A microscopic image of cells, possibly from a heart tissue sample, with a heatmap overlay. The heatmap shows areas of high intensity (yellow/green) and low intensity (dark blue/purple), indicating regions of interest or abnormality. The text is overlaid on this image.

Machine Learning for Biomedical Data

A complete ML application

2020-2021

<https://www.kaggle.com/ronitf/heart-disease-uci>

by Fernando Carazo

First of all... Open Rstudio and install the following packages

- `install.packages("dplyr")` # for data manipulation
- `install.packages(c("ggplot2", "ggpubr"))` # for awesome graphics
- `install.packages("visdat")` # for additional visualizations
- `install.packages("rpart.plot")` # for additional visualizations
- `install.packages(c("tidyverse", "titanic", "ggpubr"))`
- `install.packages("skimr")`

- # Feature engineering packages
- `install.packages("caret")` # for various ML tasks
- `install.packages("recipes")` # for feature engineering tasks

CHALLENGE – HEART DISEASE PREDICTION

Predict whether patients will have a heart attack or not

Coronary heart disease is a type of heart disease that develops when the arteries of the heart cannot deliver enough oxygen-rich blood to the heart. It is the leading cause of death in the United States.

The “goal” of this Challenge is to predict the presence of heart disease in the patient using ECG information and other clinical features.




Patient Variables

1. age
2. sex
3. chest pain type (4 values)
4. resting blood pressure
5. serum cholestoral in mg/dl
6. fbs: fasting blood sugar > 120 mg/dl

Hereon, variables are related to a nuclear stress test. That is, a stress test where a radioactive dye is also injected to the patient to see the blood flow:

7. restecg: resting electrocardiographic results (values 0,1,2)
8. thalach: maximum heart rate achieved
9. exang: exercise induced angina
10. oldpeak: ST depression induced by exercise relative to rest
10. slope: the slope of the peak exercise ST segment
11. ca: number of major vessels (0-3) colored by flourosopy
12. thal: 3 = normal; 6 = fixed defect; 7 = reversable defect

Patient Features

# age	# sex	# cp	# trestbps	# chol	# fbs
age in years	(1 = male; 0 = female)	chest pain type	resting blood pressure (in mm Hg on admission to the hospital)	serum cholestoral in mg/dl	(fasting blood sugar > 120 mg/dl) (1 = true; 0 = false)
					
29 77	0 1	0 3	94 200	126 564	0 1
63	1	3	145	233	1
37	1	2	130	250	0
41	0	1	130	204	0
56	1	1	120	236	0
57	0	0	120	354	0
57	1	0	140	192	0
56	0	1	140	294	0
44	1	1	120	263	0
52	1	2	172	199	1
57	1	2	150	168	0
54	1	0	140	239	0

STEPS **BEFORE** MODELLING

STEPS **BEFORE** MODELLING

1. Define the problem: What do we want to predict? Which data is available?

→ Make your hypotheses

2. Explore and understand the data that will be used to create the model.

→ Create new features?

3. Preprocess the data: define the necessary transformations so that the data can be interpreted by the selected machine learning algorithm.

STEPS **FOR** MODELLING





STEPS **FOR** MODELLING

- 1. Prepare** the strategy to **evaluate the model**: separate the observations in a training set, a validation set (the latter is usually a subset of the training set) and a test set. No information from the test set should participate in the model training process.
- 2. Preprocess the data**: apply the necessary transformations
- 3. Select** a model
- 4. Cross-validation** and Model Evaluation
- 5. Hyperparameter** optimization
- 6. Make the prediction** and error in the Test set

Kaggle

www.kaggle.com

Kaggle is the world's largest data science community with powerful tools and resources to help you achieve your data science goals.

Active (Not Entered)		Completed	InClass	All Categories ▾		Default Sort ▾
	OSIC Pulmonary Fibrosis Progression Predict lung function decline Featured • 3 months to go • Code Competition • 14 Teams					\$55,000
	SIIM-ISIC Melanoma Classification Identify melanoma in lesion images Featured • a month to go • 1824 Teams					\$30,000
	ALASKA2 Image Steganalysis Detect secret data hidden within digital images Research • 13 days to go • 922 Teams					\$25,000
	Prostate cANcer graDe Assessment (PANDA) Challenge Prostate cancer diagnosis using the Gleason grading system Featured • 15 days to go • Code Competition • 803 Teams					\$25,000

Trabajo...

