction: Mechanical | Hxcsection: Reproductive history: Hx of Prior C-Section |
| MthInd\_Miso: Method of induction: Cytotec/  Misoprostol/PGE1 | Hxdepression: Medical History: Depression |
| MthInd\_PGE2: Method of induction: Other  prostaglandins | HxGIdis: Medical History: Gastrointestinal disorder |
| no\_TD: Maternal ICD-9 collection: No thyroid disease | Hxheartdis: Medical History: Heart disease |
| Oligo: Prenatal History: Oligohydramnios | Hxmacrosomia: Reproductive history: Hx of Macrosomia |
| other\_TD: Other thyroid diseases (ICD-9 codes 240, 241, 193, 226, 245, 246) | HxnumCS: Reproductive history: Prior C-Sections |
| Parity: Reproductive history: Parity | Hxpreterm: Reproductive history: Hx of Preterm Birth |
| Polyhydramnios: Prenatal History: Polyhydramnios | Hxrenaldis: Medical History: Renal disease |
| PostHBP: Maternal Postpartum: HTN/preeclampsia | Hxseizure: Medical History: Seizure |
| Preeclampsia: Prenatal History: Preeclampsia/HELLP | HxSTD: Medical History: STD |
| prelaborCD: Derived variable from chart: Prelabor cesarean section | Hxstillbirth: Reproductive history: Hx of Prior Still Births |
| pre\_diab: Derived variable: maternal diabetes | Hxthyroid: Medical History: Thyroid |
| pre\_PROM | Hypertyro: Maternal hyperthyroidism (ICD-9 codes 242) |
| prim\_hypo: Primary hypothyroidism (ICD-9 code 244.9, 244) | Hyp\_ace: Hypertensives: ACE Inhibitors |
| renal\_disease9: maternal chronic disease Renal disease (ICD-9 codes 585, 586, 588, 646.2) | Hyp\_alpha: Hypertensives: Alpha-blockers |
| renal\_disease\_comb: maternal chronic disease: kidney disease | Hyp\_any: Hypertensives: Any medication |
| Rhincompat: Prenatal History: Rh incompatability | Hyp\_beta: Hypertensives: Beta-blockers |
| Smoke: Prenatal History: Smoking during  pregnancy | Hyp\_calc: Hypertensives: Calcium Channel  Blockers |
| no\_TD: Maternal ICD-9 collection: No thyroid disease | Hyp\_clon: Hypertensives: Clonidine (Catapres) |
| ThreatenedPB: Prenatal History: Threatened preterm birth | Hyp\_hydr: Hypertensives: Hydralazine |
| threatpb9: Threatened preterm birth (ICD-9 code 644.0) | Hyp\_meth: Hypertensives: Methyldopa (Aldomet) |
| UnspecHBP: Prenatal History: Unspecified hypertension | Hyp\_othr: Hypertensives: Others |
| Uscar: Derived variable: previous uterine scar | iatro\_hypo: Maternal iatrogenic hypothyroidism (ICD-9 codes 243, 244.0-244.3) |
| version9: Successful external version of malpresentation (ICD-9 code 652.1) | ImposedPE: Pre/eclampsia superimposed on hypertension |
|  | Incompetence: Prenatal History: Cervical incompetence |
|  | Induction: Labor and Delivery summary: Labor induction |
|  | Ind\_anomaly: Indication for labor induction: Fetal anomaly |
|  | Ind\_Chorio: Indication for labor induction: Chorioamnionitis |
|  | Ind\_elect: Indication for labor induction: Elective induction |
|  | Ind\_Fcomp: Indication for labor induction: Fetal  compromise |
|  | Ind\_Fmacro: Indication for labor induction:  Suspected fetal macrosomia |
|  | Ind\_HTN: Indication for labor induction: Maternal  hypertensive disorders |
|  | Ind\_Hxfetal: Indication for labor induction: Previous  history of fetal indications |
|  | Ind\_HxMat: Indication for labor induction: History of  maternal indications |
|  | Ind\_Mcond: Indication for labor induction: Maternal  condition |
|  | Ind\_Postdate: Indication for labor induction:  Postdate (as determined by physician) |
|  | Ind\_Still: Indication for labor induction: Stillbirth |
|  | Ind\_Unkn: Indication for labor induction: Unknown |
|  | Ind\_Vbleed: Indication for labor induction: Vaginal  bleeding |
|  | Inoxy\_incrdose: Institution Oxytocin Increment  dose (mU/min) |
|  | Insurance: Maternal demographic: Insurance type |
|  | Intrachorio: Labor and Delivery summary:  Chroiamnionitis |
|  | Intrafetdistress: Labor and Delivery summary:  Intrapartum fetal distress |
|  | Intrafever: Labor and Delivery summary: Fever |
|  | IntraMgSO: Labor and Delivery summary:  magnesium sulfate |
|  | Intratocolytix: Labor and Delivery summary: Intra  tocolytics |
|  | intra\_abruptio |
|  | intra\_previa |
|  | iufd9: Intrauterine fetal death (ICD-9 code 656.4) |
|  | IUPC: Labor and Delivery summary: IUPC |
|  | Lac\_Cerv: Lacerations: Cervical |
|  | Lac\_Majoth: Lacerations: Other Major (Sulcus,  Vaginal wall) |
|  | Lac\_Majperi: Lacerations: Major Perineal (3rd and  4th degree) |
|  | Lac\_Min: Lacerations: Minor (perineal 1st/2nd  degres,labial, periurethral,clitoral,abrasion) |
|  | Lac\_None: Lacerations: None |
|  | Lac\_Other: Lacerations: Other |
|  | Malpresentation9: Other malpresentation of the  fetus (ICD-9 codes 652, 652.3- 652.9) |
|  | Marital: Maternal demographic: Marital status |
|  | Meconium: Labor and Delivery summary:  Meconium stain |
|  | momrace\_new: Maternal race, some missing data  replaced with data from repeat pregnancies |
|  | Momseizure: Labor and Delivery summary:  maternal seizure |
|  | MthInd\_AROM: Method of induction: Amniotomy/  AROM |
|  | MthInd\_Mec: Method of induction: Mechanical |
|  | MthInd\_Miso: Method of induction: Cytotec/  Misoprostol/PGE1 |
|  | MthInd\_Oxy: Method of induction: Oxytocin/Pitocin |
|  | MthInd\_PGE2: Method of induction: Other  prostaglandins |
|  | M\_pre: Mild preeclampsia |
|  | no\_TD: No thyroid disease |
|  | Oligo: Prenatal History: Oligohydramnios |
|  | Operative: Labor and Delivery summary: Operative delivery |
|  | other\_TD: Other thyroid diseases (ICD-9 codes 240, 241, 193, 226, 245, 246) |
|  | Parity: Reproductive history: Parity |
|  | Polyhydramnios: Prenatal History: Polyhydramnios |
|  | PostHBP: Maternal Postpartum: HTN/  preeclampsia |
|  | Preeclampsia: Prenatal History: Preeclampsia/HELLP |
|  | prelaborCD: Derived variable from chart: Prelabor cesarean section |
|  | Presentdel: Labor and Delivery summary: Fetal  Presentation at Delivery |
|  | pre\_diab: Derived variable: maternal diabetes |
|  | pre\_PROM |
|  | prim\_hypo: Primary hypothyroidism (ICD-9 code 244.9, 244) |
|  | Prolapse: Labor and Delivery summary: Cord prolapse |
|  | renal\_disease9: maternal chronic disease Renal disease (ICD-9 codes 585, 586, 588, 646.2) |
|  | renal\_disease\_comb: maternal chronic disease: kidney disease |
|  | Rhincompat: Prenatal History: Rh incompatability |
|  | ROM: PROM, exclusive of spontaneous labor |
|  | ROMmeth: Labor and Delivery summary: Method of ROM |
|  | SE\_pre: Superimposed preeclampsia |
|  | Shoulder: Labor and Delivery summary: Shoulder  dystocia |
|  | Smoke: Prenatal History: Smoking during  pregnancy |
|  | Spontlabor: Spontaneous labor |
|  | TD\_nos: Unspecified thyroid disease during pregnancy |
|  | ThreatenedPB: Threatened preterm birth |
|  | threatpb9: Threatened preterm birth (ICD-9 code 644.0) |
|  | TrialLabor: Trial of Labor (defined as Vag  deliveries or C-Section with 2 records in repeated  measures database) |
|  | UnspecHBP: Prenatal History: Unspecified  hypertension |
|  | Urupture: Labor and Delivery summary: uterine rupture |
|  | Uscar: Derived variable: previous uterine scar |
|  | version9: Successful external version of malpresentation (ICD-9 code 652.1) |
|  | Vertex: Derived variable from chart: vertex  presentation |

