

Supplementary Materials

Supplementary Table 1. Hyperparameters for all models.

Machine learning method	Hyperparameters
LR	'penalty': ['l1', 'l2', 'none'], 'class_weight': ['balanced', None]
MLP	'activation': 'relu', 'solver': 'sgd', 'hidden_layer_sizes': (100, 200), 'alpha': [0.0001, 0.01], 'epsilon': [1e-08, 0.0001, 0.001, 0.01, 0.1], 'max_iter': [100, 200, 500]
RF	'max_depth': [10, 20, 50, 100], 'class_weight': 'balanced' 'min_samples_split': [2, 5, 10], 'n_estimators': [10, 100, 500, 1000]
SVM	'C': [0.1, 1.0], 'class_weight': 'balanced' 'l1_ratio': [0, 0.1, 0.5, 1, None], 'max_iter': [100, 300, 500], 'penalty': ['l1', 'l2', 'elasticnet', 'none']
XG Boost	'n_estimators': [100, 500, 1000] 'learning_rate': [0.01, 0.1] 'max_depth': [2, 5], 'reg_lambda': [0.01, 0.1, 1, 5], 'gamma': [0.2, 0.3], 'colsample_bytree': [0.3, 0.5] 'scale_pos_weight': [5, 10, 1/prevalence]

LR: Logistic regression

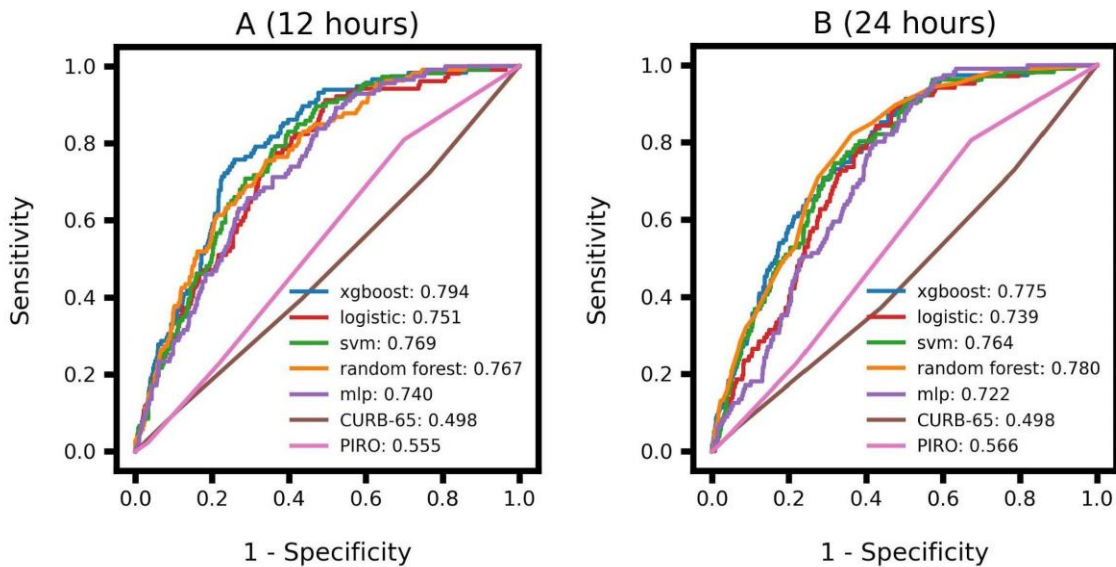
MLP: Multilayer perceptron

RF: Random forest

SVM: Support vector machine

Supplementary Table 2. Comorbidities in the intubation task population.

	Characteristic	VAP Pos n = 524	VAP Neg n = 5602
Comorbidity	Intracranial Hemorrhage	34 (6.49%)	138 (2.46%)
	Sepsis	11 (2.1%)	144 (2.57%)
	Congestive Heart Failure	8 (1.53%)	128 (2.28%)
	Subarachnoid Hemorrhage	14 (2.67%)	57 (1.02%)
	Respiratory Failure	10 (1.91%)	47 (0.84%)
	Fever	5 (0.95%)	49 (0.87%)
	Respiratory Distress	2 (0.38%)	38 (0.68%)
	Shortness of Breath	2 (0.38%)	28 (0.5%)
	Renal Failure	1 (0.19%)	8 (0.14%)
	Cirrhosis	0 (0%)	6 (0.11%)
	Bacteremia	0 (0%)	3 (0.05%)



