Diagnosis of Thyroid Diseases from Blood Work

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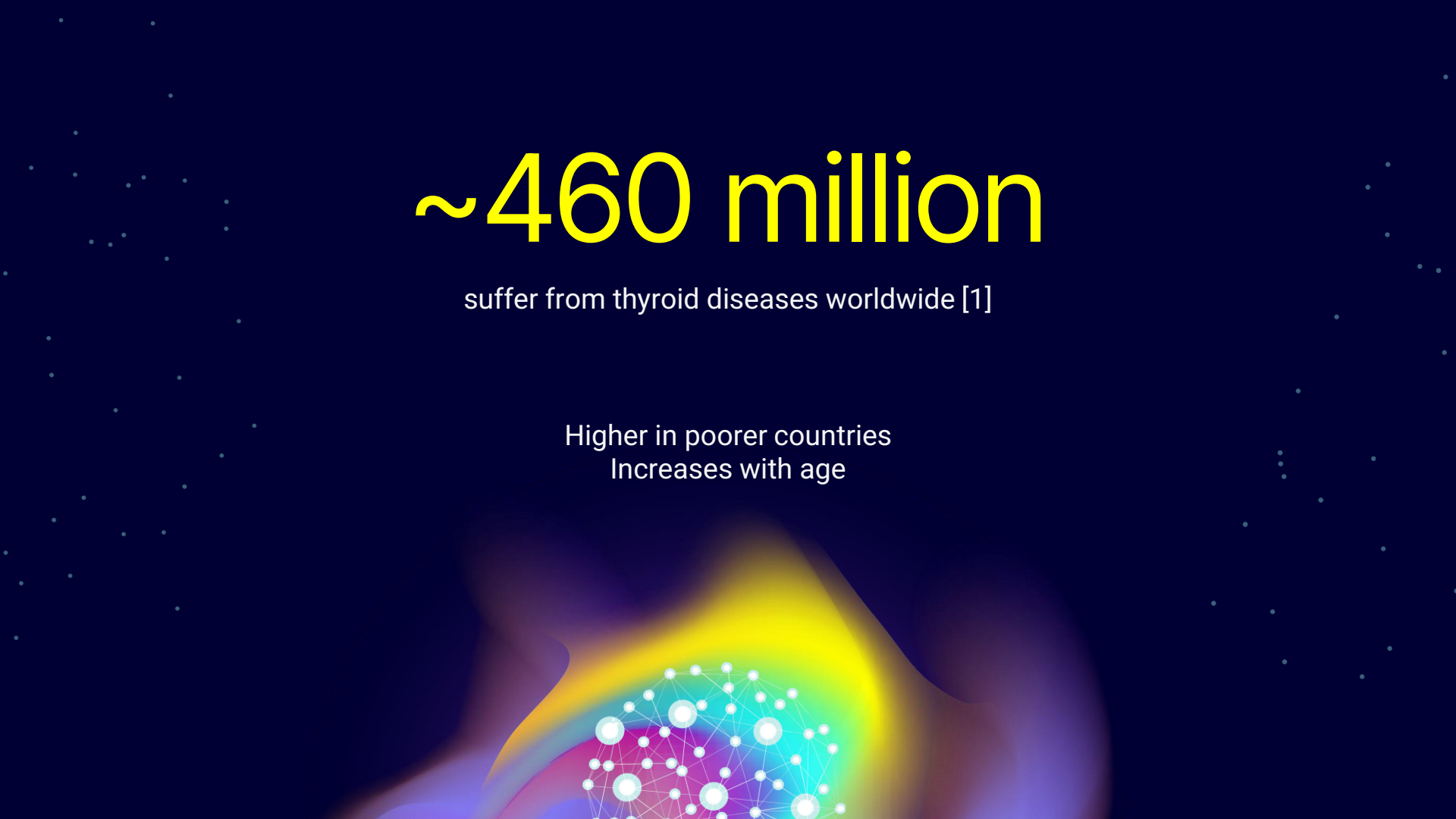
~460 million

suffer from thyroid diseases worldwide [1]

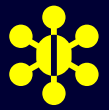
Higher in poorer countries
Increases with age



Missed...

Symptom Variety

Thyroid diseases can manifest many different symptoms



Symptom Overlap

Thyroid disease symptoms often overlap with mundane problems, like sleep deprivation & obesity [2]

Blood Work Ambiguity

Blood work abnormalities can often be explained by other mundane problems [2]

JUST

make a model
to classify it

BLOOD.

…test dataset [3] from the UCI machine learning repository

DATASET

AGE

SEX

SURGERY?

MEDICATION?

