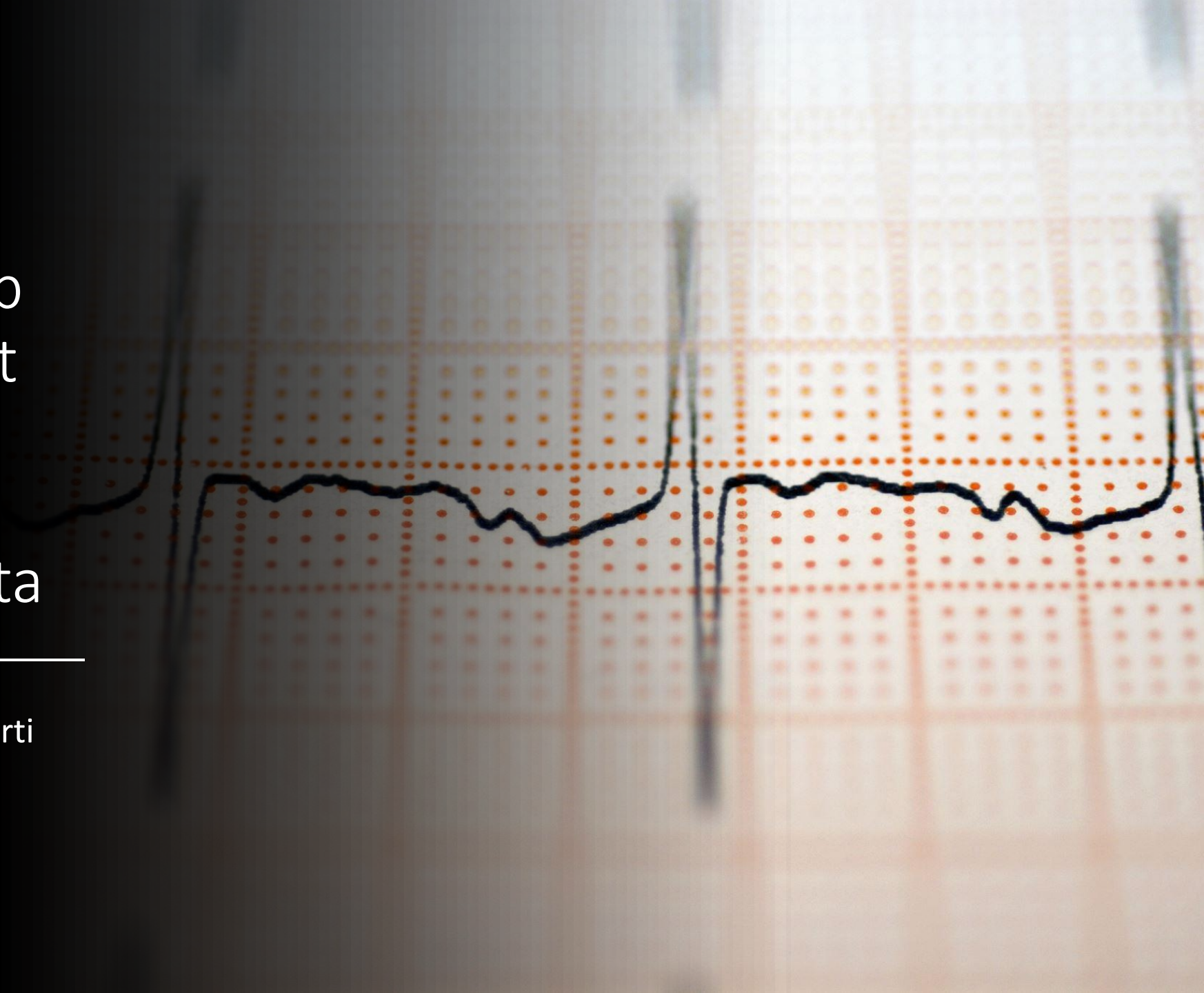
Reproducing Deep Learning for Heart Failure Onset Prediction Using Temporal EHR Data

A Reproduction Study - Shiv Bharti



Importance of Early Detection

Heart failure affects millions worldwide

Early detection is crucial for effective treatment

EHRs provide a rich data source for predictive models

Objective of the Original Paper

- Explore the use of deep learning for modeling temporal relations among events in EHRs
- Compare the performance of RNN models to conventional methods for predicting heart failure onset

Scope of Reproducibility

- Re-implement the original study's methodology
- Validate results by comparing RNN models to conventional methods
- Focus on 12- and 18-month observation windows

Reproduction Results

- **12-month observation window**
- RNN AUC: 0.714
- Logistic Regression AUC: 0.788
- MLP AUC: 0.762
- SVM AUC: 0.850
- KNN AUC: 0.703