|  |  |  |
| --- | --- | --- |
| Supplemental Table 2. Overall Patient Characteristics | | |
| **Characteristics** | **Number** | **Percentage** |
| ***Mode of Delivery*** | | |
| Vaginal | 117640 | 63.4 |
| Vaginal-assisted | 9126 | 4.9 |
| VBAC | 4364 | 2.4 |
| Cesarean | 32991 | 17.8 |
| Cesarean-repeat | 21292 | 11.5 |
| ***Maternal Race*** | | |
| Non-Hispanic White | 90466 | 48.8 |
| Non-Hispanic Black | 41780 | 22.5 |
| Hispanic | 32727 | 17.7 |
| Asian/ Pacific Islander | 7719 | 4.2 |
| Multi-racial | 316 | 0.2 |
| Other Race | 12405 | 6.7 |
| ***Age (year)*** |  |  |
| <20 | 17242 | 9.3 |
| 20- 40 | 162006 | 87.4 |
| 40- 45 | 5972 | 3.2 |
| >45 | 193 | 0.1 |
| ***BMI*** |  |  |
| <=20 | 19325 | 10.4 |
| 20-40 | 161785 | 87.3 |
| 40-50 | 3675 | 2.0 |
| >50 | 628 | 0.3 |
| ***Education*** |  |  |
| Less than High School Diploma | 12014 | 6.5 |
| High School Diploma | 18709 | 10.1 |
| More than High School Diploma | 29647 | 16.0 |
| Unknown | 125043 | 67.4 |
| ***Insurance*** |  |  |
| Public | 101657 | 54.83 |
| Private | 60193 | 32.46 |
| Hospital | 2276 | 1.23 |
| Other/ Unknown | 21287 | 11.49 |
| ***Parity***  Mean (SD)  Median (IQR) | * 1. (0.066)   1 (0,2) |  |

