NTHU Introduction to ML 2024
Lab 2

Mortality Prediction using Decision Tree and Random Forest

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Introduction

- Machine learning is playing an increasingly important role in healthcare, where its ability to analyze vast amounts of data can directly **impact human lives**.
- By implementing predictive models on ICU patient data, you'll explore how machine learning can be used to support critical healthcare decisions. Whether it's identifying at-risk patients or improving care outcomes, these techniques offer the potential to transform patient care and **save lives**.
- By the end of this lab, you will have a deeper understanding of how machine learning can be applied to healthcare scenarios, where every decision can make a difference.

Dataset

- ***Real*** Data
  - A database containing a large amount of critical care data from many different intensive care units (ICUs) worldwide
- Basic Part: We extracted 40 cases with 10 attributes and 1 label (‘hospital_death’)
- Advanced Part: We extracted 8500 cases with 29 attributes and 1 label (‘hospital_death’)

Goal

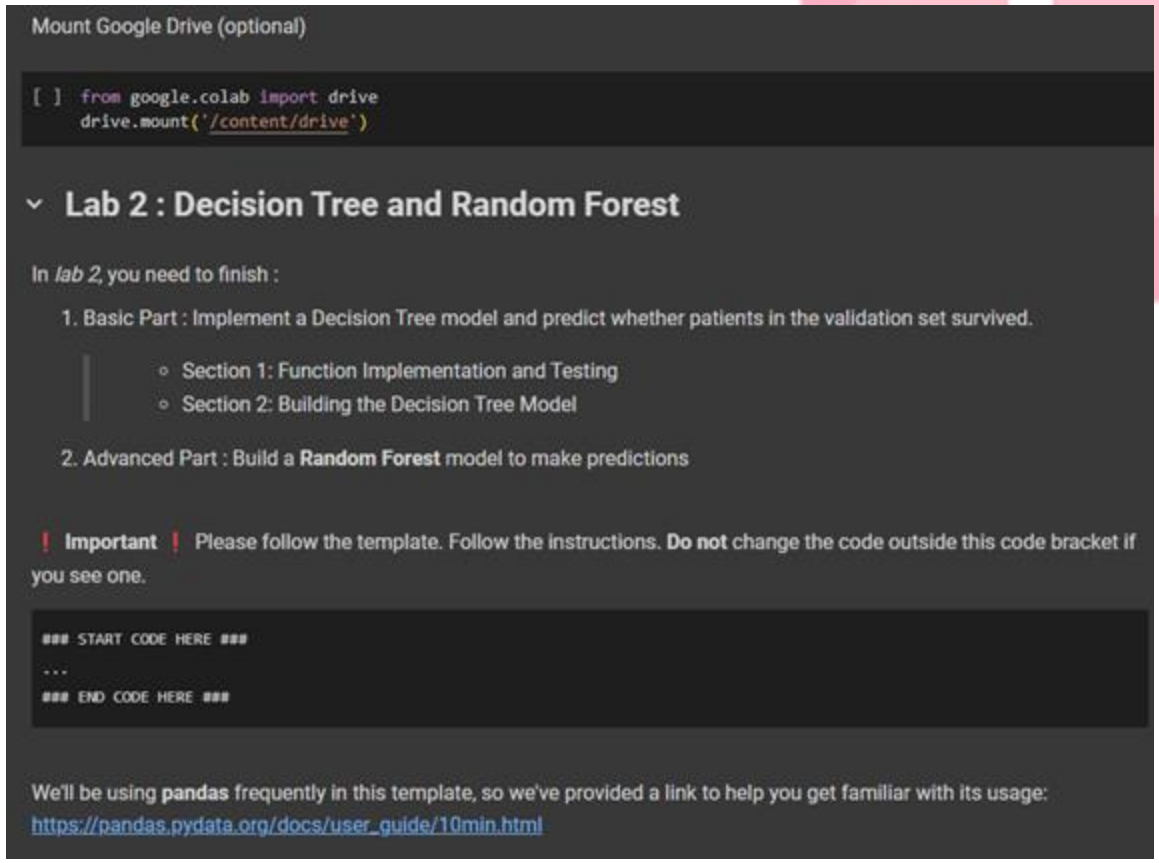
- Be familiar with the concepts of building a decision tree
- Implement a decision tree
- Implement a random forest
- Make predictions on patients' survival ('hospital_death') from real data
- Fine-tune the model for better performance

You will have the following items

- Template : lab2.ipynb
- Input file :
  - lab2_basic_input.csv
  - lab2_advanced_training.csv
  - lab2_advanced_testing.csv (without label ‘hospital_death’)

Template

- You must use the given file **lab2.ipynb** to build the model
- Except for the imported packages in the template, you **cannot** use any other packages
- Please follow the template, and only modify the content where we specifically indicate you can.



