



MACHINE LEARNING APPROACHES USING MATLAB

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DEPARTMENT OF ELECTRICAL ENGINEERING

The University of Texas at

TYLER Center for Health
Informatics & Analytics

ORS Research Design & Data Analysis Lab

Office of Research and Scholarship

OUTLINE

➤ INTRODUCTION

➤ DIFFERENT MACHINE LEARNING APPROACHES

➤ DISCUSSION

OUTLINE

➤ INTRODUCTION

➤ DIFFERENT MACHINE LEARNING APPROACHES

➤ DISCUSSION

INTRODUCTION

➤ What is Machine Learning ?

- Machine Learning is a field of study that gives computers the ability to “learn” without being explicitly programmed
 - Prediction
 - Classification

INTRODUCTION

➤ Too many books spoil the curiosity

- Start with Andrew Ng, Machine Learning, Stanford University available on YouTube

Some Statistics & Programming Knowledge Helps !

INTRODUCTION

➤ Machine Learning with MATLAB



https://commons.wikimedia.org/wiki/File:Man_Driving_Car_Cartoon_Vector.svg



<http://clipart-library.com/mechanic-cliparts.html>



Machine Learning Driving School

The screenshot shows the MathWorks website for the 'Machine Learning with MATLAB' course. The page features the MathWorks logo at the top left, a 'Get MATLAB' button, and a user profile icon at the top right. The main content area has a dark blue background with a glowing neural network pattern on the right. The title 'Machine Learning with MATLAB' is prominently displayed in white, with a green 'Read ebook' button below it. A paragraph of text describes the course as a systematic workflow for solving complex data problems. A 'Read ebook' button is also present in a white box on the right side of the page.

MathWorks®

Get MATLAB

```
houette (meas, idxCos, 'cos');  
(silh3) mean (silhCos)]  
  
idxCos==i);  
st,1), meas (class, 2), meas (class, 1)
```

Machine Learning with MATLAB

[Read ebook](#)

You have a complex problem involving a large amount of data and lots of variables. You know that machine learning would be the best approach—but you've never used it before. How do you deal with data that's messy, incomplete, or in a variety of formats? How do you choose the right model for the data?

Sounds daunting? Don't be discouraged. A systematic workflow will help you get off to a smooth start.

[Mastering Machine Learning: A Step-by-Step Guide with MATLAB](#)

[Read ebook](#)

INTRODUCTION



University of Texas at Tyler

Get Software | Learn MATLAB | Teach with MATLAB | What's New

MATLAB Access for Everyone at

University of Texas at Tyler

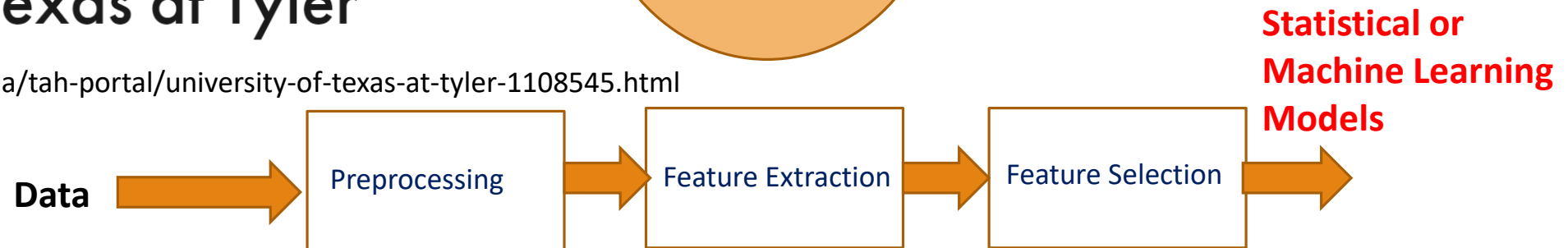
<https://www.mathworks.com/academia/tah-portal/university-of-texas-at-tyler-1108545.html>

ORS Webinar Recordings

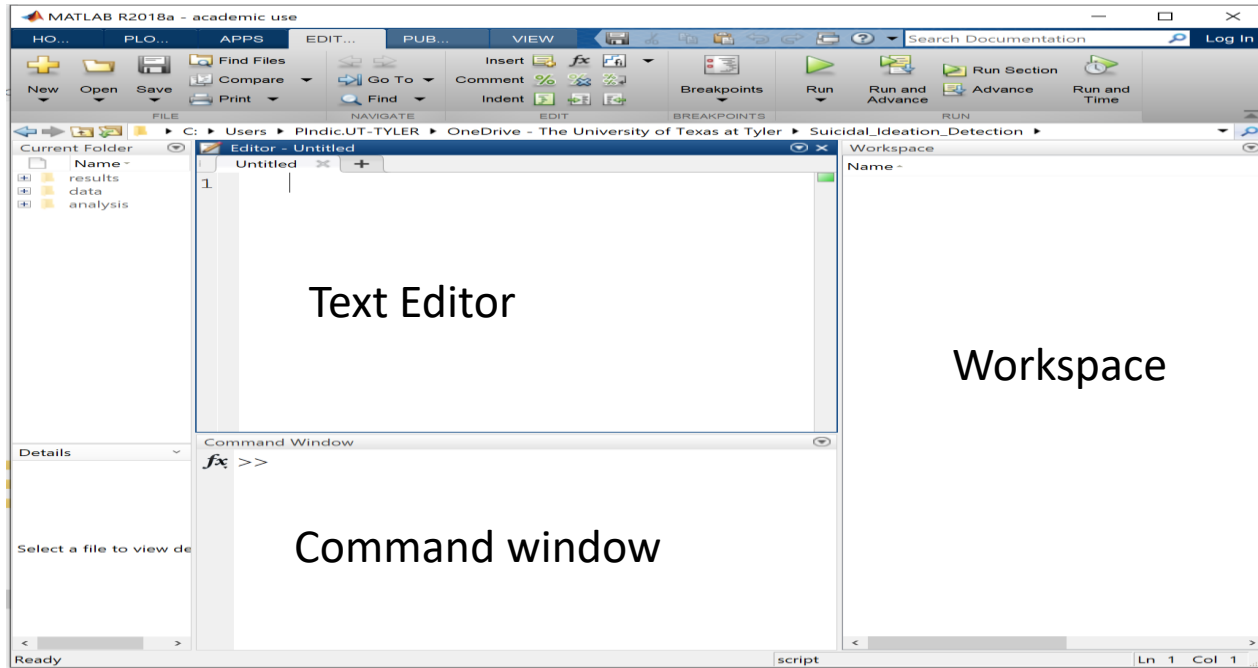
<https://www.uttyler.edu/research/ors-research-design-data-analysis-lab/ors-research-design-data-analysis-lab-resources/ors-consultant-recordings.php>

30

Minute
Feature Extraction



INTRODUCTION



30
Minute
Feature Extraction



OUTLINE

➤ INTRODUCTION

➤ DIFFERENT MACHINE LEARNING APPROACHES

➤ DISCUSSION

Statistical vs. Machine Learning Models

Purpose:

Statistical models are used for inference (To find association between features and an outcome). Results should be interpretable.