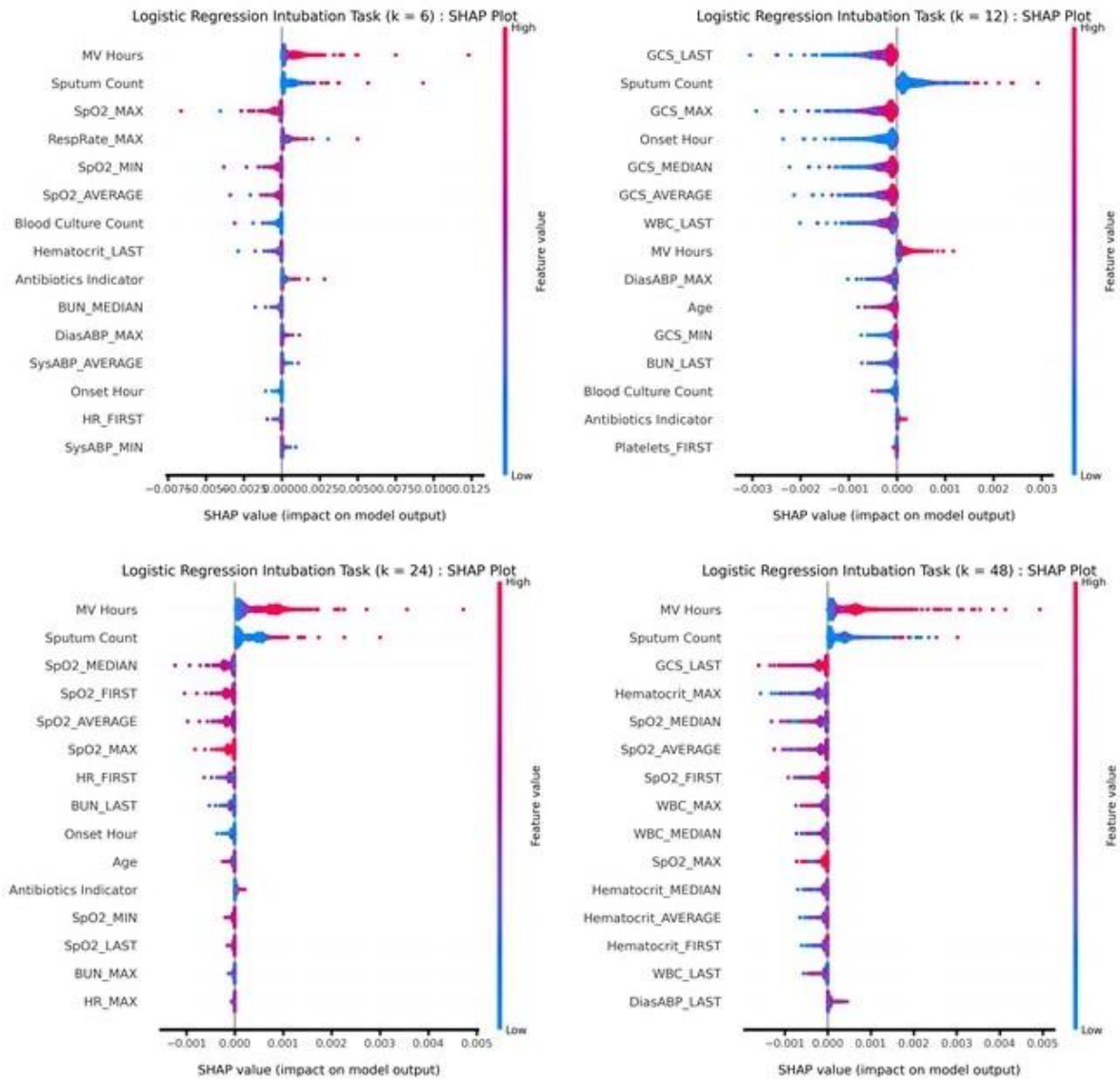
Supplementary Figure 1. ROC curve comparison for intubation task models, with summary statistics calculated from the 12 (A) and 24 (B) hours of data preceding the time of prediction.

Supplementary Table 3: Figure legend interpretation for SHAP plots.

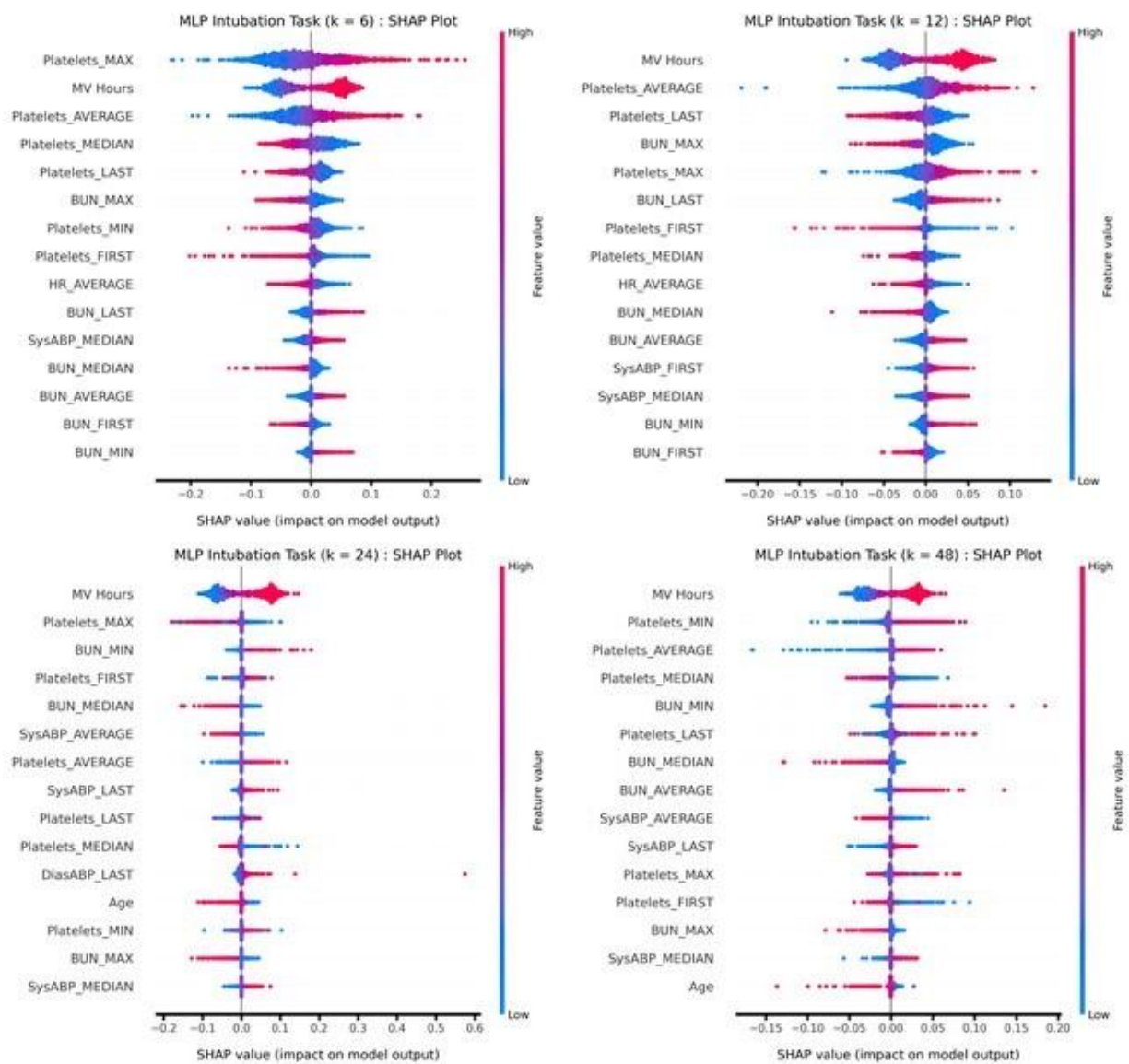
	Figure Legend	Interpretation
Feature summary statistics	AVERAGE	The mean value for a given feature recorded over the data collection window
	FIRST	The first value for a given feature recorded during the data collection window
	LAST	The last value for a given feature collected before VAP predictions were generated
	MAX	The maximum value for a given feature recorded over the data collection window
	MEDIAN	The median value for a given feature recorded over the data collection window
	MIN	The minimum value for a given feature recorded over the data collection window
Features	Age	Patient age