Mount Google Drive (optional)

```
[ ] from google.colab import drive
    drive.mount('/content/drive')
```

Lab 2 : Decision Tree and Random Forest

In *lab 2*, you need to finish :

1. Basic Part : Implement a Decision Tree model and predict whether patients in the validation set survived.
    - Section 1: Function Implementation and Testing
    - Section 2: Building the Decision Tree Model
2. Advanced Part : Build a **Random Forest** model to make predictions

! **Important** ! Please follow the template. Follow the instructions. **Do not** change the code outside this code bracket if you see one.

```
### START CODE HERE ###
...
### END CODE HERE ###
```

We'll be using **pandas** frequently in this template, so we've provided a link to help you get familiar with its usage:
https://pandas.pydata.org/docs/user_guide/10min.html

Basic Input File Format

- Named "**lab2_basic_input.csv**"
  - 40 instances in total
  - Each instance has 10 features and 1 class label

10 features

Class label

	age	bmi	gender	height	weight	pre_icu_los_days	glucose_apache	heart_rate_apache	resprate_apache	sodium_apache	hospital_death
0	28.0	26.596278	1	173.0	79.60	0.000000	199.0	52.0	29.0	140.0	0
1	51.0	36.267895	0	180.3	117.90	0.141667	88.0	104.0	31.0	143.0	0
2	81.0	24.196007	1	162.0	63.50	1.988194	285.0	178.0	4.0	138.0	1
3	83.0	21.105377	1	162.6	55.80	0.211111	189.0	115.0	18.0	158.0	0
4	76.0	20.470093	0	167.6	57.50	14.493056	278.0	93.0	8.0	134.0	1
5	60.0	46.111111	0	180.0	149.40	0.027778	186.0	146.0	34.0	139.0	1
6	70.0	17.361111	1	168.0	49.00	0.156944	181.0	111.0	12.0	158.0	1

Advanced Training File Format

- Named "***lab2_advanced_training*.csv**"
  - 8500 instances in total
  - Each instance has 29 features and 1 class label

29 features

Class label

	age	bmi	gender	height	weight	pre_icu_los_days	arf_apache	bun_apache	creatinine_apache	gcs_eyes_apache	...	aids	cirrhosis	diabetes_mellitus	leukemia	hospital_death
0	79.0	25.616497	1	168.0	72.3	0.305556	0.0	20.0	0.92	4.0	...	0.0	0.0	0.0	0.0	0
1	43.0	23.494409	0	171.0	68.7	0.011806	0.0	9.0	0.70	1.0	...	0.0	0.0	0.0	0.0	0
2	62.0	29.145882	0	182.9	97.5	0.006250	0.0	54.0	3.59	1.0	...	0.0	0.0	0.0	0.0	1
3	72.0	41.183318	1	170.2	119.3	1.945139	0.0	53.0	2.25	4.0	...	0.0	0.0	1.0	0.0	1
4	87.0	22.914211	0	170.1	66.3	0.085417	0.0	33.0	1.60	4.0	...	0.0	0.0	0.0	0.0	0

Advanced Testing File Format

- Named "***lab2_advanced_testing*.csv**"
  - 900 instances in total
  - Each instance has 29 features
  - Without class label

29 features

	age	bmi	gender	height	weight	pre_icu_los_days	arf_apache	bun_apache	creatinine_apache	gcs_eyes_apache	...	sodium_apache	temp_apache	ventilated_apache	wbc_apache
0	82	38.733847	1	158.23	96.82	0.232639	0.0	50	3.32	1.0	...	135	33.0	1.0	14.8
1	65	22.692476	0	173.67	69.40	0.121528	0.0	33	1.40	1.0	...	133	32.1	1.0	12.5
2	72	33.702285	0	177.47	105.70	0.143750	0.0	17	1.71	1.0	...	143	33.9	1.0	17.8
3	81	20.274075	0	171.74	61.10	0.664583	0.0	35	2.09	3.0	...	136	36.4	1.0	9.0
4	41	29.027749	1	175.75	90.00	0.004167	0.0	3	0.41	1.0	...	149	32.3	1.0	24.0

Grading Policy

Item	Score
Basic Implementation (Decision Tree)	30%
Advanced Implementation (Random Forest)	65%
Report	5%

Basic Implementation (30%)