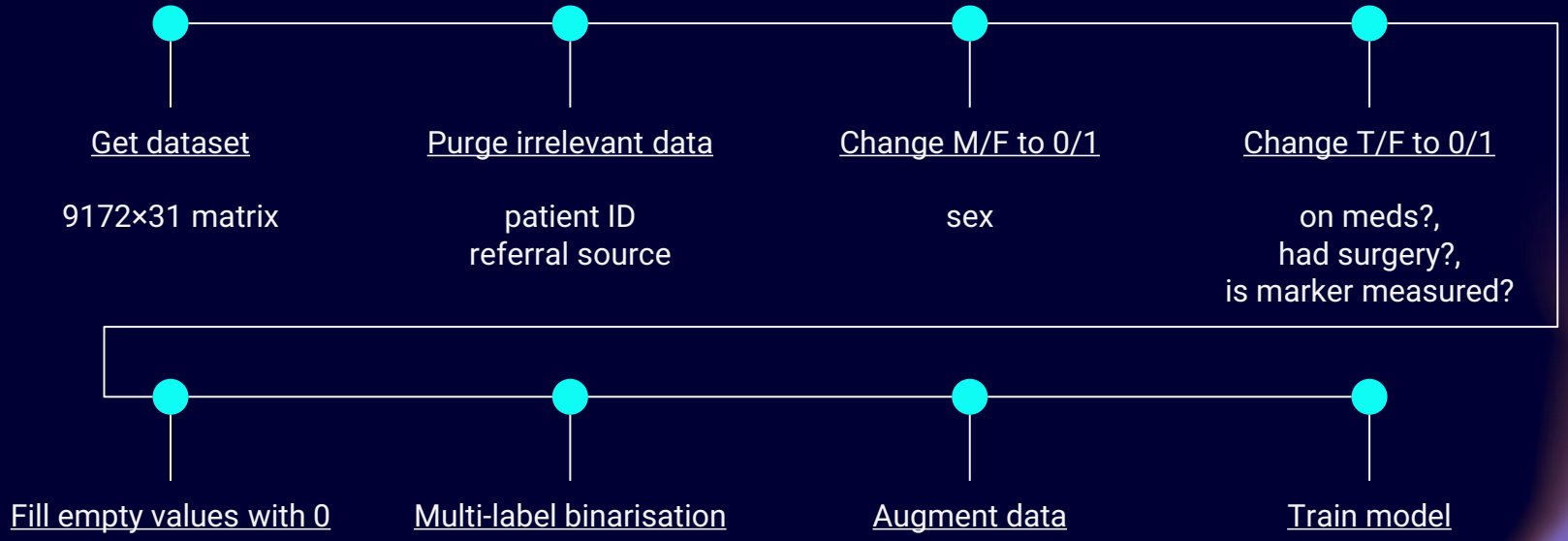
BLOOD MARKERS

TSH, T3, TT4, T4U, FTI, TBG

DIAGNOSIS

Thyroid disease variation

Sanitisation & Augmentation



Diagnosis

Characters

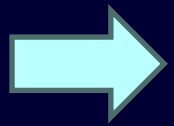
-	Healthy
A	Hyperthyroid
B	T3 toxic
C	Toxic goitre
D	Secondary toxic
...	
S	Elevated TBG

Multi-label

A	A is the diagnosis
AB	Both A & B are diagnosed
A|B	A is the more likely diagnosis, but B is also possible