	BUN	Blood Urea Nitrogen
	Creatinine	Creatinine measure
	DiasABP	Diastolic Arterial Blood Pressure
	GCS	Glasgow Coma Scale
	Hematocrit	Hematocrit measure
	HR	Heart Rate
	MV Hours	Total number of hours the patient had been mechanically ventilated at prediction time
	Onset Hour	The hour in the patient's stay at which VAP onset is first possible
	Platelets	Platelet count
	RespRate	Respiratory Rate
	SpO2	Peripheral oxygen saturation (SpO ₂)
	SysABP	Systolic Arterial Blood Pressure
	Temp	Patient temperature
	Urine	Urine output measurement
	WBC	White Blood Cell (WBC) count
Indicator and Count Features	Antibiotics Indicator	Indicator variable (Yes/No) for whether the patient had received antibiotics during their stay
	ARDS indicator	Indicator variable (Yes/No) for whether the patient had received a diagnosis of acute respiratory distress syndrome (ARDS) by prediction time
	Blood culture count	The count of the total number of blood

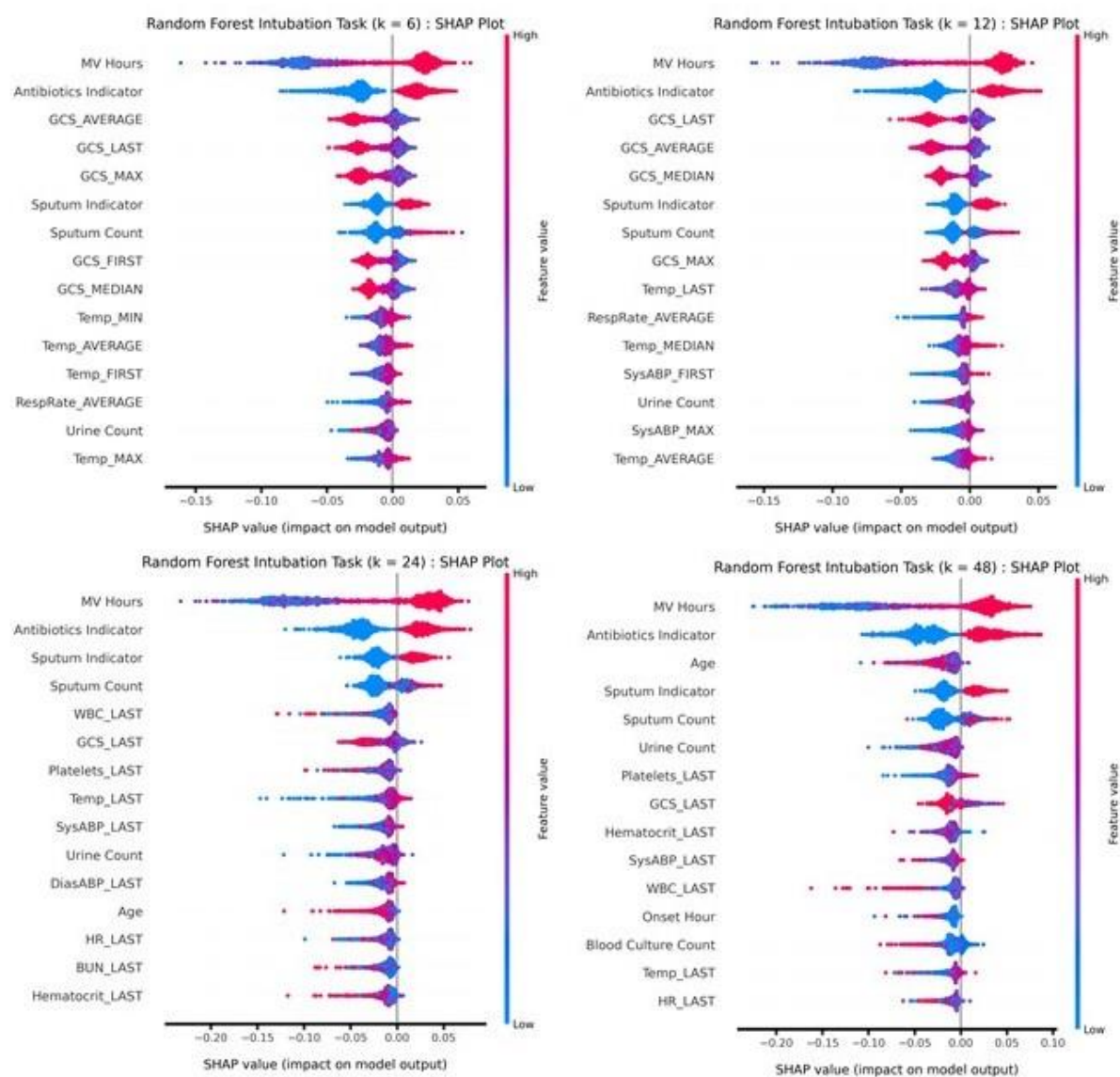
		cultures ordered by prediction time
	Blood culture indicator	Indicator variable (Yes/No) for whether any blood culture orders had been placed by prediction time
	Comorbidity Indicator	Indicator variable (Yes/No) for whether the patient had any of the following comorbidities: cirrhosis, congestive heart failure, fever, bacteremia, intracranial hemorrhage, renal failure, respiratory distress, respiratory failure, sepsis, subarachnoid hemorrhage, shortness of breath
	Sputum Count	The count of the total number of sputum cultures ordered by prediction time
	Sputum Indicator	Indicator variable (Yes/No) for whether any sputum culture orders had been placed by prediction time