Supplemental Table 3 a-b. Performance of machine learning and statistical models. A. Model included antepartum maternal features predicting transfusion and/or postpartum hemorrhage. B. Model included antepartum maternal features predicting transfusion of any blood products only.

Appendix 3a. Pre/Trans Loss

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Alg** | **NTP** | **NFN** | **NFP** | **NTN** | **precision** | **recall** | **specificity** | **ROC\_AUC** | **PR\_AUC** | **MCC** | **F2** |
| GB | 44 | 12 | 319 | 625 | 0.121 | 0.787 | 0.662 | 0.786 | 0.176 | 0.214 | 0.374 |
| RF | 44 | 12 | 338 | 606 | 0.116 | 0.793 | 0.642 | 0.777 | 0.163 | 0.206 | 0.365 |
| Emb | 43 | 13 | 319 | 625 | 0.119 | 0.773 | 0.662 | 0.778 | 0.158 | 0.207 | 0.368 |
| MLP | 41 | 15 | 299 | 645 | 0.121 | 0.739 | 0.683 | 0.771 | 0.164 | 0.204 | 0.366 |
| TFIM | 39 | 17 | 279 | 665 | 0.122 | 0.692 | 0.705 | 0.762 | 0.155 | 0.195 | 0.357 |
| SVC | 42 | 14 | 342 | 602 | 0.110 | 0.757 | 0.638 | 0.750 | 0.142 | 0.186 | 0.348 |
| LR | 41 | 15 | 324 | 620 | 0.112 | 0.735 | 0.657 | 0.754 | 0.149 | 0.187 | 0.349 |

Appendix 3b. Pre/ Trans\_yes

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Alg** | **NTP** | **NFN** | **NFP** | **NTN** | **precision** | **recall** | **specificity** | **ROC\_AUC** | **PR\_AUC** | **MCC** | **F2** |
| GB | 24 | 4 | 247 | 725 | 0.090 | 0.874 | 0.746 | 0.859 | 0.110 | 0.230 | 0.319 |
| RF | 24 | 4 | 238 | 734 | 0.092 | 0.865 | 0.755 | 0.857 | 0.106 | 0.232 | 0.323 |
| Emb | 23 | 5 | 232 | 741 | 0.994 | 0.762 | 0.762 | 0.848 | 0.104 | 0.224 | 0.316 |
| MLP | 22 | 5 | 216 | 757 | 0.094 | 0.805 | 0.778 | 0.852 | 0.109 | 0.226 | 0.321 |
| TFIM | 22 | 6 | 226 | 746 | 0.089 | 0.795 | 0.767 | 0.842 | 0.107 | 0.214 | 0.308 |
| SVC | 22 | 5 | 252 | 720 | 0.082 | 0.803 | 0.741 | 0.824 | 0.094 | 0.201 | 0.290 |
| LR | 22 | 6 | 246 | 727 | 0.084 | 0.802 | 0.747 | 0.828 | 0.096 | 0.204 | 0.295 |

\*Alg=algorithm, NTP=normalized true positive, NFN=normalized false negative, NFP=normalized false positive, NTN=normalized true negative, ROC\_AUC (receiver operator curve\_area under the curve; 0.5 was considered no better than chance, greater than 0.5 to less than 0.7 poor, 0.7 to less than 0.8 acceptable, 0.8 to less than 0.9 excellent, 0.9 or greater outstanding), PR\_AUC (precision recall\_area under the curve), MCC=Matthews correlation coefficient, F2= modified F-score skewed towards recall)