Diagnosis multi-label binarisation

		target
180		-
181		MK

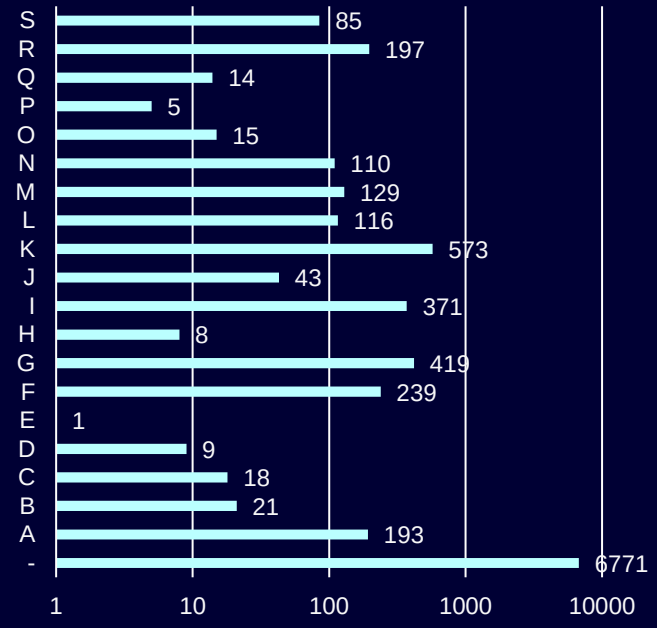


	K	R	I	M	N
179	0.0	0.0	0.0	0.0	0.0
180	0.0	0.0	0.0	0.0	0.0
181	1.0	0.0	0.0	1.0	0.0
182	0.0	0.0	0.0	0.0	0.0

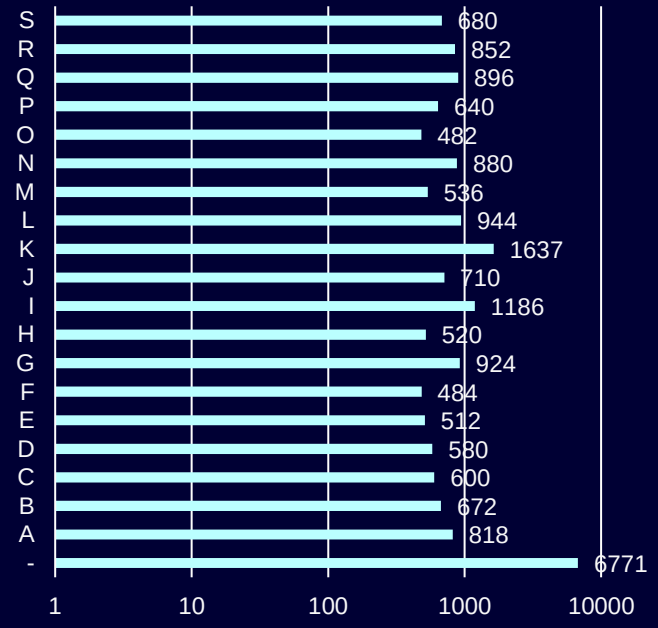
		target
521		-
522		C|I

	R	I	M	N	G	J	L	Q	C
519	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
522	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0

