Evaluating machine learning models in predicting mortality risk among geriatric hip fracture patients

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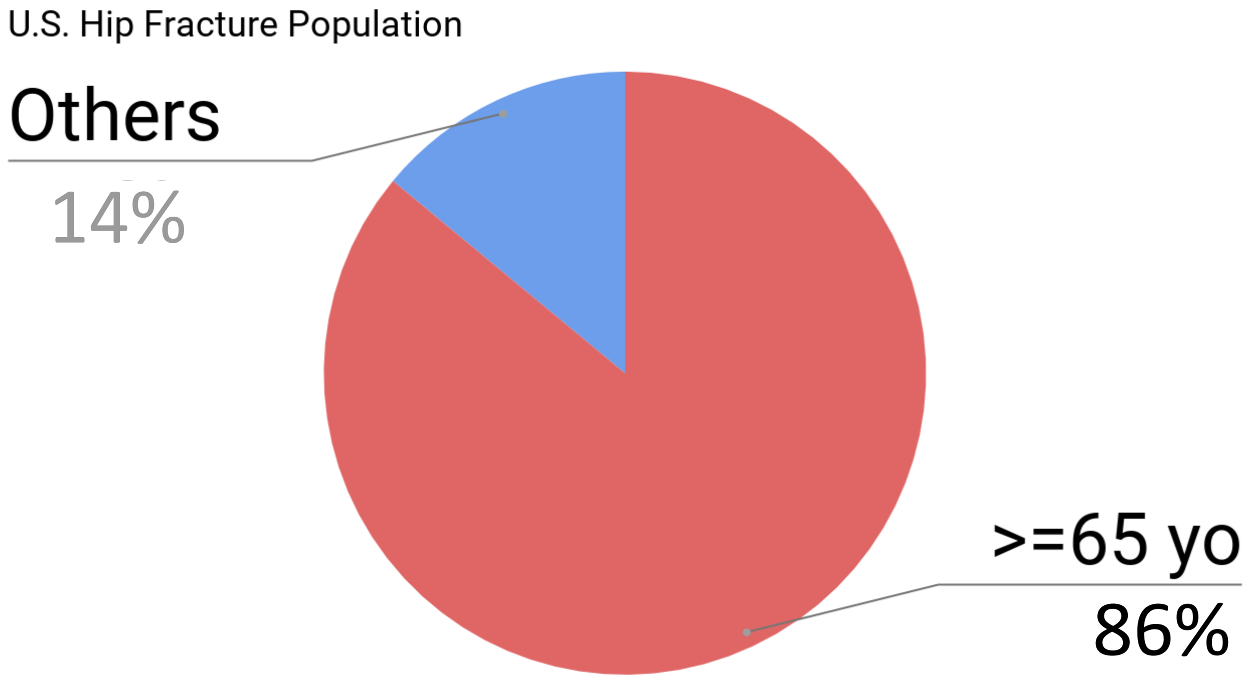
Hip Fracture Population

> 300,000 hip fractures hospitalizations annually



~25% 1 year mortality

Palliative Care Programs

Improve quality of life

Pain, symptom management

Psychosocial, spiritual concerns

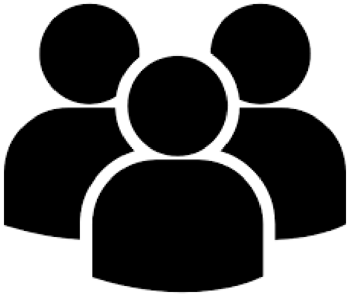
Workforce shortages

Difficult to implement at scale

For advance stage of disease

Existing Literature

Logistic Regression



Research Aim

Machine learning models:
- Logistic Regression
- Multilayer perceptron

Predict 30-day and 1-year mortality

Hip fracture patients

Inpatient rehabilitation facilities (IRFs)

2015 Medicare data

Functional status, comorbid conditions, utilization

Inclusion & Exclusion

Inclusion Criteria	Exclusion criteria
1. Medicare 2. >= 65 years old 3. discharged from acute care hospital 4. lived at home	1. Patient assessment >3 days after admission 2. Admitted >30 days after hip fracture 3. Delirious 4. Died during rehabilitation period