4, 11, 18, 25

FEBRUARY

ML pipeline

How to deal with a real
Machine Learning problem

Heart Disease UCI

<https://archive.ics.uci.edu/ml/datasets/Heart+Disease>

11, 25, 15A

MARCH

Diving inside ML algorithms

Programming your own
algorithm

Breast Cancer Wisconsin (Diagnostic)

Predict whether the cancer is benign or malignant

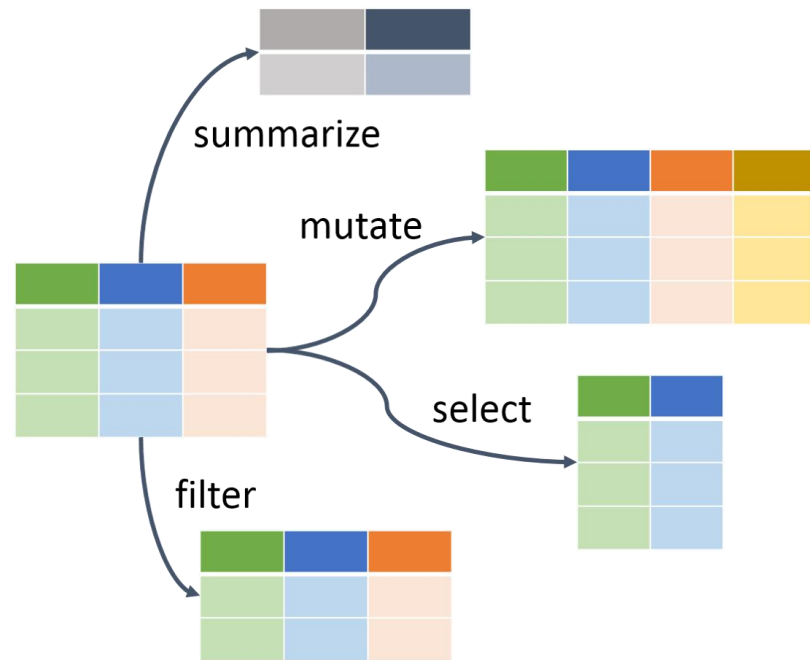
22, 29, 6M

APRIL

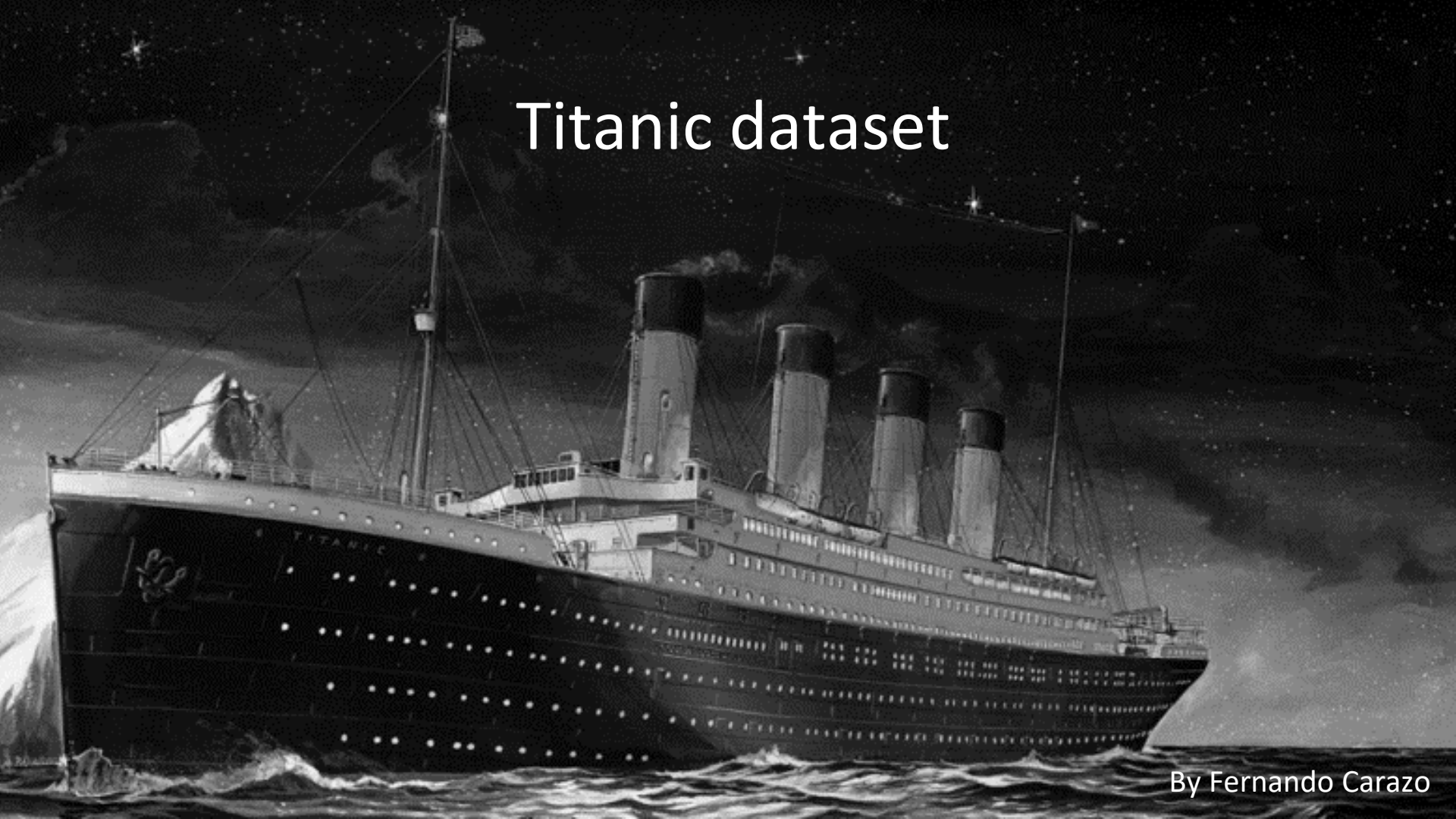
Deep Learning Medical Imaging



13, 20 MAY – WORK SESSIONS



Titanic dataset

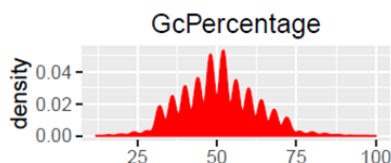
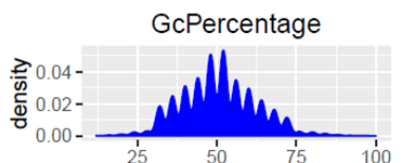
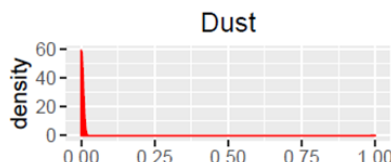
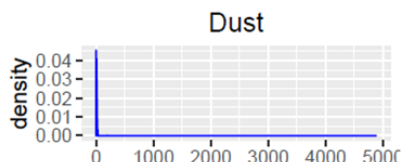