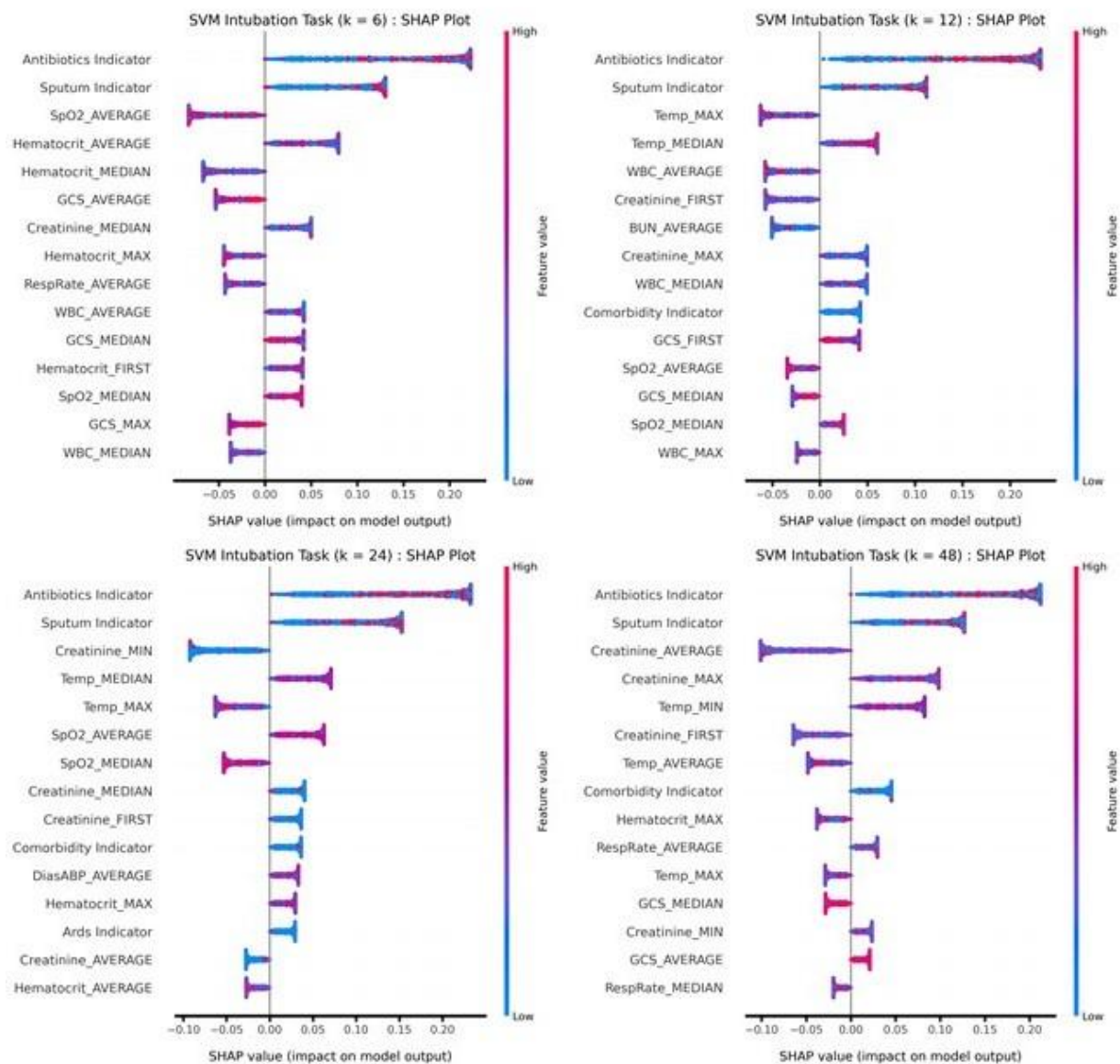
Supplementary Figure 2: Logistic Regression Intubation Task feature importance