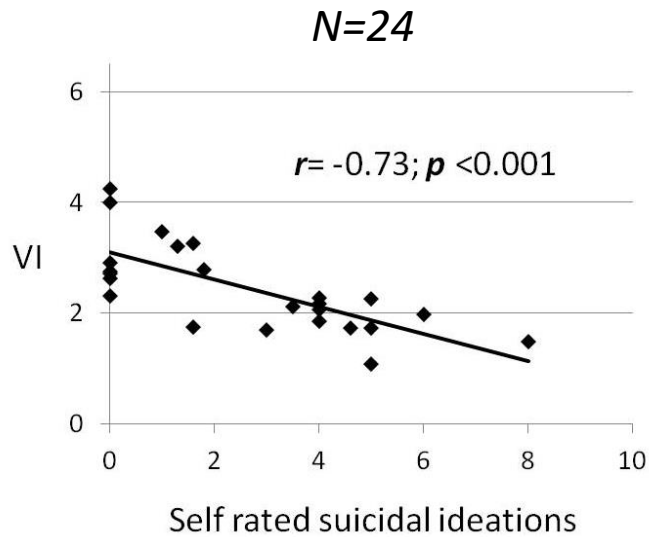
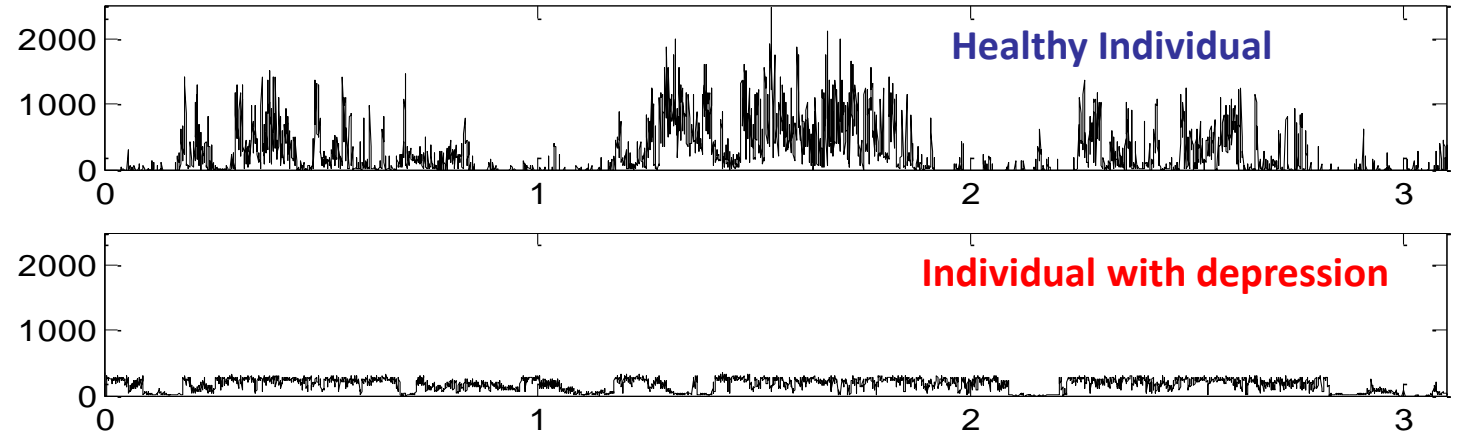
Machine Learning models are used for prediction (Use features that can predict an outcome). Results may not be interpretable.

Statistical vs. Machine Learning Models

Association vs. Prediction



Philips Actiwatch 2



$$VI = m \times SI + C$$

$$m = r \frac{\sigma_{VI}}{\sigma_{SI}}$$

$$C = \mu_{VI} - m\mu_{SI}$$

$$\tilde{SI} = a \times VI + b$$

Sensitivity & Specificity

LEARNING APPROACHES

- Supervised Learning

Learning a relationship between features and the outcome using a training set

- Unsupervised Learning

Learning underlying structures in features

LEARNING APPROACHES

➤ Supervised Learning

- Linear Regression
- Logistic Regression
- Support Vector Machine
- Artificial Neural Network
-
-
-

LEARNING APPROACHES

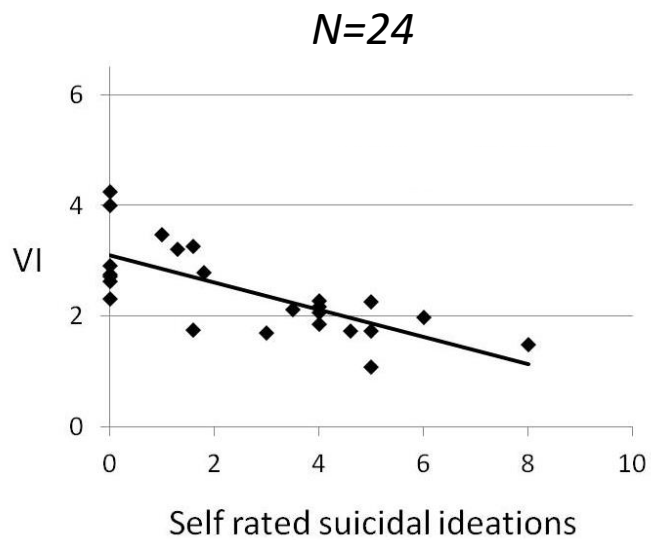
➤ Unsupervised Learning

Clustering

- Principal Component Analysis
- Independent Component Analysis
- Singular Value Decomposition
-
-

LEARNING APPROACHES

➤ Do machines actually “learn” ?



➔

$$VI = m \times SI + C$$

LEARNING APPROACHES

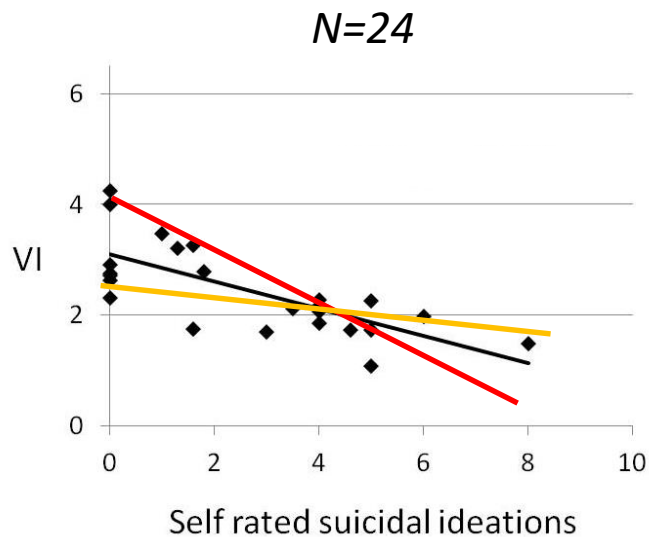
➤ Do machines actually “learn” ?

$$e(N = 1) = \widetilde{VI}(N = 1) - VI(N = 1)$$

$$e(N = 2) = \widetilde{VI}(N = 2) - VI(N = 2)$$

.....
.....