Features

Demographic factors	**Clinical factors**	**Utilization**
Race	Functional status	Length of stay
Ethnicity	Chronic conditions	
Sex		
Social support		

Outcome

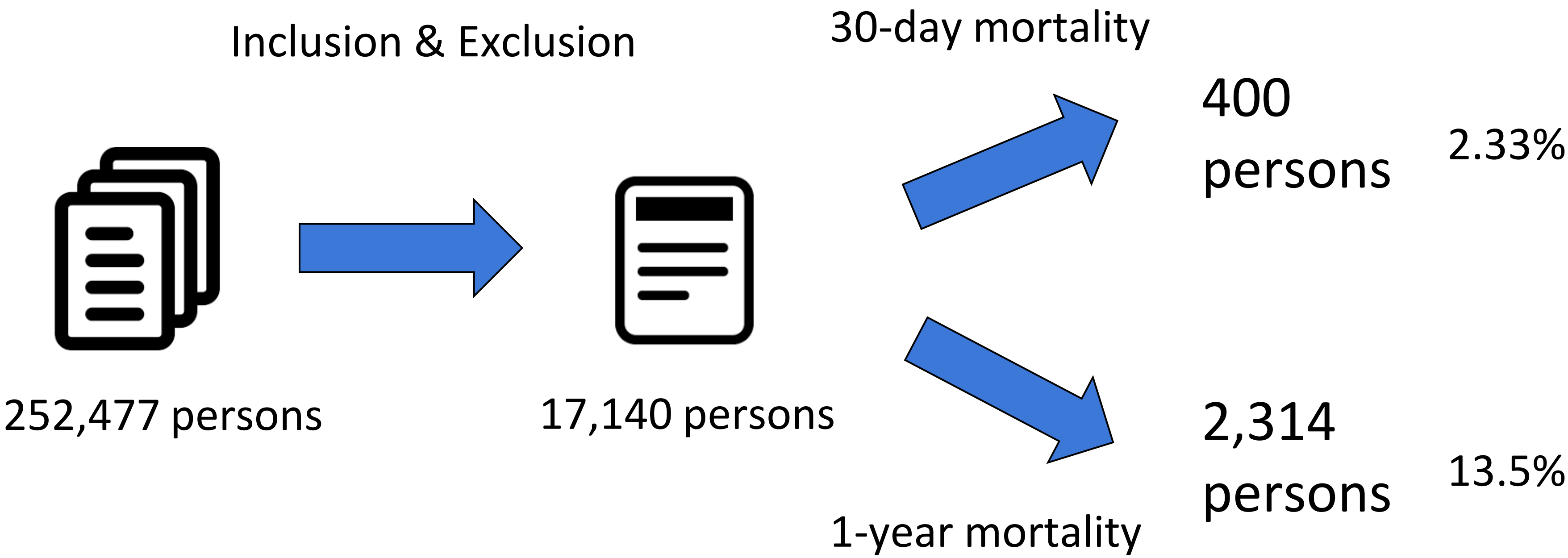
Post IRF

Death