- **Section 1: Function Implementation and Testing**
  - Implement 5 functions that are necessary for building a decision tree model.
  - After implementing each function, you must run it with the given input variables to verify its correctness.
- **Section 2: Build a Decision Tree Model and make Predictions**
  - Use the functions from section 1 to build a decision tree model and make predictions.
- Please use ***lab2_basic_input.csv*** as your input data

Basic Grading Policy

- Given information on 40 patients and whether they survived
- Section 1: Function Implementation and Testing
  - Step 1 : Calculate the Entropy
    (5%)
  - Step 2 : Calculate the Information Gain (5%)
  - Step 3 : Find the Best Split
    (5%)
  - Step 4 : Split the data into two branches (5%)
  - Step 5 : Build the decision tree
    (5%)
  - Step 6: Save answers
- Section 2: Build a Decision Tree Model and make Predictions
  - Step 1: Split the data into training set and validation set
  - Step 2: Train a decision tree model with the training set
  - Step 3: Predict the cases in the validation set by using the model trained in Step 2
  - Step 4: Calculate the f1-score of your predictions in Step 3 (5%)

Basic Output File Format

- Please save your answers into ***lab2_basic.csv***
  - Submit the file to **eeclass**
- There should be 7 rows in your csv file:

row number	description	variable
Row 1	Header	[‘Id’, ‘Ans’]
Row 2	entropy	‘ans_entropy’
Row 3	information gain	‘ans_informationGain’
Row 4	best split information gain, value, feature	[‘ans_ig’, ‘ans_value’, ‘ans_name’]
Row 5	number of instances in the left subtree	‘ans_left’
Row 6	n features and the threshold corresponding to each feature	‘ans_features’ + ‘ans_thresholds‘
Row 7	F1-score	‘ans_f1score’

Advanced Implementation (65%)

- Build a random forest
- Please use ***lab2_advanced_training.csv*** as the training data
- Make predictions with the Random Forest on the testing data ***lab2_advanced_testing.csv***

Advanced Grading Policy

- Baseline – 55%
  - F1-Score >= 0.65 (25%)
  - F1-Score >= 0.68 (15%)
  - F1-Score >= 0.7 (15%)
- Ranking – 10%
  - Compete your F1-Score with the whole class

Advanced Output File Format

- There should be (900+1) rows in your csv file
  - First row is the header [‘Id’, ‘hospital_death’]
  - Your prediction answer should be either 0 or 1
  - Id starts from 0, and **hospital_death** is the predicted answer
- Please make sure that your output format is correct
- Submit the answer (.csv) to Kaggle **ML2024-Lab2-AdvancedPart**

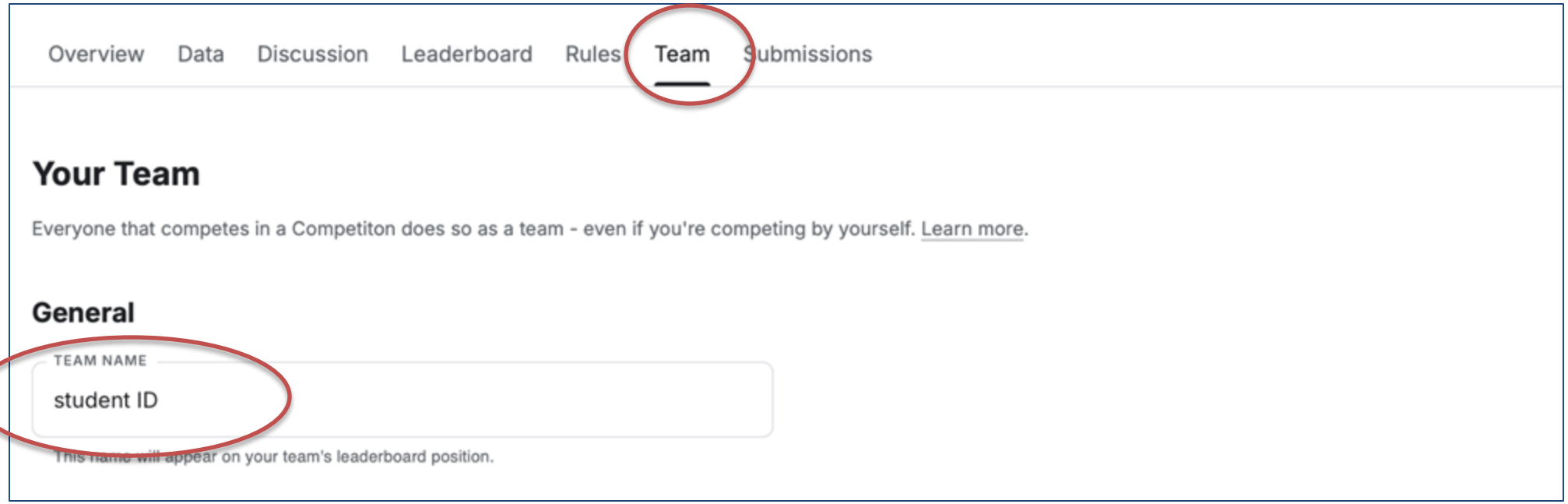
Id	hospital_death
0	1
1	1
2	1
3	1
4	1
5	0
6	0
7	1
8	1
9	1
10	0
11	0
12	0
13	1
14	0