$$e(N = 24) = \widetilde{VI}(N = 24) - VI(N = 24)$$



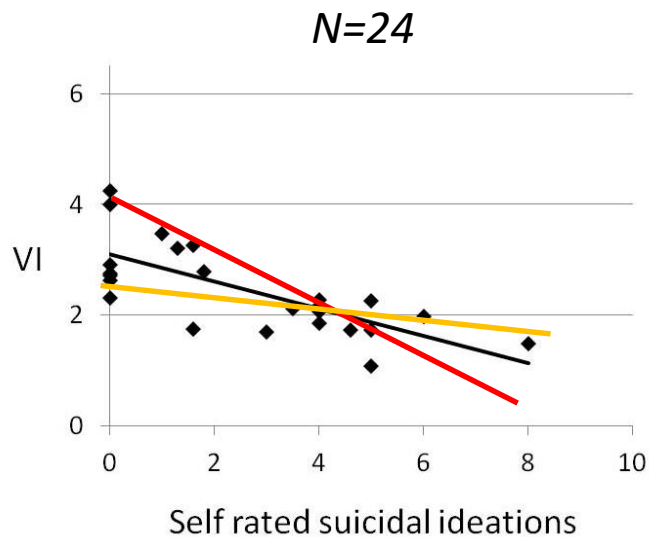
$$\widetilde{VI} = m \times SI + C$$

$$E = \sum_{n=1}^N e^2$$

LEARNING APPROACHES

➤ Do machines actually “learn” ?

How do we find minimum E ?



m →

↓ C

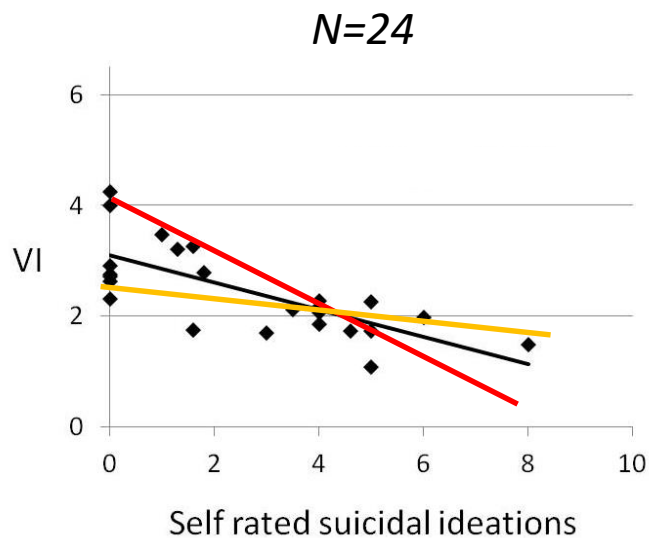
0.1	0.6	0.8	0.01	0.5
1	10	0.01	0.001	0.002
8	7	0.0006	0.03	0.55
100	12	0.1	12	0.89
2	1	2	0.5	0.05

$$\widehat{VI} = m \times SI + C$$

LEARNING APPROACHES

➤ Do machines actually “learn” ?

How do we find minimum E ?



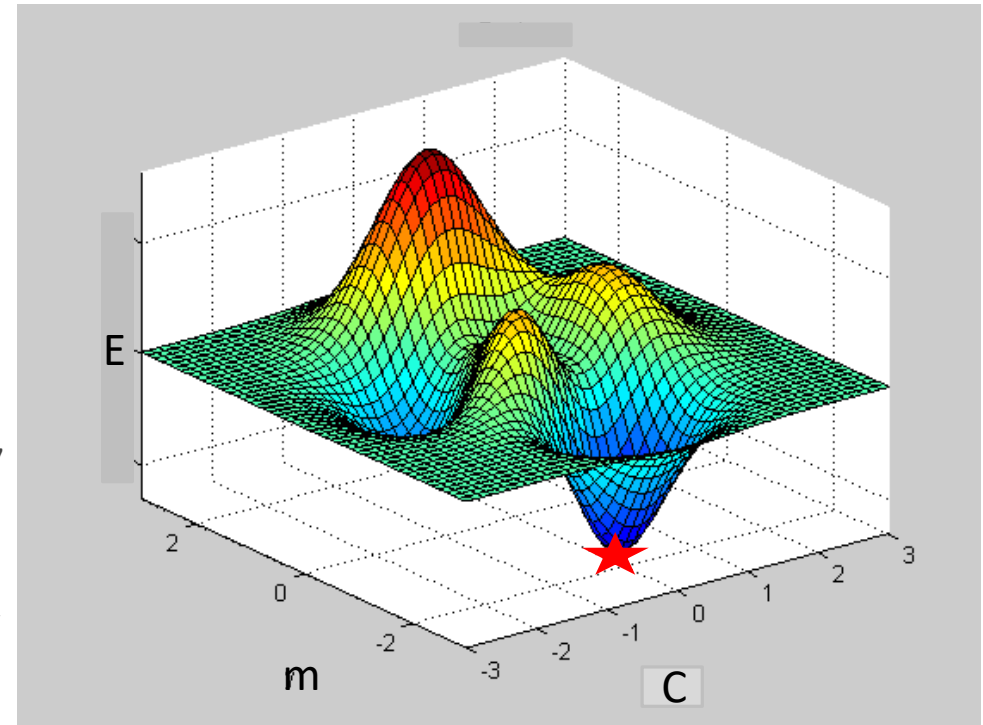
- Gradient Descent

by Louis Augustin Cauchy in 1847

$$\widetilde{VI} = m \times SI + C$$

Linear Regression

$$\widetilde{SI} = a \times VI + b$$



LEARNING APPROACHES

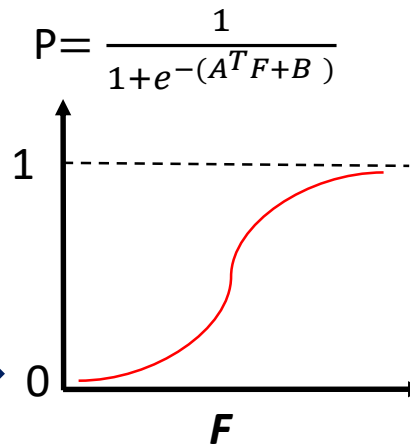
➤ Do machines actually “learn” ?

Classification of High Risk (n=43) vs. Low Risk (n=95)