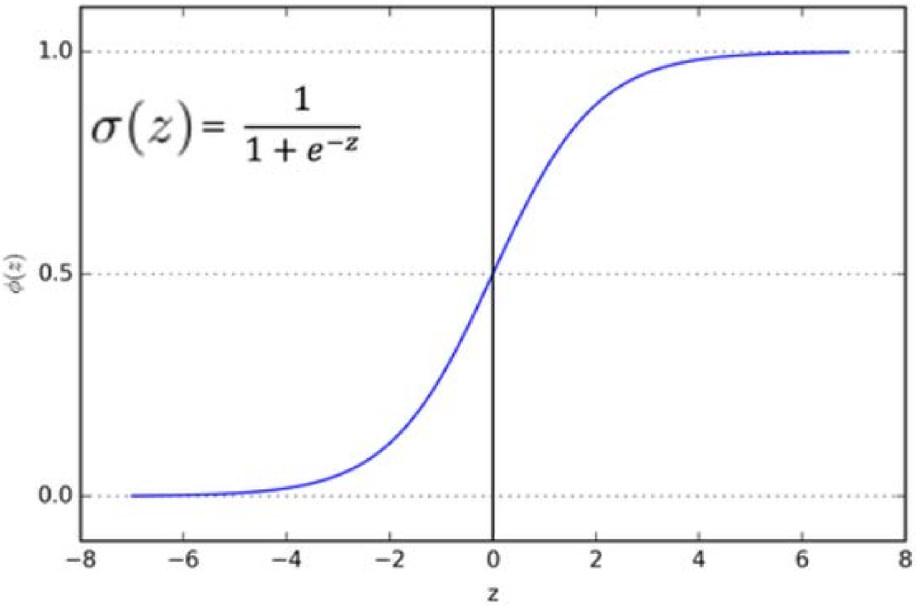
30 days

1 year

Data Summary



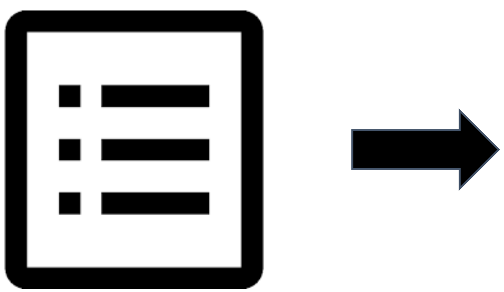
Logistic Regression

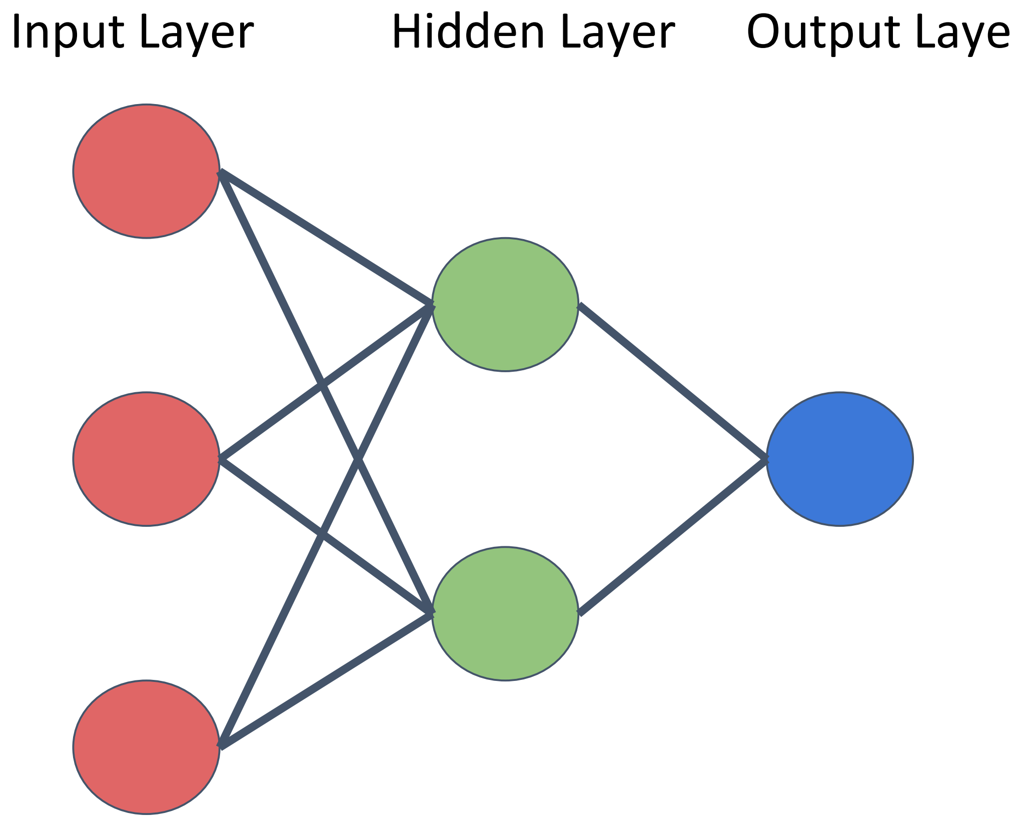


Regularization techniques (L1 and L2)

Regularization strengths (parameter C)