- **18-month observation window**
- RNN AUC: 0.784
- Logistic Regression AUC: 0.788
- MLP AUC: 0.754
- SVM AUC: 0.850
- KNN AUC: 0.703

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Edit in VS Code | Compute: sbharti2 - Stopped | No kernel connected

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```python
import os
import numpy as np
import torch
import torch.nn as nn
import torch.optim as optim
from torch.utils.data import DataLoader, Dataset
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.neural_network import MLPClassifier
from sklearn.svm import SVC
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
from sklearn.model_selection import train_test_split
import random
import pickle

# Set seed
seed = 24
random.seed(seed)
np.random.seed(seed)
torch.manual_seed(seed)
os.environ["PYTHONHASHSEED"] = str(seed)

# Define data path
DATA_PATH = "adl://sbharti.azuredatalakestore.net/path/to/DL_HC_RNN-lib/data"

# Load data
pids = pickle.load(open(os.path.join(DATA_PATH, 'train/pids.pkl'), 'rb'))
vids = pickle.load(open(os.path.join(DATA_PATH, 'train/vids.pkl'), 'rb'))
hfs = pickle.load(open(os.path.join(DATA_PATH, 'train/hfs.pkl'), 'rb'))
seqs = pickle.load(open(os.path.join(DATA_PATH, 'train/seqs.pkl'), 'rb'))
types = pickle.load(open(os.path.join(DATA_PATH, 'train/types.pkl'), 'rb'))
rtypes = pickle.load(open(os.path.join(DATA_PATH, 'train/rtypes.pkl'), 'rb'))

input_size = len(types)

def pad_and_encode_sequence(sequence, max_visits, max_seq_length):
    padded_sequence = np.zeros((max_visits, max_seq_length))
    for i, visit in enumerate(sequence[:max_visits]):
```

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Results

```
print(f"Logistic Regression AUC: {aucs_12[1]:.3f}")
print(f"MLP AUC: {aucs_12[2]:.3f}")
print(f"SVM AUC: {aucs_12[3]:.3f}")
print(f"KNN AUC: {aucs_12[4]:.3f}")

aucs_18 = train_and_evaluate_models(train_seqs_18, test_seqs_18, train_hfs_18, test_hfs_18)
print("Results for 18-month observation window:")
print(f"RNN AUC: {aucs_18[0]:.3f}")
print(f"Logistic Regression AUC: {aucs_18[1]:.3f}")
print(f"MLP AUC: {aucs_18[2]:.3f}")
print(f"SVM AUC: {aucs_18[3]:.3f}")
print(f"KNN AUC: {aucs_18[4]:.3f}")
```