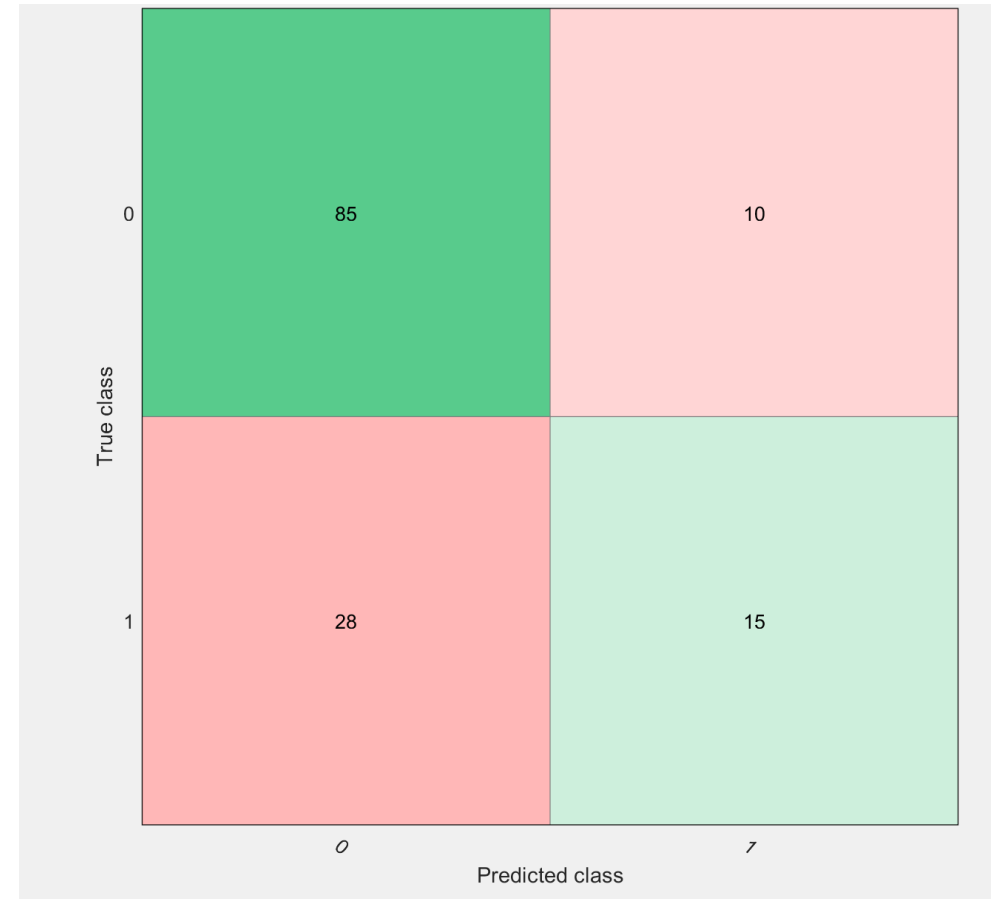
0 = Low Risk, 1 = High Risk

VI → $p = \frac{1}{1 + e^{-(a \times VI + b)}}$
Mean
Variance
Skewness
Kurtosis
Power
Period

Linear Regression



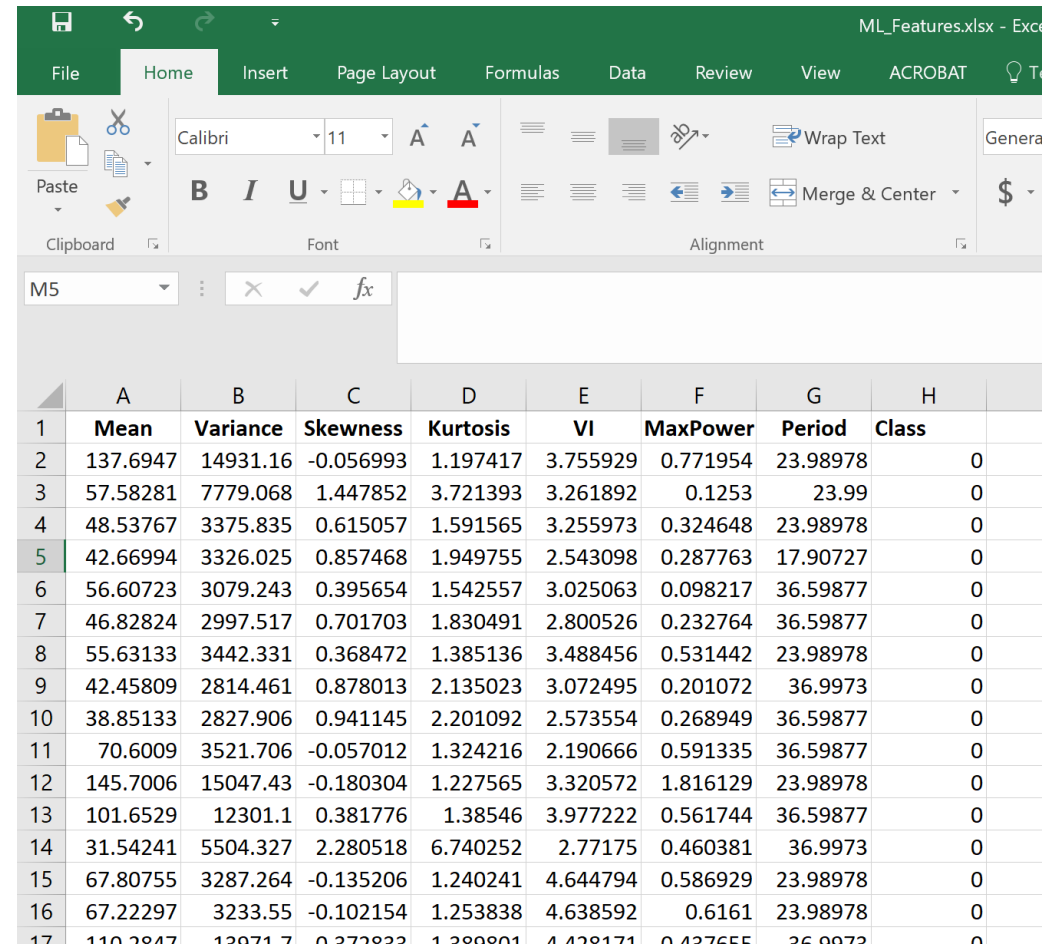
Logistic Regression
Accuracy ~73%



LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 1: Create an excel sheet with features with class assignments



The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G	H	
1	Mean	Variance	Skewness	Kurtosis	VI	MaxPower	Period	Class	
2	137.6947	14931.16	-0.056993	1.197417	3.755929	0.771954	23.98978	0	
3	57.58281	7779.068	1.447852	3.721393	3.261892	0.1253	23.99	0	
4	48.53767	3375.835	0.615057	1.591565	3.255973	0.324648	23.98978	0	
5	42.66994	3326.025	0.857468	1.949755	2.543098	0.287763	17.90727	0	
6	56.60723	3079.243	0.395654	1.542557	3.025063	0.098217	36.59877	0	
7	46.82824	2997.517	0.701703	1.830491	2.800526	0.232764	36.59877	0	
8	55.63133	3442.331	0.368472	1.385136	3.488456	0.531442	23.98978	0	
9	42.45809	2814.461	0.878013	2.135023	3.072495	0.201072	36.9973	0	
10	38.85133	2827.906	0.941145	2.201092	2.573554	0.268949	36.59877	0	
11	70.6009	3521.706	-0.057012	1.324216	2.190666	0.591335	36.59877	0	
12	145.7006	15047.43	-0.180304	1.227565	3.320572	1.816129	23.98978	0	
13	101.6529	12301.1	0.381776	1.38546	3.977222	0.561744	36.59877	0	
14	31.54241	5504.327	2.280518	6.740252	2.77175	0.460381	36.9973	0	
15	67.80755	3287.264	-0.135206	1.240241	4.644794	0.586929	23.98978	0	
16	67.22297	3233.55	-0.102154	1.253838	4.638592	0.6161	23.98978	0	
17	110.2847	12071.7	0.272822	1.280801	4.428171	0.427655	26.0072	0	

LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 2: Open MATLAB and drag the excel file to workspace