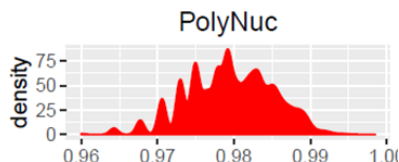
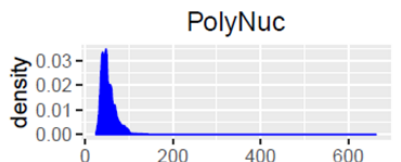
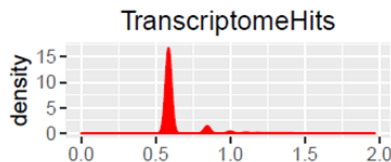
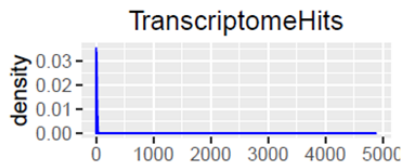
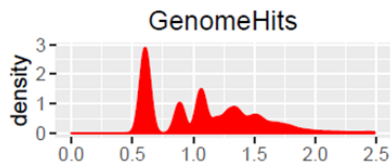
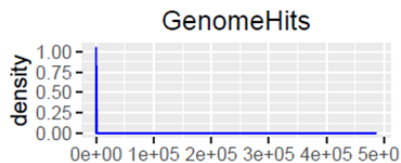


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RAW DATA

TRANSFORMED DATA

Transformation method



- Box-Cox transformation*

$$\lambda = -0.4$$

*

$$y_i^{(\lambda)} = \begin{cases} \frac{y_i^\lambda - 1}{\lambda} & \text{if } \lambda \neq 0, \\ \ln(y_i) & \text{if } \lambda = 0, \end{cases}$$

- Box-Cox transformation

$$\lambda = -0.5$$

- Box-Cox transformation

$$\lambda = -1$$

- Box-Cox transformation

$$\lambda = -1$$

- No transformation