Multilayer Perceptron (MLP)





Hyperparameters:

Layers

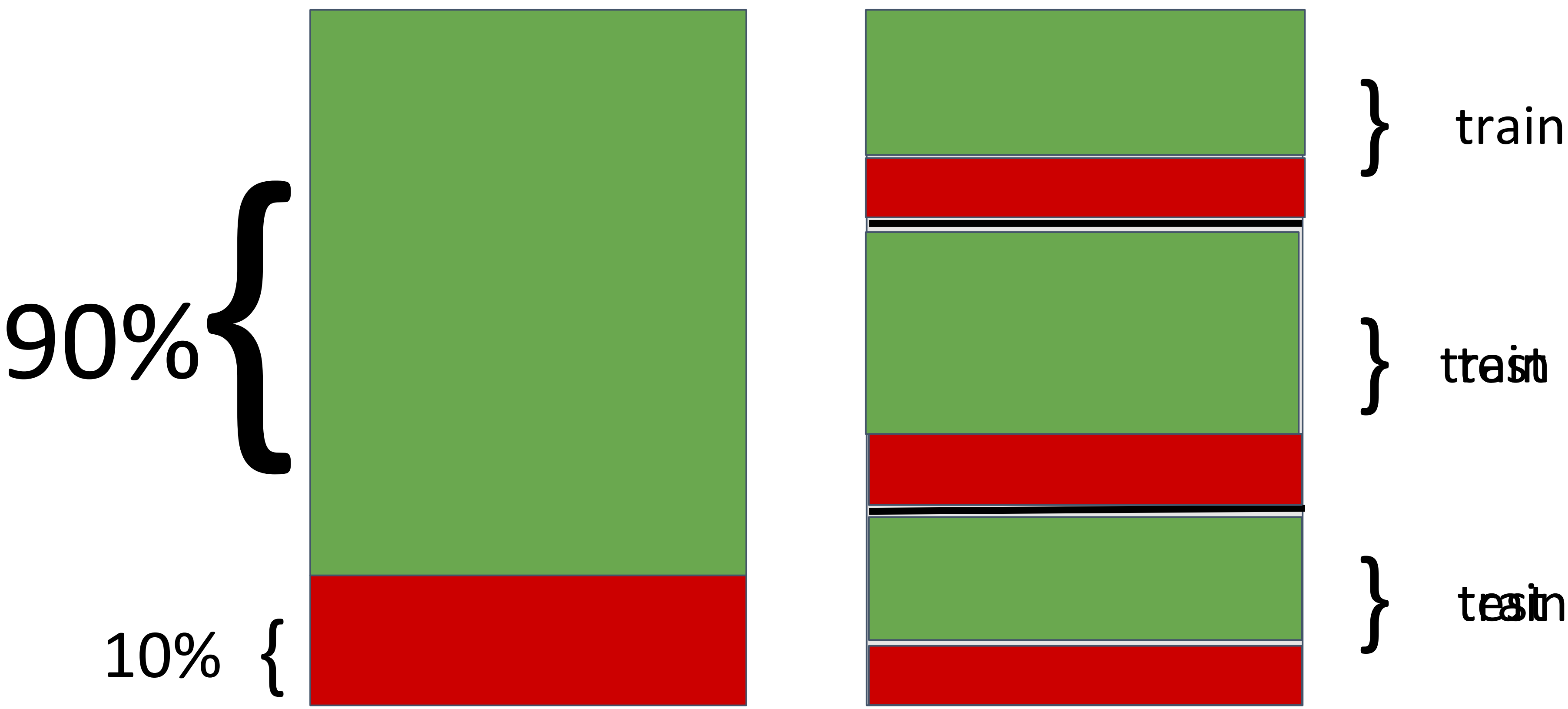
Learning rate

Number of epochs

Size of ensembles

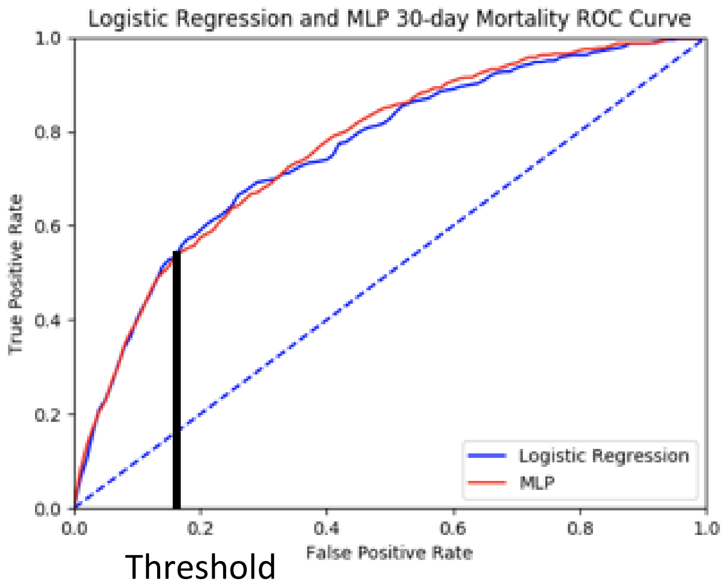
Dropout rates