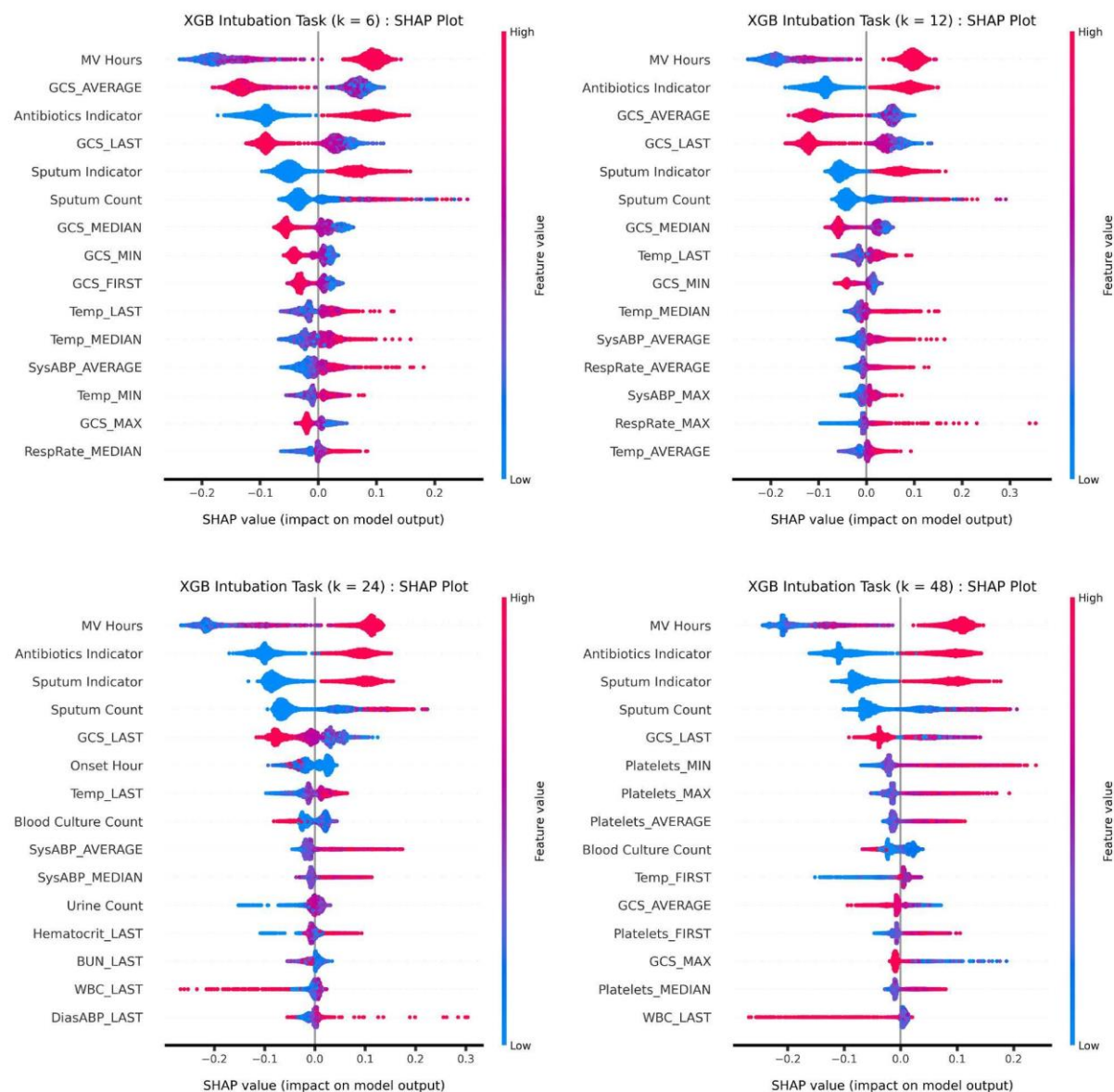
Supplementary Figure 3: MLP Intubation Task feature importance



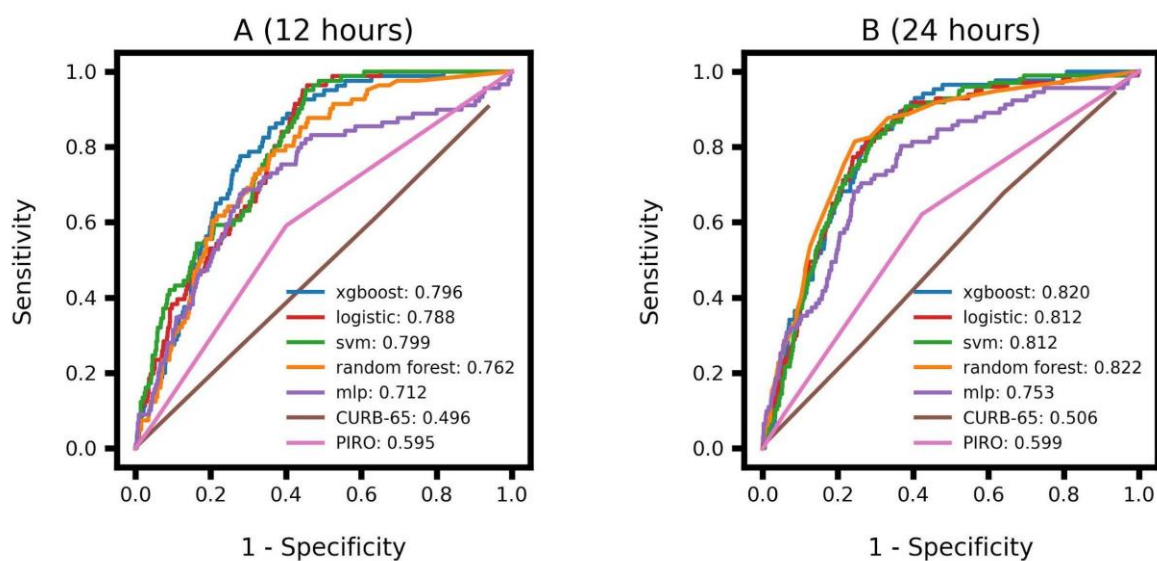
Supplementary Figure 4: Random Forest Intubation Task feature importance