Kaggle

- We’ve created a competition for the Advanced part
- link: https://www.kaggle.com/t/f429abd0842e414e9685155f9bcb21ce
  - In the advanced part, we split the testing data into **public** & **private** parts.
  - The score you see on kaggle after submission is your public score
    - You can directly check if you have passed the three baselines
  - Private score is for ranking.
    - The private score will be revealed after the deadline.

Kaggle

- After joining the competition, you should change your team name (each student is a team) to your **student ID.**



Report

- Named as “**lab2_report.pdf**”
- Briefly describe the attributes setting of the random forest model , including:
  - The number of trees you used (1%)
  - The number of features you used (1%)
  - The number of instances you used to build each tree (1%)
  - (optional) any other settings
- Briefly describe the difficulty you encountered (1%)
- Summarize how you solved the difficulty and your reflections (1%)
- **No more than one page**

Lab 2 Requirements

- Do it individually! Not as a team! (The team is for the final project)
- Announce date: 2024/10/1
- Deadline: 2024/10/15 23:59 (Late submission is not allowed!)
- Hand in your files in the following format (Do not compress!)
    - lab2.ipynb
    - lab2_report.pdf
    - lab2_basic.csv

The Evaluation Metric

- F1-score

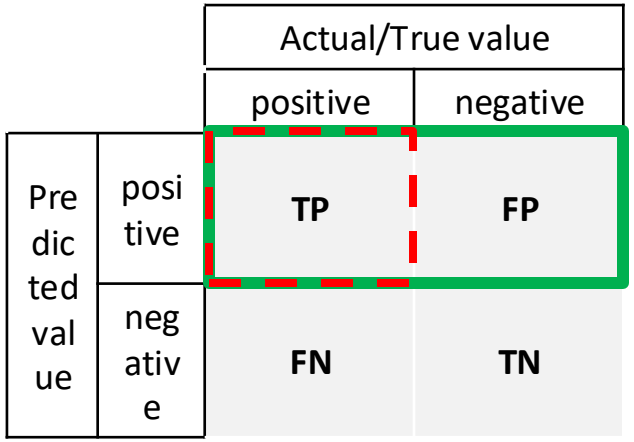
$$F1\text{-}score = 2 \times \frac{(Precision \times Recall)}{(Precision + Recall)}$$

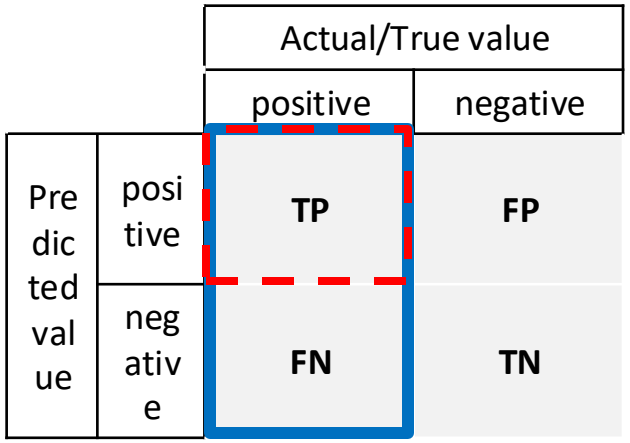
- For example
  - The class you predicted:

    $\hat{y}$ = [1, 1, 0, 0, 0, 0, 1]
  - Actual values:

    y = [0, 0, 0, 0, 0, 1, 1]

  - F1-score = 0.4





Penalty

- 0 points if any of the following conditions happened
  - Plagiarism
  - Late submission
  - Not using a template or importing any other packages in this assignment
  - No submission record on Kaggle
  - Your submission was not generated by your code
  - Not following the instructions to print certain answers in the template
  - Kaggle’s team name is not your student ID(we cannot identify who you are)

Questions?

- TA: Ya-Ting Lin (ivylin752@gmail.com)
- Do not ask for debugging.
- **TA time for 10/3 and 10/9 will be moved to 17:30~18:30**