Stratified 10-Fold Cross Validation



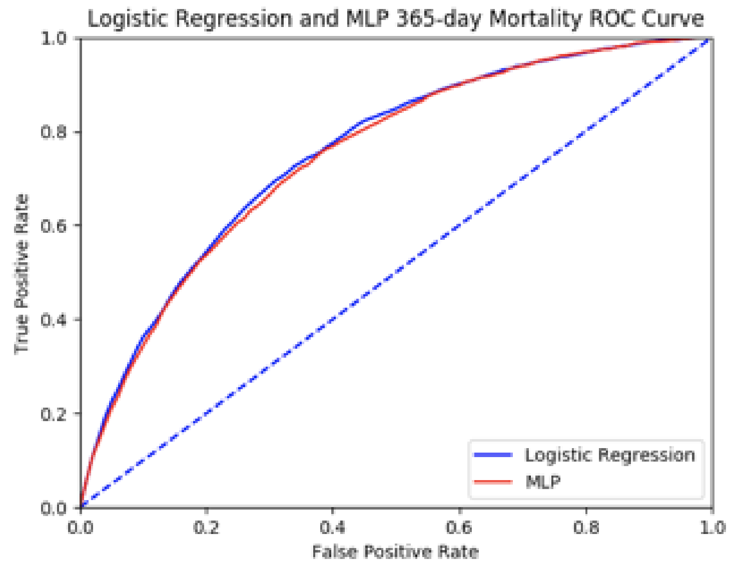
ROC Curves

30-day Mortality



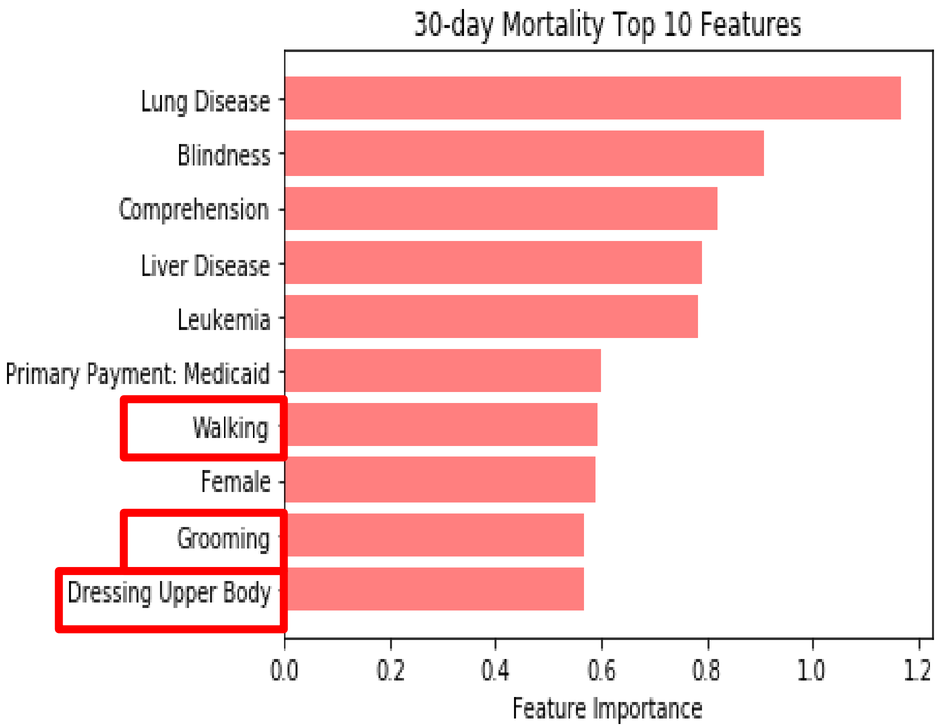
	Accuracy	AUROC
Log Reg	0.78	0.76
MLP	0.728	0.765