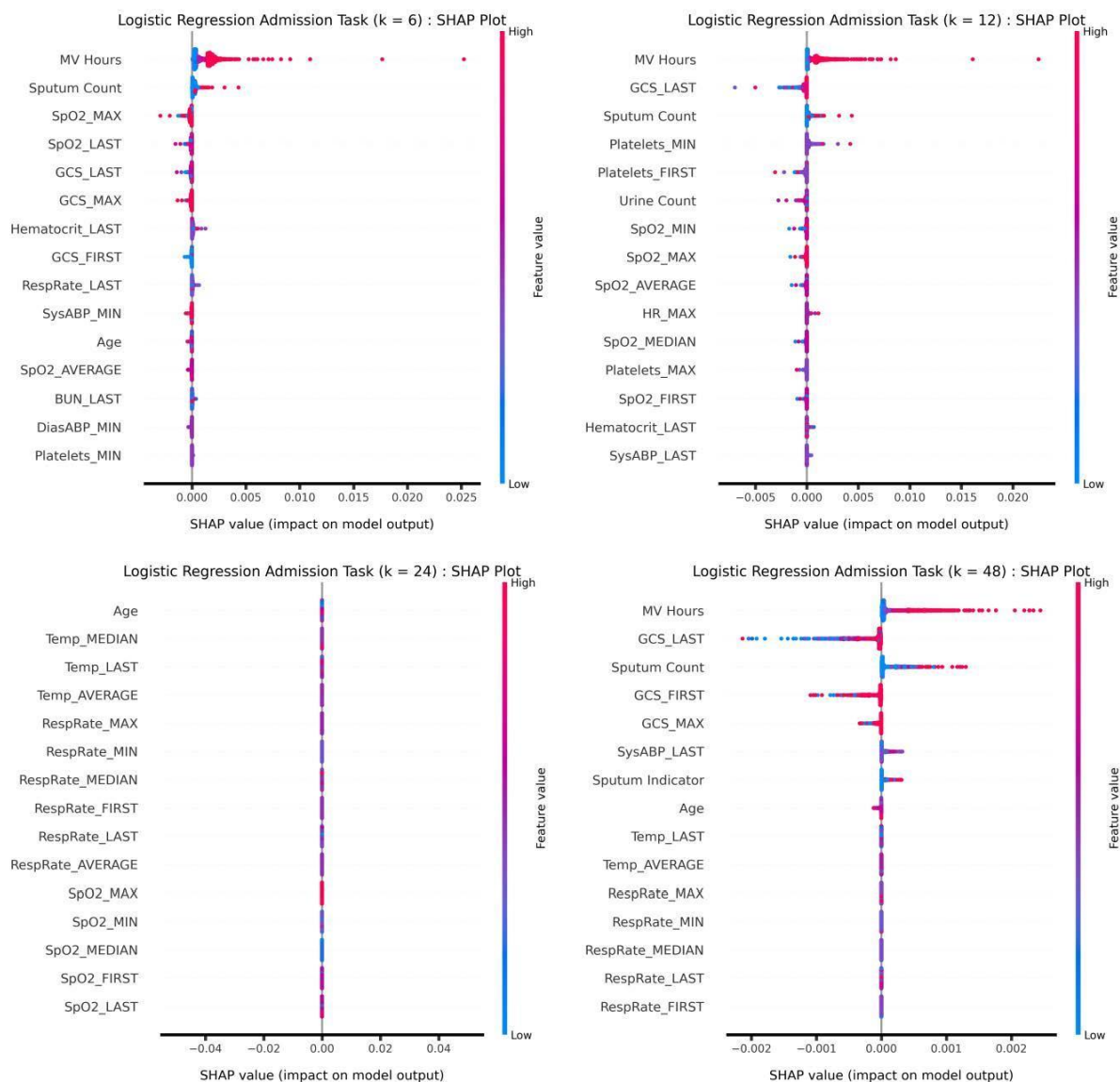
Supplementary Figure 5: SVM Intubation Task feature importance