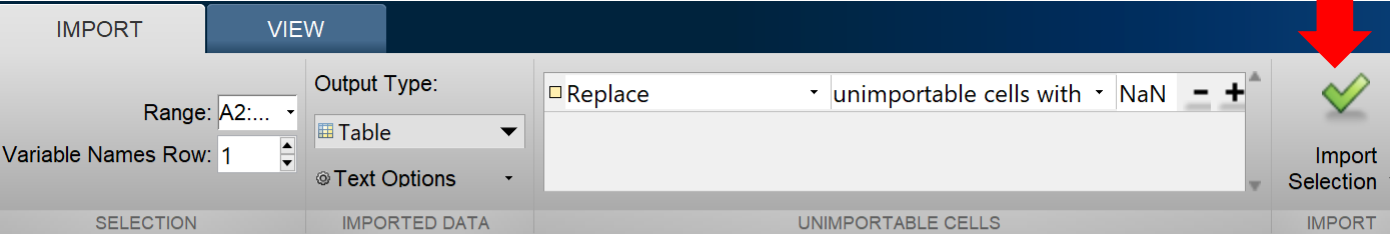
The screenshot shows the MATLAB Import Wizard interface. The 'VIEW' tab is selected, and the 'Range' is set to 'A2:...', 'Variable Names Row' is '1', and 'Output Type' is 'Table'. The 'Replace unimportable cells with NaN' option is checked. Below the wizard, the imported data is displayed in a table with columns: Mean, Variance, Skewness, Kurtosis, VI, MaxPower, Period, Class, and VarName9. The 'Class' column is circled in red.

	A	B	C	D	E	F	G	H	I
	Mean	Variance	Skewness	Kurtosis	VI	MaxPower	Period	Class	VarName9
	Number	Number	Number	Number	Number	Number	Number	Categorical	Text
1	Mean	Variance	Skewness	Kurtosis	VI	MaxPower	Period	Class	
2	137.6947	1.4931e+04	-0.0570	1.1974	3.7559	0.7720	23.9898	0	
3	57.5828	7.7791e+03	1.4479	3.7214	3.2619	0.1253	23.9900	0	
4	48.5377	3.3758e+03	0.6151	1.5916	3.2560	0.3246	23.9898	0	
5	42.6699	3.3260e+03	0.8575	1.9498	2.5431	0.2878	17.9073	0	
6	56.6072	3.0792e+03	0.3957	1.5426	3.0251	0.0982	36.5988	0	
7	46.8282	2.9975e+03	0.7017	1.8305	2.8005	0.2328	36.5988	0	
8	55.6313	3.4423e+03	0.3685	1.3851	3.4885	0.5314	23.9898	0	
9	42.4581	2.8145e+03	0.8780	2.1350	3.0725	0.2011	36.9973	0	
10	38.8513	2.8279e+03	0.9411	2.2011	2.5736	0.2689	36.5988	0	
11	70.6009	3.5217e+03	-0.0570	1.3242	2.1907	0.5913	36.5988	0	
12	145.7006	1.5047e+04	-0.1803	1.2276	3.3206	1.8161	23.9898	0	
13	101.6529	1.2301e+04	0.3818	1.3855	3.9772	0.5617	36.5988	0	

LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 3: Click Import Selection and import data



The screenshot shows the MATLAB Import Wizard interface. The 'VIEW' tab is selected, and the 'Import Selection' button is highlighted with a red arrow. The 'Import Selection' button is located in the bottom right corner of the wizard, next to a green checkmark icon. The 'Import Selection' button is labeled 'Import Selection'.

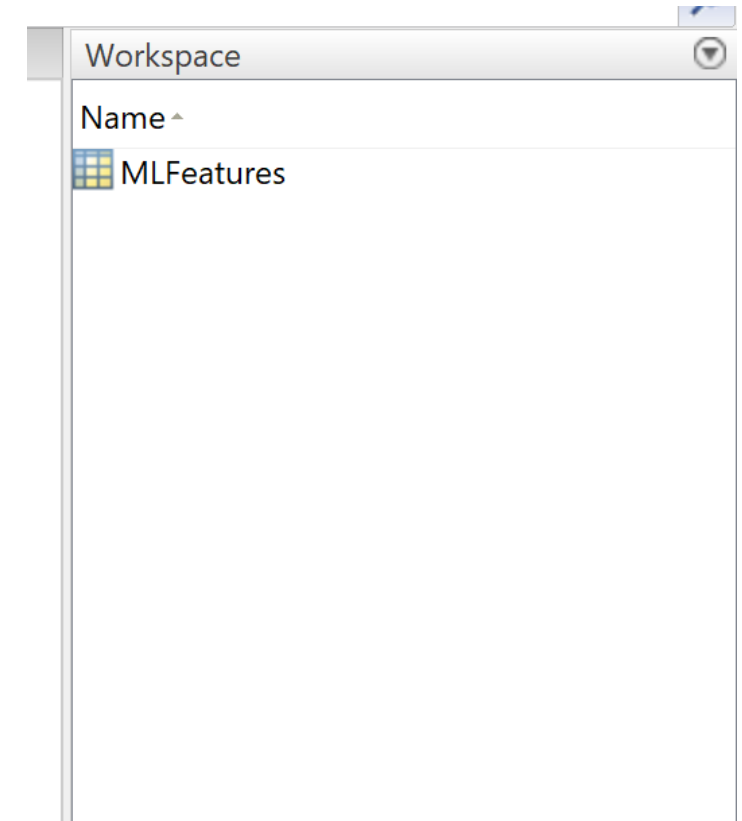
The data table below shows the imported data from 'ML_Features.xlsx'.

	A	B	C	D	E	F	G	H	I
	Mean	Variance	Skewness	Kurtosis	VI	MaxPower	Period	Class	VarName9
	Number	Number	Number	Number	Number	Number	Number	Categorical	Text
1	Mean	Variance	Skewness	Kurtosis	VI	MaxPower	Period	Class	
2	137.6947	1.4931e+04	-0.0570	1.1974	3.7559	0.7720	23.9898	0	
3	57.5828	7.7791e+03	1.4479	3.7214	3.2619	0.1253	23.9900	0	
4	48.5377	3.3758e+03	0.6151	1.5916	3.2560	0.3246	23.9898	0	
5	42.6699	3.3260e+03	0.8575	1.9498	2.5431	0.2878	17.9073	0	
6	56.6072	3.0792e+03	0.3957	1.5426	3.0251	0.0982	36.5988	0	
7	46.8282	2.9975e+03	0.7017	1.8305	2.8005	0.2328	36.5988	0	
8	55.6313	3.4423e+03	0.3685	1.3851	3.4885	0.5314	23.9898	0	
9	42.4581	2.8145e+03	0.8780	2.1350	3.0725	0.2011	36.9973	0	
10	38.8513	2.8279e+03	0.9411	2.2011	2.5736	0.2689	36.5988	0	
11	70.6009	3.5217e+03	-0.0570	1.3242	2.1907	0.5913	36.5988	0	
12	145.7006	1.5047e+04	-0.1803	1.2276	3.3206	1.8161	23.9898	0	
13	101.6529	1.2301e+04	0.3818	1.3855	3.9772	0.5617	36.5988	0	

LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 4: Features are in workspace and ready

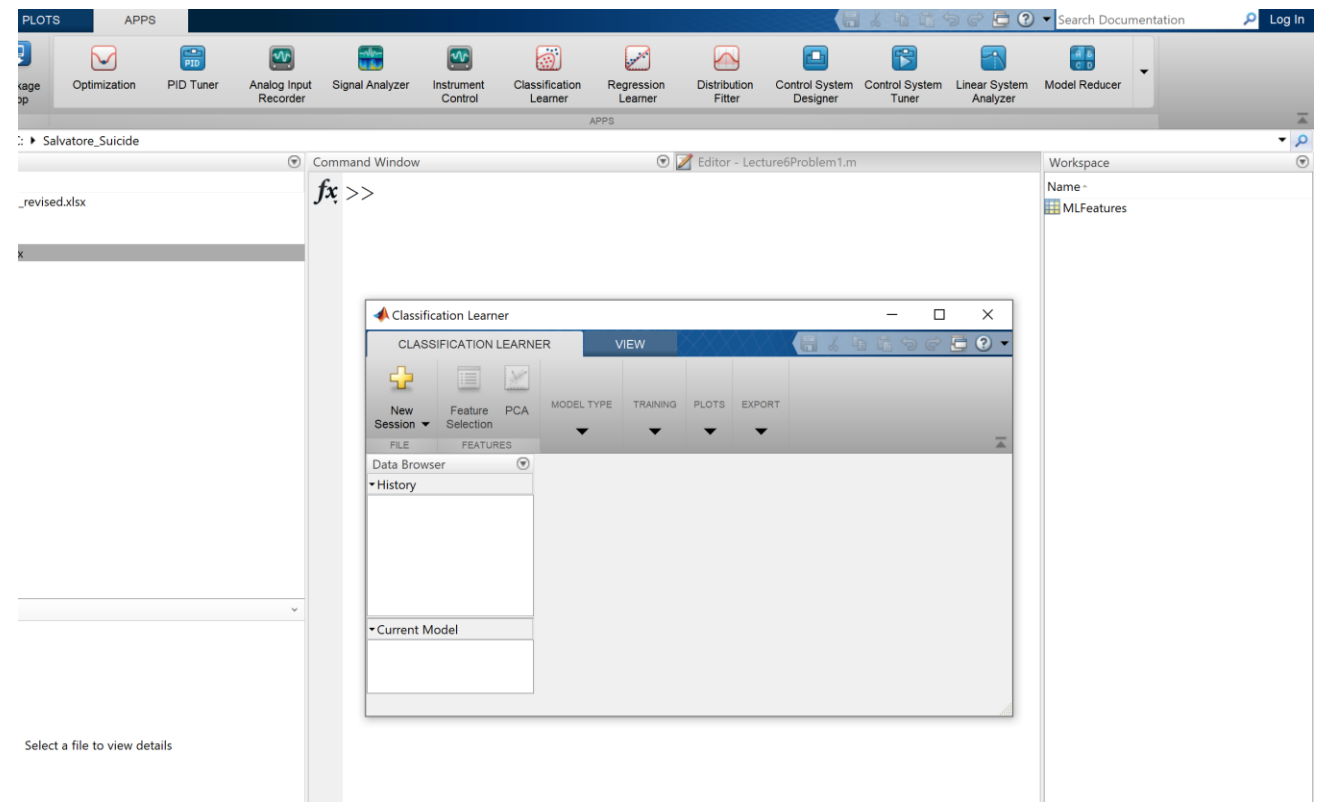


LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 5: Go to Apps,

- click classification learner,
- select Logistic Regression from Model Type
- click New Session,
- select from Workspace



LEARNING APPROACHES

➤ How to implement in MATLAB ?

Step 6: Set 10 fold Cross validation

- Start the session

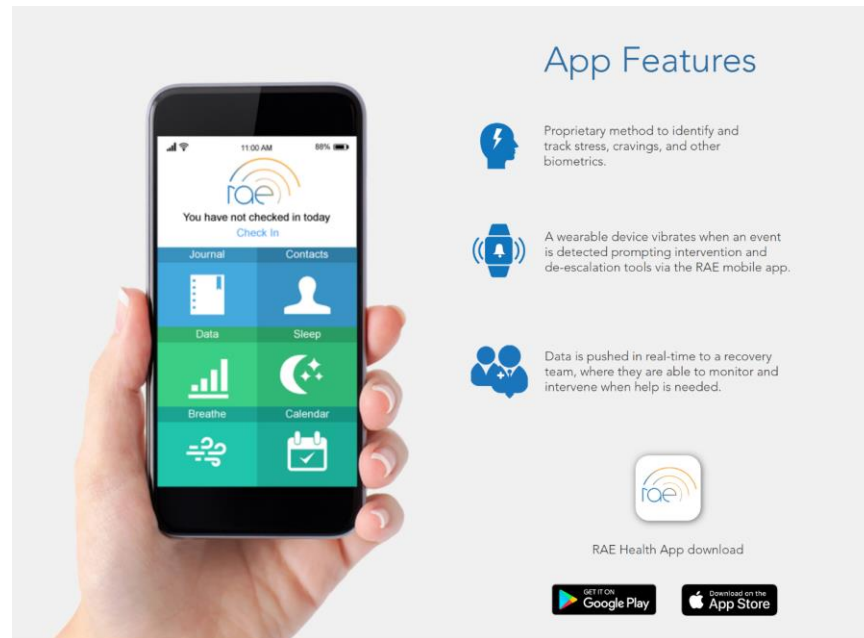
The screenshot shows the 'New Session' dialog box in MATLAB. The 'Data set' section is configured with 'MLFeatures' as the workspace variable (138x8 table) and 'Class' as the response variable (categorical2 unique). The 'Predictors' list includes Mean, Variance, Skewness, Kurtosis, VI, MaxPower, and Period, all of which are checked. The 'Validation' section has 'Cross-Validation' selected, with 'Cross-validation folds: 10 folds' set. The 'Holdout Validation' and 'No Validation' options are unselected. The 'Start Session' button is highlighted.