Data Augmentation

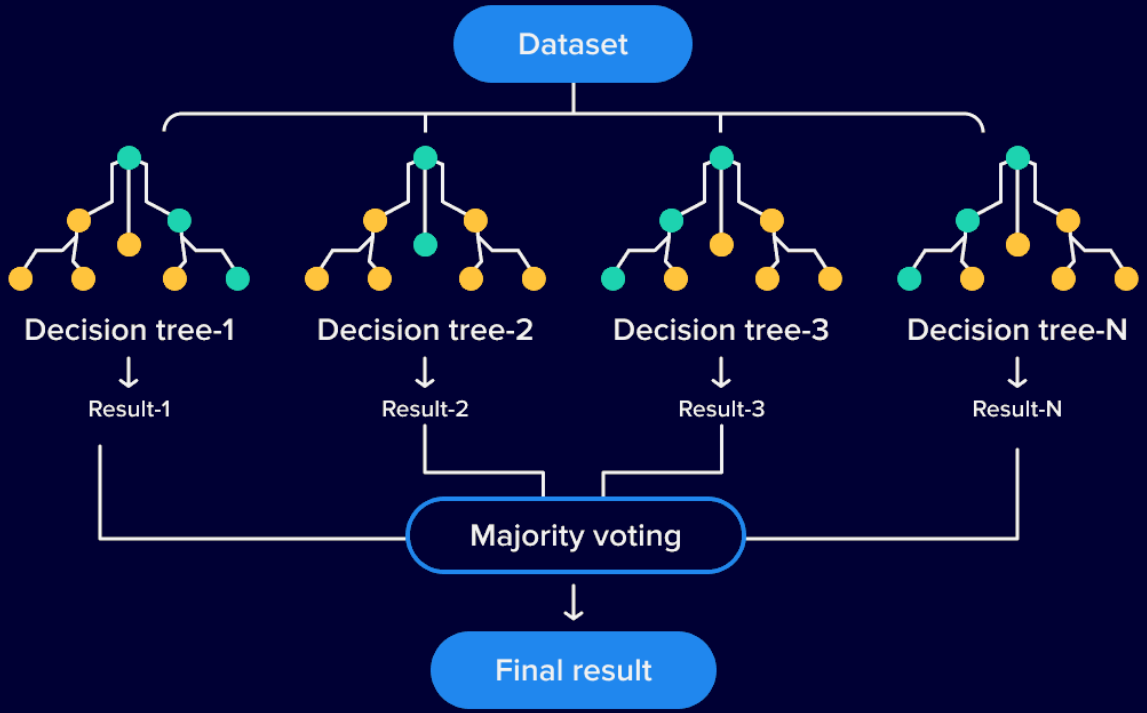


9172 samples



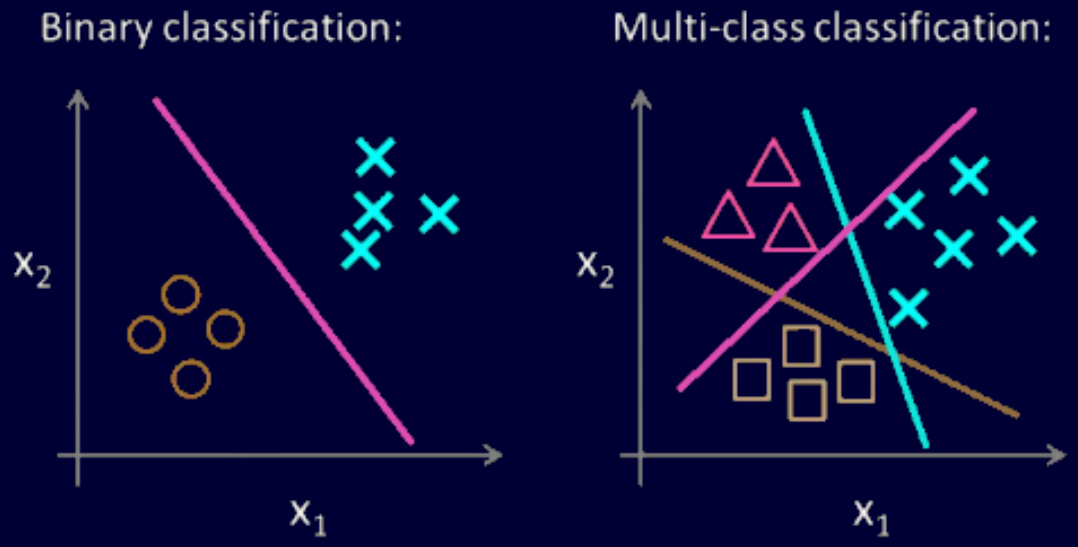
19518 samples

Random Forest Ensemble

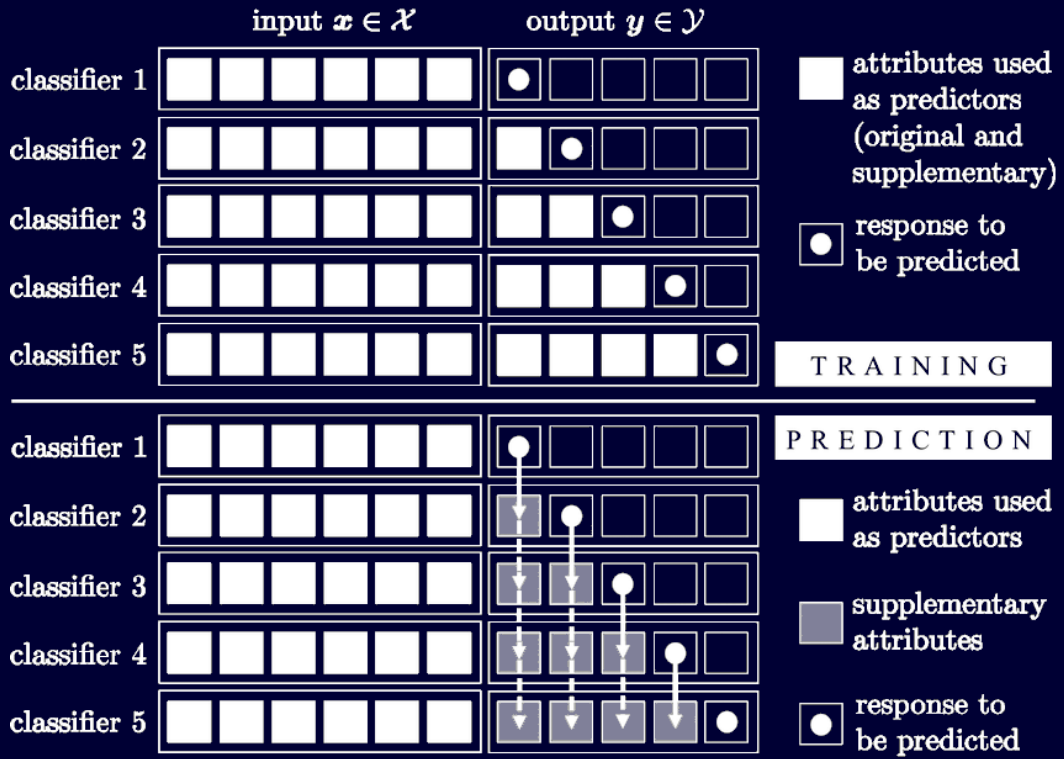


100

One vs Rest Classification

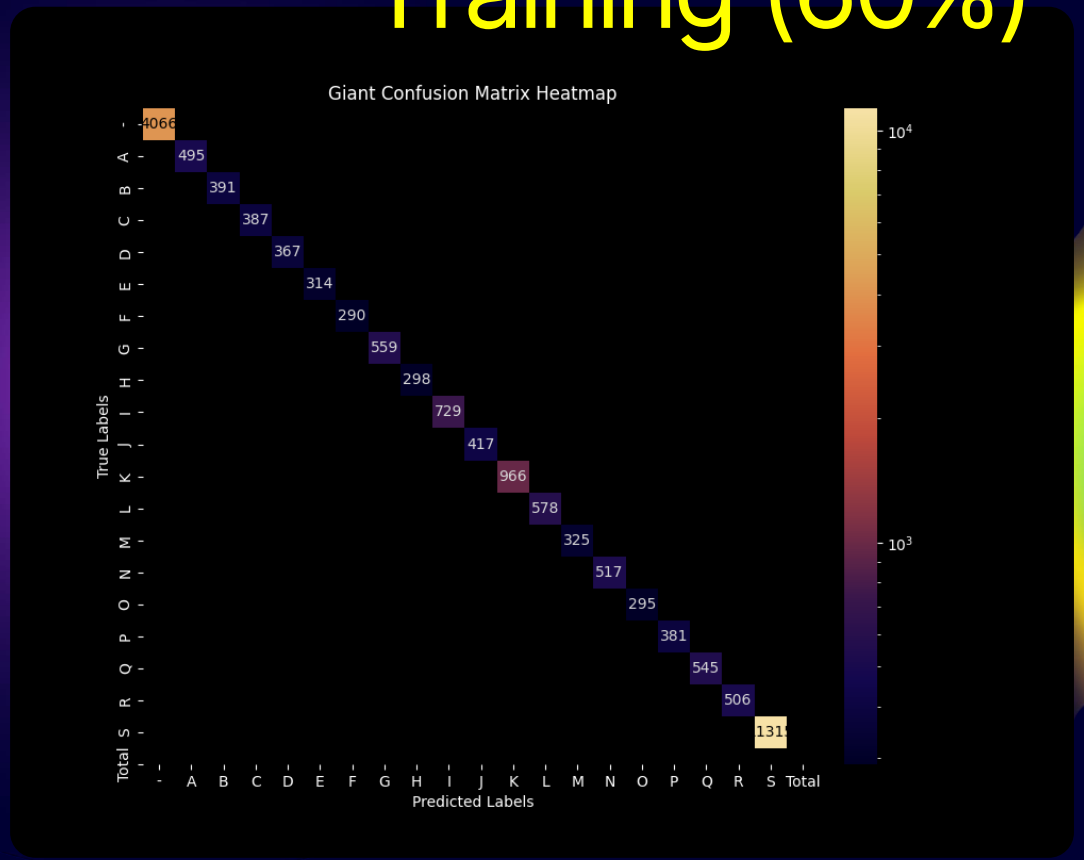


Classifier Chaining



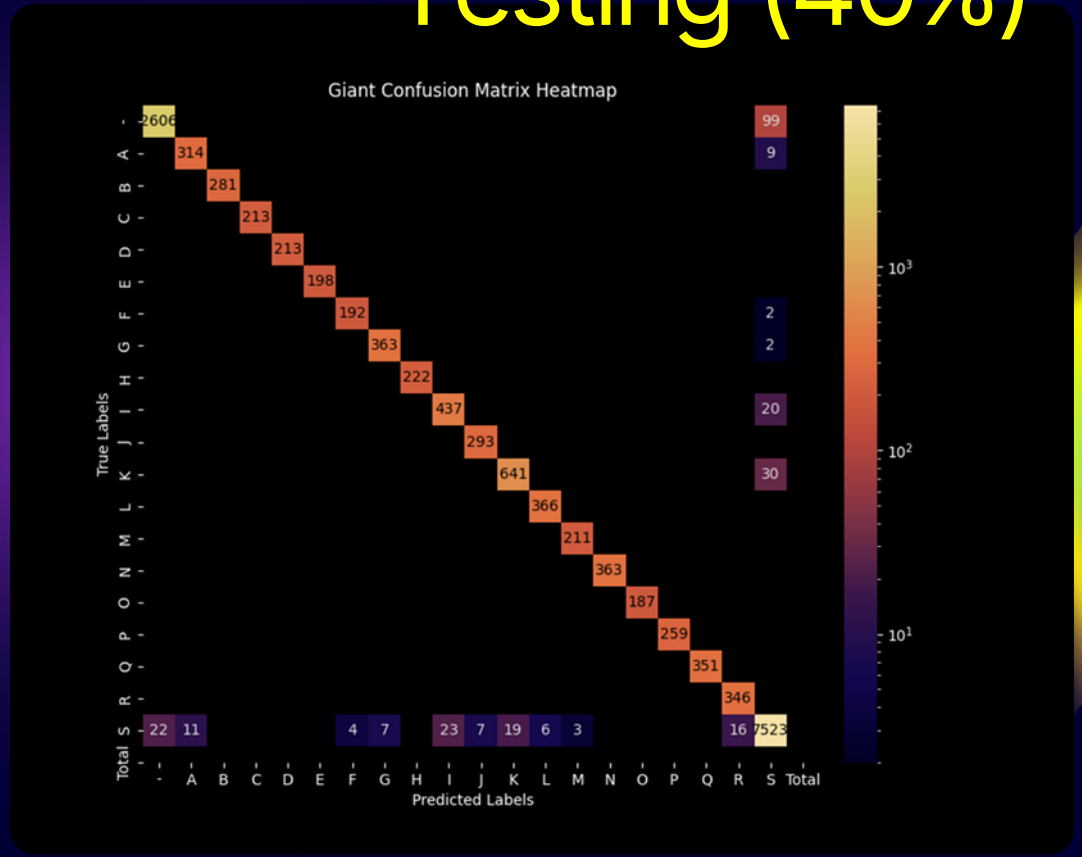
Training (60%)

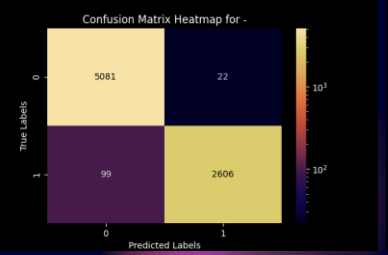
```
Overall accuracy: 1.0
Overall precision: 1.0
Overall recall: 1.0

Classification Report:
              precision    recall  f1-score   support

           -       1.00      1.00      1.00      4066
           A       1.00      1.00      1.00       495