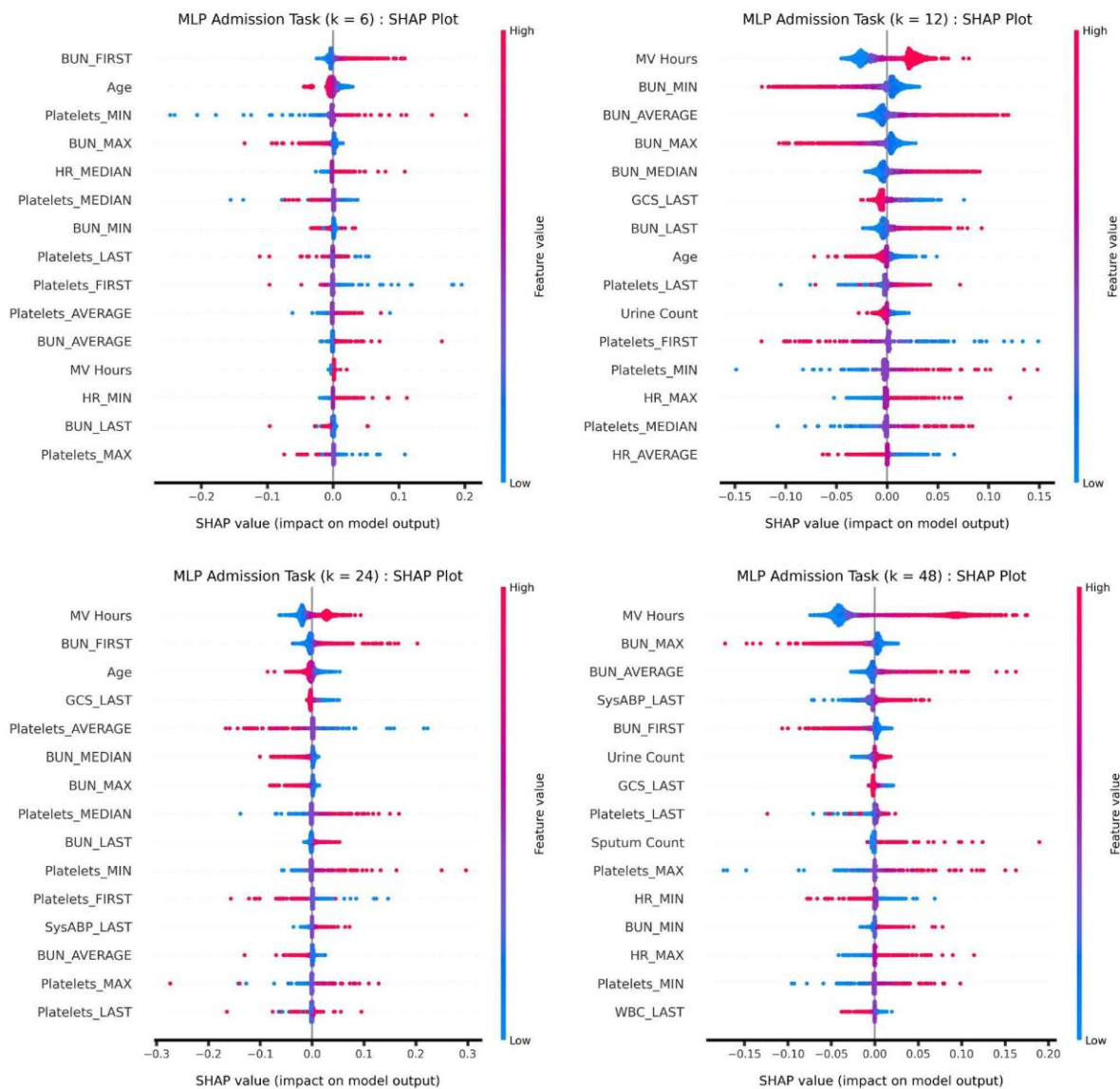
Supplementary Figure 6: XGBOOST Intubation Task feature importance



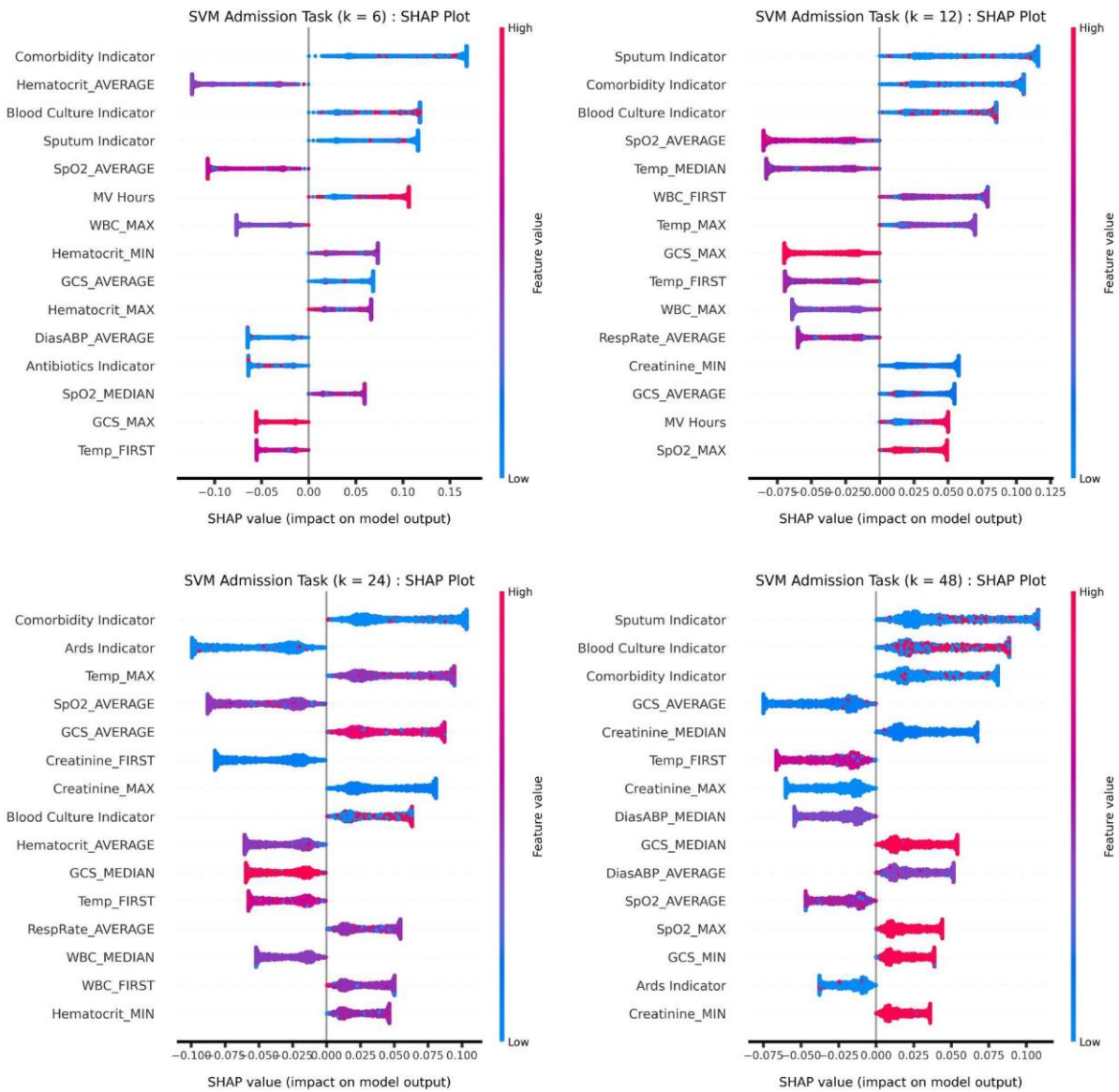
Supplementary Figure 7. ROC curve comparison for admission task models, with summary statistics calculated from the 12 (A) and 24 (B) hours of data preceding the time of prediction.