	Name	Type	Range
<input checked="" type="checkbox"/>	Mean	double	15.5746 .. 167.386
<input checked="" type="checkbox"/>	Variance	double	1304.91 .. 15047.4
<input checked="" type="checkbox"/>	Skewness	double	-0.43029 .. 3.65444
<input checked="" type="checkbox"/>	Kurtosis	double	1.19742 .. 15.4255
<input checked="" type="checkbox"/>	VI	double	0.762202 .. 5.76226
<input checked="" type="checkbox"/>	MaxPower	double	0.04125 .. 3.66369
<input checked="" type="checkbox"/>	Period	double	17.9073 .. 37.4002
<input type="checkbox"/>	Class	categorical	2 unique




LEARNING APPROACHES

➤ NONLINEAR FEATURES


Cravings Detection




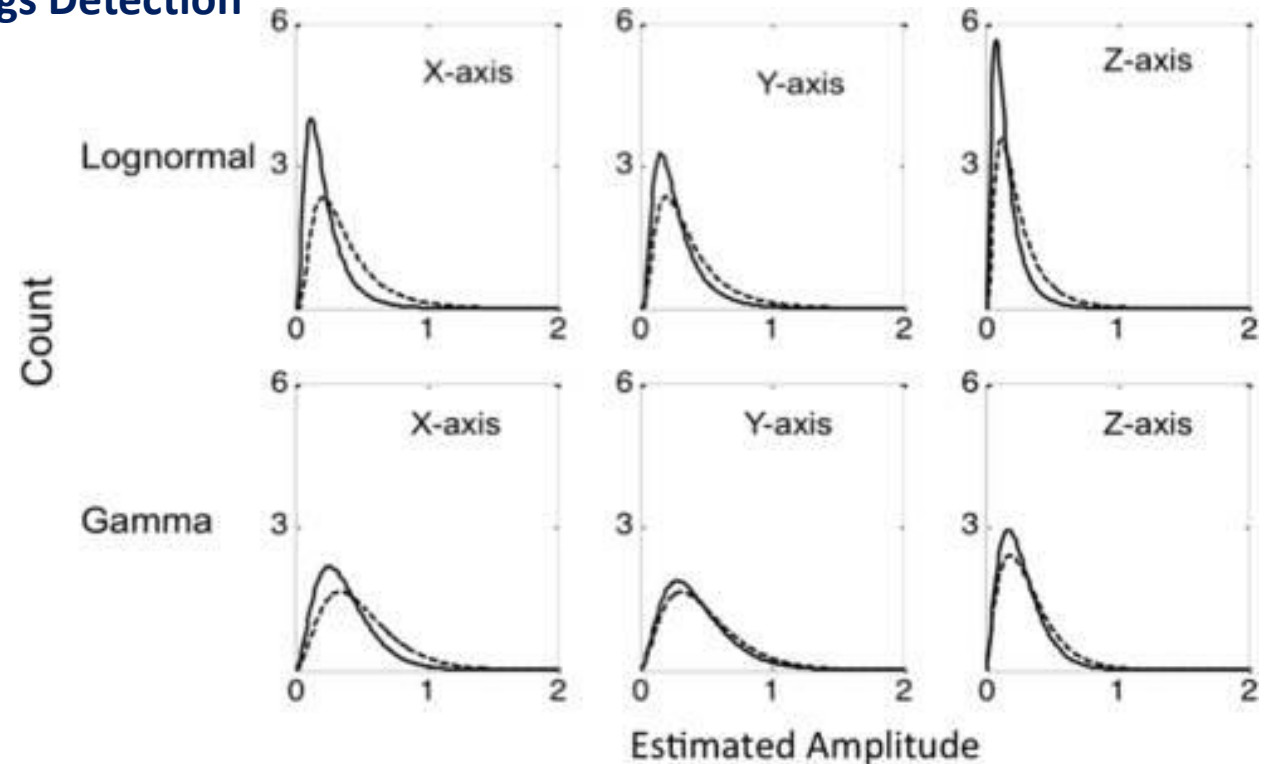
App Features

-  Proprietary method to identify and track stress, cravings, and other biometrics.
-  A wearable device vibrates when an event is detected prompting intervention and de-escalation tools via the RAE mobile app.
-  Data is pushed in real-time to a recovery team, where they are able to monitor and intervene when help is needed.