           B       1.00      1.00      1.00       391
           C       1.00      1.00      1.00       387
           D       1.00      1.00      1.00       367
           E       1.00      1.00      1.00       314
           F       1.00      1.00      1.00       290
           G       1.00      1.00      1.00       559
           H       1.00      1.00      1.00       298
           I       1.00      1.00      1.00       729
           J       1.00      1.00      1.00       417
           K       1.00      1.00      1.00       966
           L       1.00      1.00      1.00       578
           M       1.00      1.00      1.00       325
           N       1.00      1.00      1.00       517
           O       1.00      1.00      1.00       295
           P       1.00      1.00      1.00       381
           Q       1.00      1.00      1.00       545
           R       1.00      1.00      1.00       506
           S       1.00      1.00      1.00       395

   micro avg       1.00      1.00      1.00     12821
   macro avg       1.00      1.00      1.00     12821
weighted avg       1.00      1.00      1.00     12821
 samples avg       1.00      1.00      1.00     12821
```

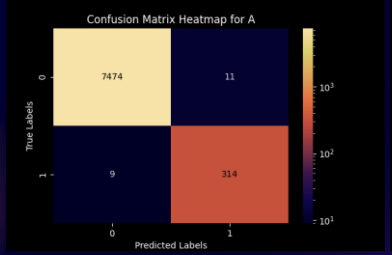


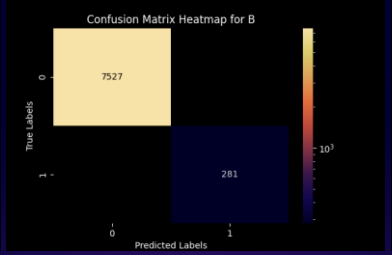
Testing (40%)