```
Results for 12-month observation window:
RNN AUC: 0.714
Logistic Regression AUC: 0.788
MLP AUC: 0.762
SVM AUC: 0.850
KNN AUC: 0.703
Results for 18-month observation window:
RNN AUC: 0.784
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MLP AUC: 0.754
SVM AUC: 0.850
KNN AUC: 0.703
```

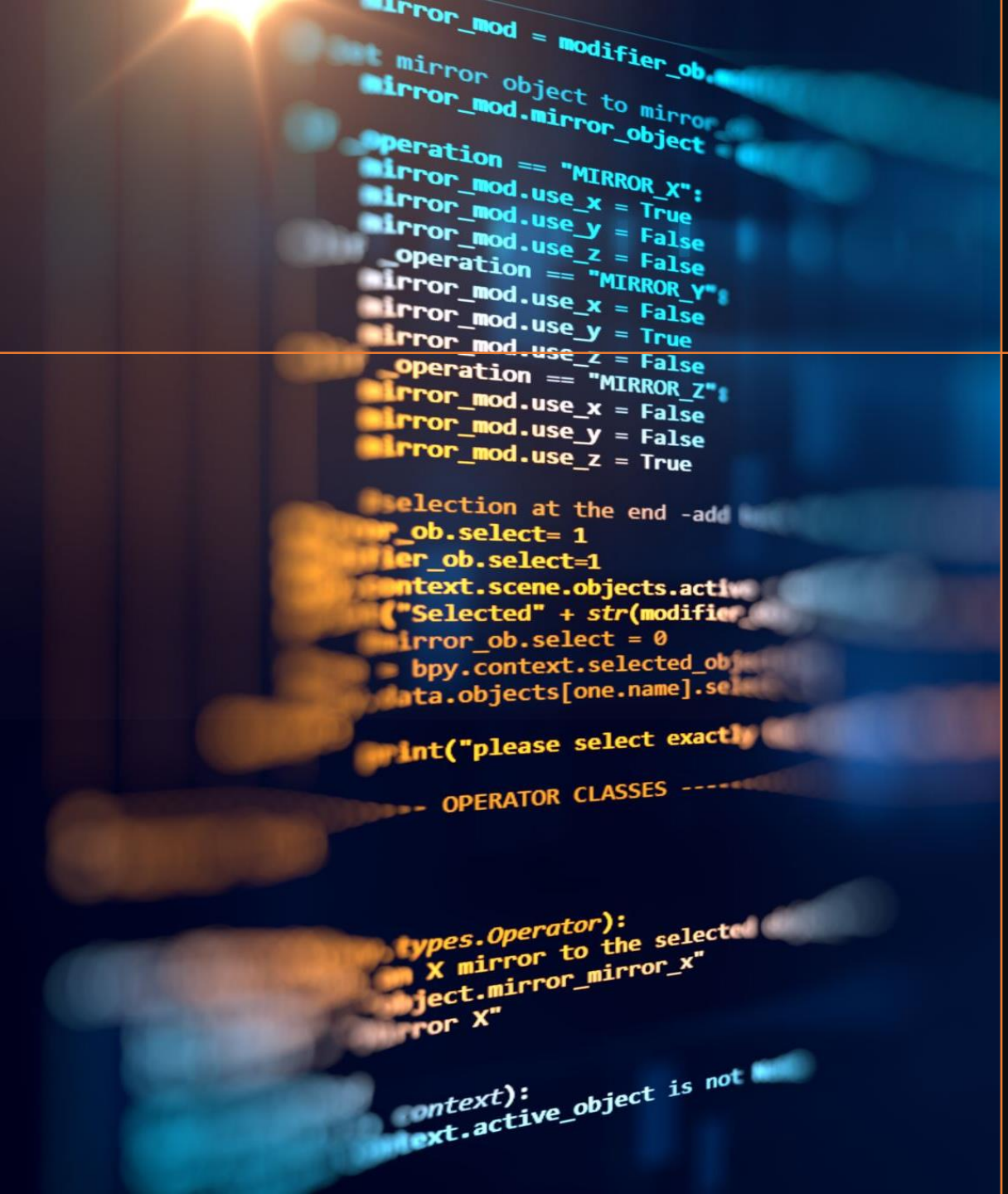

Challenges and Recommendations

Challenges:

- Obtaining access to EHR data
- Limited data availability

Recommendations:

- Data sharing (de-identified or synthetic)
- Clear documentation
- Open-source code
- Benchmarking on public datasets

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Basic Course	55704866	80%	100%	04-May-2023	04-May-2023	04-May-2026	View	View-Print-S

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- Find the "Files" section in the project description
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Regards, The PhysioNet Team, MIT Laboratory for Computational Physiology Institute for Medical Engineering and Science, MIT, E25-505 77 Massachusetts Ave, Cambridge, MA 02139

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MIMIC-III Clinical Database

Alistair Johnson , **Tom Pollard** , **Roger Mark**

Published: Sept. 4, 2016. Version: 1.4

MIMIC-III available on the cloud *(Sept. 30, 2019, 2:28 p.m.)*

The MIMIC-III database is now available on two major cloud platforms: Google Cloud Platform (G
data on the cloud, simply add the relevant cloud identifier to your PhysioNet profile. Further inst

Tutorials are available for using MIMIC-III with BigQuery (GCP) and using MIMIC-III with Athena

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Johnson, A., Pollard, T., & Mark, R. (2016). MIMIC-III Clinical Database (version 1.4). *PhysioNet*. https://doi.org/10.13026/C2XW26.

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Goldberger, A., Amaral, L., Glass, L., Hausdorff, J., Ivanov, P. C., Mark, R., ... & Stanley, H. E. (2000). PhysioBank, PhysioToolkit, and PhysioNet: Components of a new research resource for complex physiologic signals. Circulation [Online]. 101 (23), pp. e215–e220.

Abstract

MIMIC-III is a large, freely-available database comprising deidentified health-related data associate
with over forty thousand patients who stayed in critical care units of the Beth Israel Deaconess Med
Center between 2001 and 2012. The database includes information such as demographics, vital sigr
measurements made at the bedside (~1 data point per hour), laboratory test results, procedures,
medications, caregiver notes, imaging reports, and mortality (including post-hospital discharge).

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Files

Total uncompressed size: 6.2 GB.

Access the files

- Download the ZIP file (6.2 GB)
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- Access using AWS Open Data repository
- Request access to the data using AWS command line tools: `aws s3 sync s3://mimic-iii-physionet DESTINATION`
- Request access using Google BigQuery.
- Download the files using your terminal: `wget -r -N -c -np --user shivbharti --ask-password https://physionet.org/files/mimiciii/1.4/`

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LABEVENTS.csv.gz	320.3 MB	2019-03-19

Conclusion

- Reproduced the original study with some variations in results
- RNN models showed potential for heart failure prediction
- Challenges in data access and limited data availability