RAE Health App download

GET IT ON  Google Play

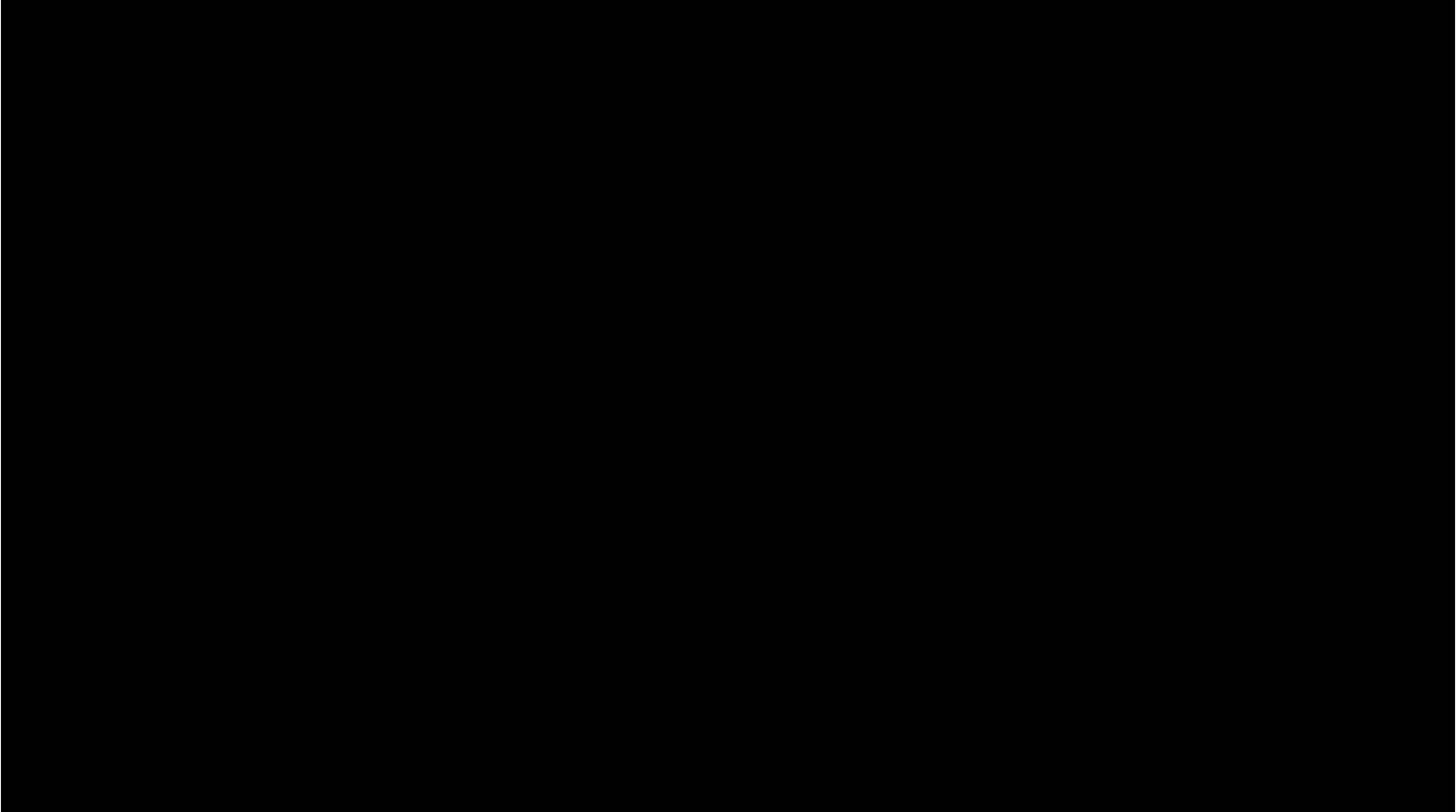
Download on the  App Store



LEARNING APPROACHES

2 : No Stress

3: Stress



Stress Detection Algorithm



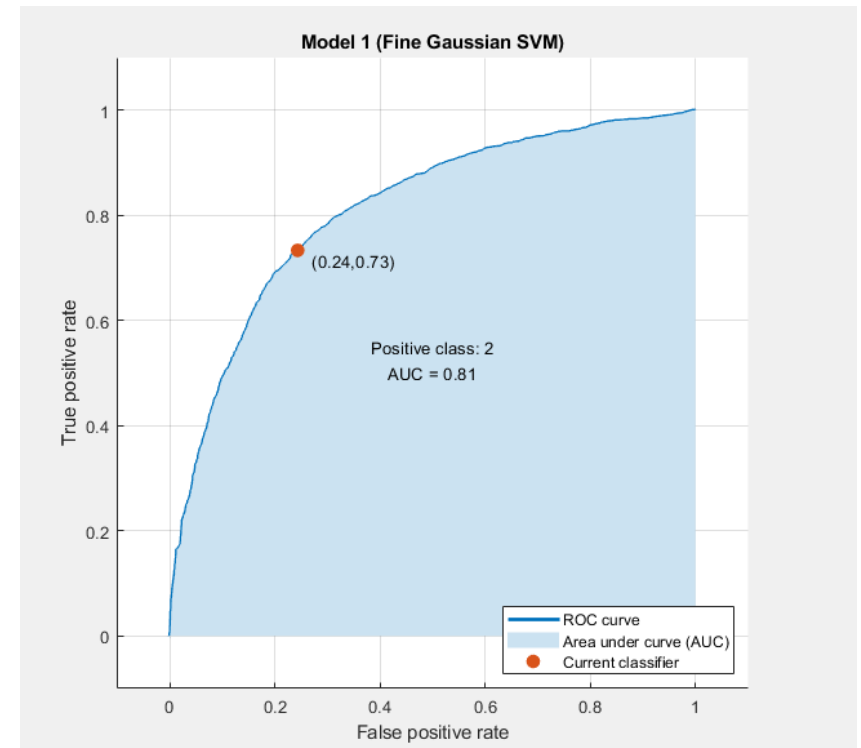
Sloke Shrestha

LEARNING APPROACHES

Stress Detection Algorithm

2 : No Stress

3 : Stress



SUMMARY

ORS Research Design & Data Analysis Lab

Office of Research and Scholarship

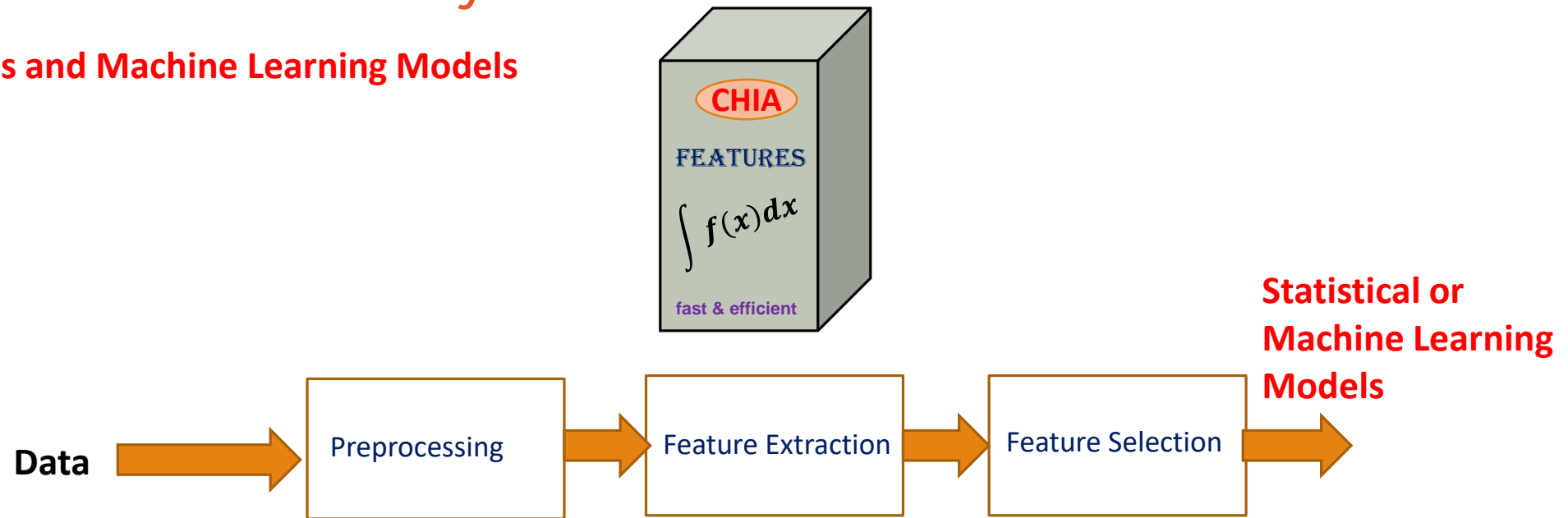
- Identification of Features
- Develop MATLAB code for feature extraction
- Set up database
- Assist with experiment protocol and data analysis
- Machine Learning



SUMMARY

The University of Texas at
TYLER Center for Health
Informatics & Analytics

- Ready to go features and Machine Learning Models



THANK YOU

Current Students:



Sloke Shrestha, UG



Mohammed Alenazi, Graduate



Pravitha Ramanand, PhD, Postdoc



Joshua Stapp, Graduate

Former Students:

Apurupa Amperayani (PhD Student, Arizona State University)

Jonathan Wells (PhD Student, UT Austin)

Pallavi Atluri

Keerthi Chintha (Data Scientist, Wabtec Corporation)

Selorm Darkey (Business Intelligent Analyst, Taylor Solutions)



SBIR: RAE (Realize, Analyze, Engage) - A digital biomarker based detection and intervention system for stress and cravings during recovery from substance abuse disorders.
PIs: M. Reinhardt, S. Carreiro, P. Indic



STARs Award
 The University of Texas System
P. Indic (PI, UT Tyler)

THANK YOU

ORS Research Design & Data Analysis Lab Office of Research and Scholarship



Department of
 Veterans Affairs

Design of a wearable sensor system and associated algorithm to track suicidal ideation from movement variability and develop a novel objective marker of suicidal ideation and behavior risk in veterans.
 Clinical Science Research and Development Grant (approved for funding),
P. Indic (site PI, UT-Tyler)
E.G. Smith (Project PI, VA)
P. Salvatore (Investigator, Harvard University)



Design of a wearable biosensor sensor system with wireless network for the remote detection of life threatening events in neonates.

National Science Foundation Smart & Connected Health Grant
P. Indic (Lead PI, UT-Tyler)
D. Paydarfar (Co PI, UT-Austin)
H. Wang (Co PI, UMass Dartmouth)
Y. Kim (Co PI, UMass Dartmouth)



Pre-Vent

National Institute Of Health Grant
P. Indic (Analytical Core PI, UT-Tyler)
N. Ambal (PI, Univ. of Alabama, Birmingham)

Wearable system for the detection of addiction
P. Indic (PI, UT-Tyler)
M. Reinhart (PI, ContinueYou, LLC)
S. Carriero, (PI. Univ. of Mass. Med. School)

DISCUSSION