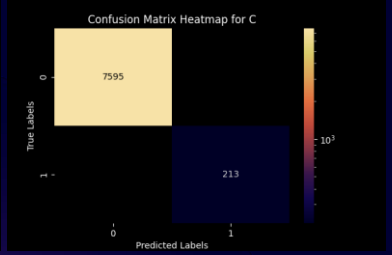
```
Overall accuracy: 0.9798924180327869
Overall precision: 0.9860525323222735
Overall recall: 0.980947900740915

Classification Report:
              precision    recall  f1-score   support

           -       0.99      0.96      0.98      2705
           A       0.97      0.97      0.97       323
           B       1.00      1.00      1.00       281
           C       1.00      1.00      1.00       213
           D       1.00      1.00      1.00       213
           E       1.00      1.00      1.00       198
           F       0.98      0.99      0.98       194
           G       0.98      0.99      0.99       365
           H       1.00      1.00      1.00       222
           I       0.95      0.96      0.95       457
           J       0.98      1.00      0.99       293
           K       0.97      0.96      0.96       671
           L       0.98      1.00      0.99       366
           M       0.99      1.00      0.99       211
           N       1.00      1.00      1.00       363
           O       1.00      1.00      1.00       187
           P       1.00      1.00      1.00       259
           Q       1.00      1.00      1.00       351
           R       0.96      1.00      0.98       346
           S       1.00      1.00      1.00       285

   micro avg       0.99      0.98      0.98      8503
   macro avg       0.99      0.99      0.99      8503
weighted avg       0.99      0.98      0.98      8503
 samples avg       0.98      0.98      0.98      8503
```