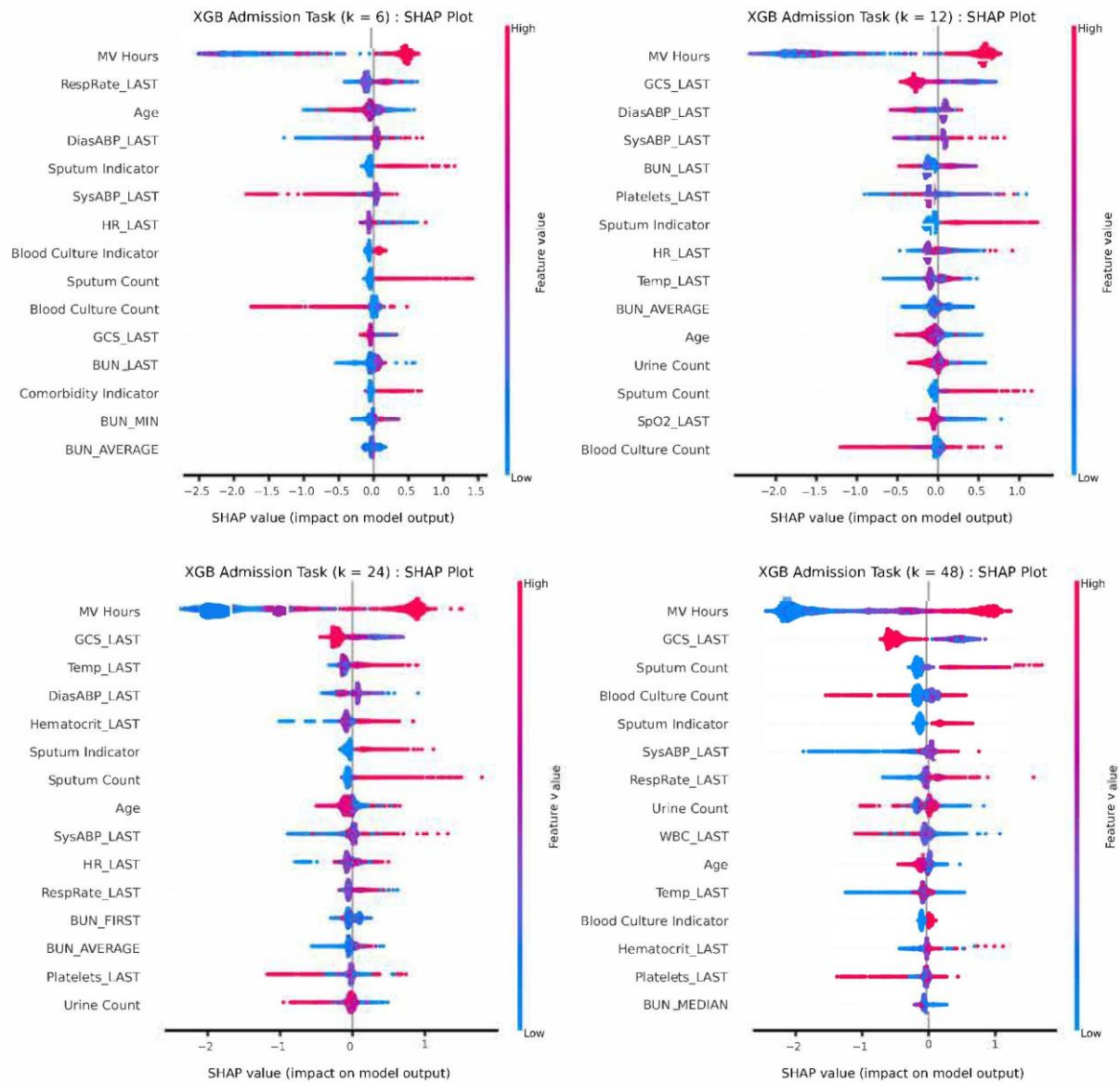
Supplementary Figure 8: Logistic Regression Admission Task feature importance



Supplementary Figure 9: MLP Admission Task feature importance



Supplementary Figure 11: SVM Admission Task feature importance



Supplementary Figure 12: XGBOOST Admission Task feature importance