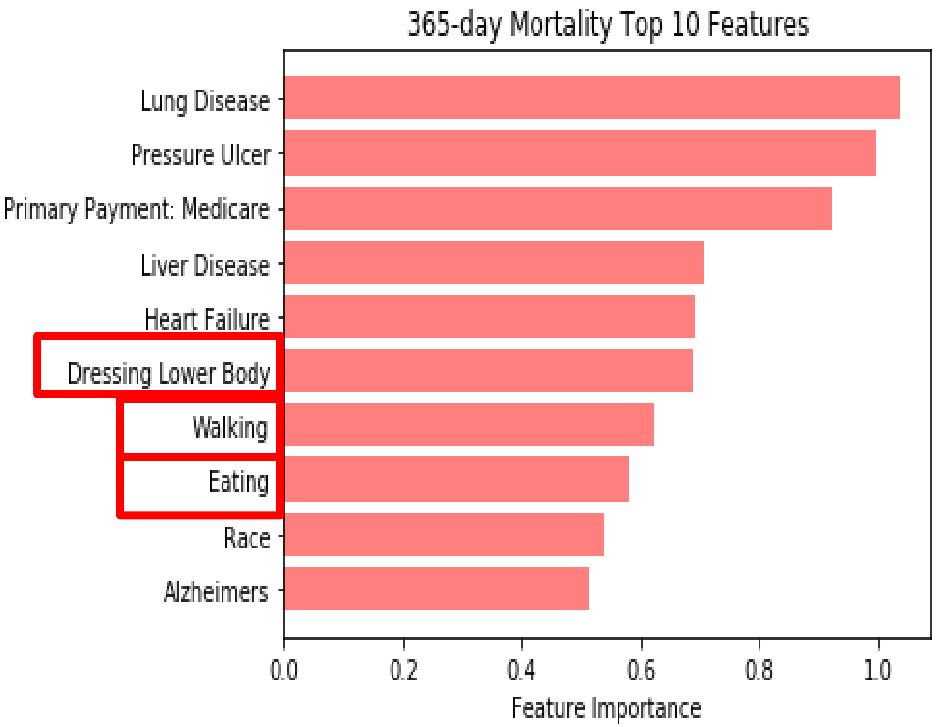
1-year Mortality



	Accuracy	AUROC
Log Reg	0.684	0.756
MLP	0.681	0.758

Feature Importance





Conclusion

Logistic regression vs MLP

Largest older adult population in the U.S

Flexibility of machine learning

Uncaptured post-acute care and post-discharge services

Data lacks laboratory results and socio-behavioral information

Acknowledgements

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Thank you!

Backup slides

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Why IRF?

1. patients have a complex care regimen

1. challenging transitions after discharge

1. clinicians within IRFs are required to routinely document functional status using a valid instrument, the Functional Independence Measure (FIM®)