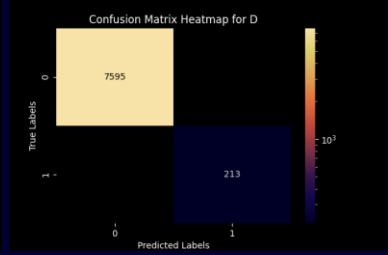


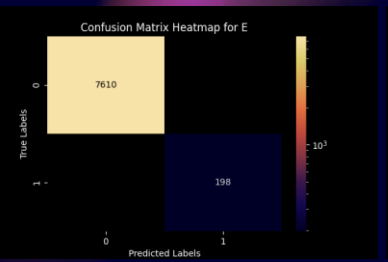

Confusion Matrix Heatmap for -
5081
22
99
2606
True Labels
Predicted Labels

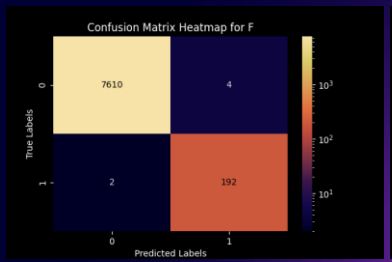

Confusion Matrix Heatmap for A
7474
11
9
314
True Labels
Predicted Labels

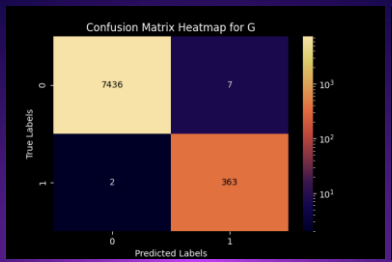

Confusion Matrix Heatmap for B
7527
281
True Labels
Predicted Labels

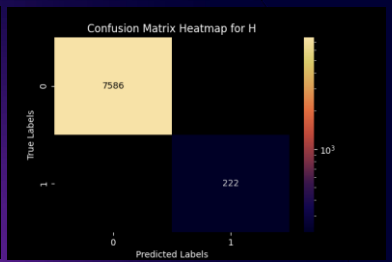

Confusion Matrix Heatmap for C
7595
213
True Labels
Predicted Labels

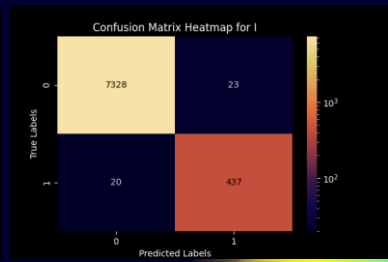

Confusion Matrix Heatmap for D
7595
213
True Labels
Predicted Labels

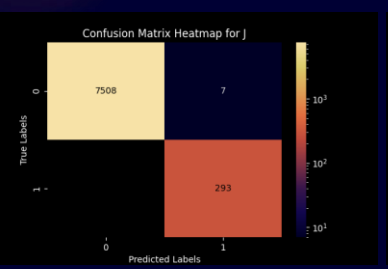

Confusion Matrix Heatmap for E
7610
198
True Labels
Predicted Labels

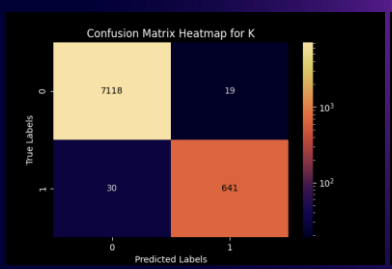

Confusion Matrix Heatmap for F
7610
4
2
192
True Labels
Predicted Labels

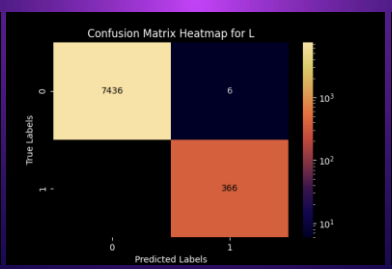

Confusion Matrix Heatmap for G
7436
7
2
363
True Labels
Predicted Labels

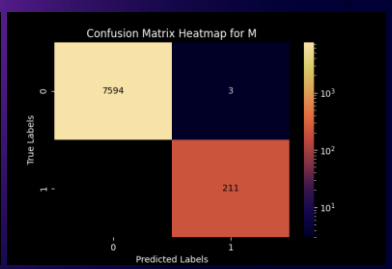

Confusion Matrix Heatmap for H
7586
222
True Labels
Predicted Labels

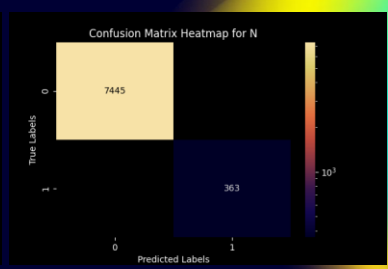

Confusion Matrix Heatmap for I
7328
23
20
437
True Labels
Predicted Labels

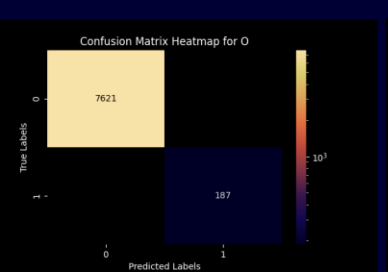

Confusion Matrix Heatmap for J
7508
7
293
True Labels
Predicted Labels

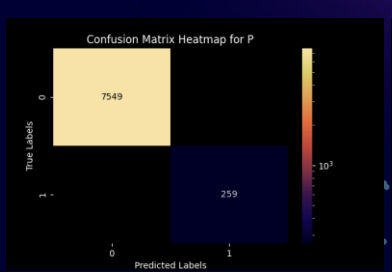

Confusion Matrix Heatmap for K
7118
19
30
641
True Labels
Predicted Labels

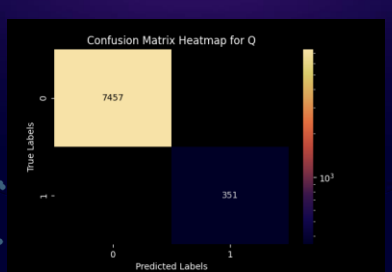

Confusion Matrix Heatmap for L
7436
6
366
True Labels
Predicted Labels

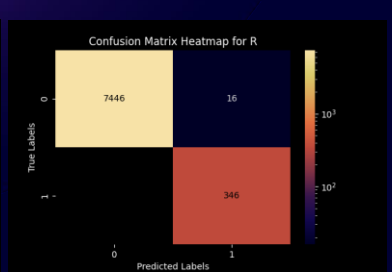

Confusion Matrix Heatmap for M
7594
3
211
True Labels
Predicted Labels

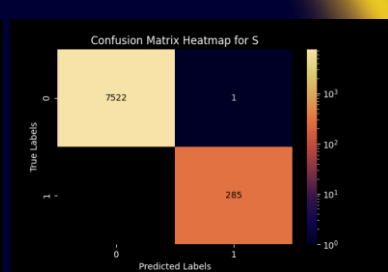

Confusion Matrix Heatmap for N
7445
363
True Labels
Predicted Labels


Confusion Matrix Heatmap for O
7621
187
True Labels
Predicted Labels


Confusion Matrix Heatmap for P
7549
259
True Labels
Predicted Labels


Confusion Matrix Heatmap for Q
7457
351
True Labels
Predicted Labels


Confusion Matrix Heatmap for R
7446
16
346
True Labels
Predicted Labels


Confusion Matrix Heatmap for S
7522
1
285
True Labels
Predicted Labels

Conclusion:

can classify

98% accuracy

Future Direction?

1. Compile a dataset with more features and more diagnoses, this can probably help to discriminate differential diagnoses
2. Give output in terms of severity/stage
3. Evaluate treatment plans of more diseases

References

[1] Vanderpump, M.P.J. (2019). Epidemiology of Thyroid Disorders. In: Luster, M., Duntas, L., Wartofsky, L. (eds) The Thyroid and Its Diseases. Springer, Cham. https://doi.org/10.1007/978-3-319-72102-6_6

[2] J. L. Eaton, Thyroid disease and reproduction : a clinical guide to diagnosis and management. Cham, Switzerland: Springer, 2019.

[3] R. Quinlan. "Thyroid Disease," UCI Machine Learning Repository, 1986. [Online]. Available: https://doi.org/10.24432/C5D010

Thanks!

Do you have any questions?

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