Data Sources

2015 data

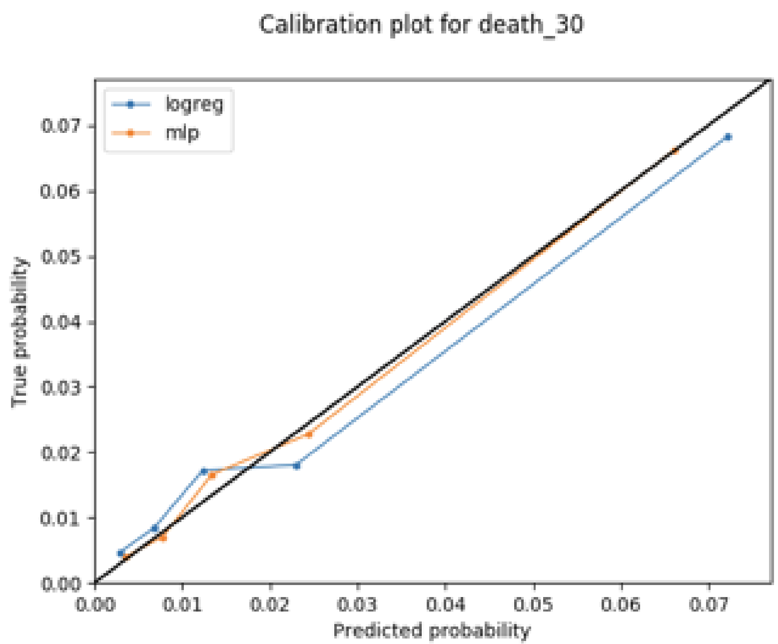
Inpatient Rehabilitation Facility - Patient Assessment Instrument (IRF-PAI)

Medicare Provider Analysis and Review (MedPAR)

Master Beneficiary Summary files

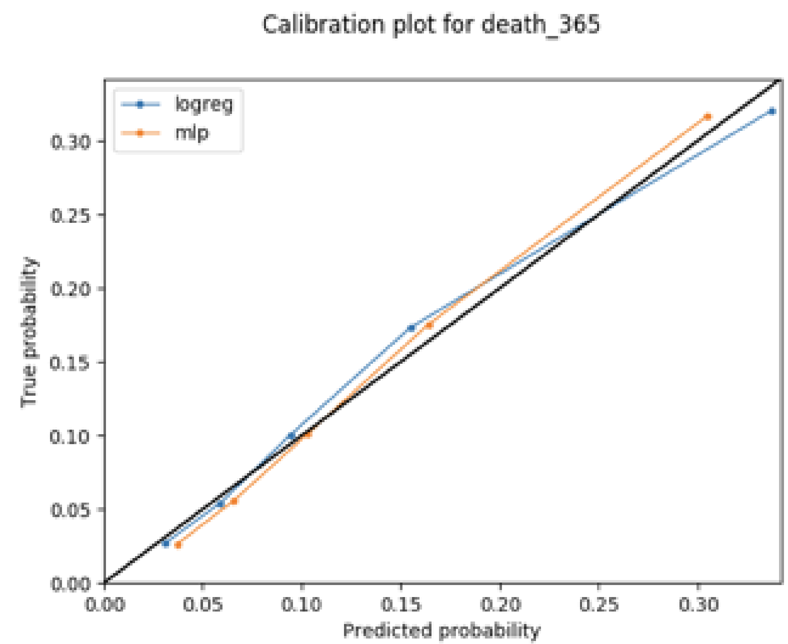
Calibration Plots

30-day Mortality



	Slope
Log Reg	1.20
MLP	1.14

1-year Mortality



	Slope
Log Reg	0.957
MLP	0.962

Results

30-day Mortality

	Learning rate	Acc	AUC	Avg_ Prec	MCC	PPV	NPV	TPR+ TNR	TPR	TNR	Threshold
Log reg	1	0.78	0.76	0.097	0.164	0.071	0.99	1.443	0.66	0.783	0.03
MLP	0.001	0.728	0.765	0.101	0.154	0.062	0.991	1.453	0.725	0.728	0.025

Best logistic regression model: C = 1, Penalty = L1

Best MLP model: Ensemble = 5, epoch = 33, layer = [30,20,1]

1-year Mortality

	Learning rate	Acc	AUC	Avg_ Prec	MCC	PPV	NPV	TPR+ TNR	TPR	TNR	Threshol d
Log reg	1	0.684	0.756	0.326	0.291	0.266	0.942	1.406	0.729	0.677	0.126
MLP	1.0	0.681	0.758	0.327	0.293	0.263	0.944	1.415	0.743	0.672	0.127

Best logistic regression model: C = 1, Penalty = L1

Best MLP model: Ensemble = 5, Epoch = 15, MLP Layer = [30,20,1]