iHeartB

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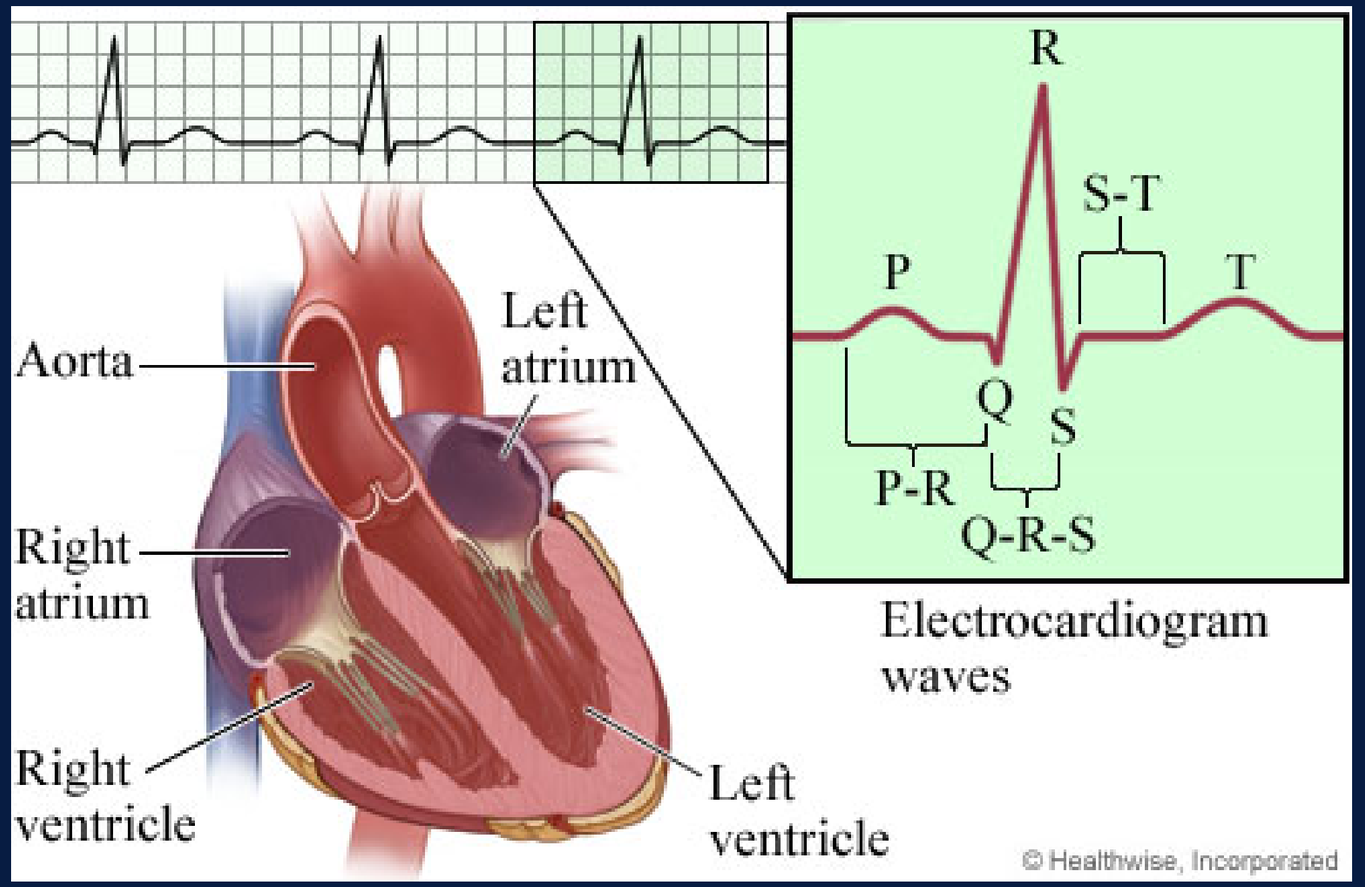
Team IA1

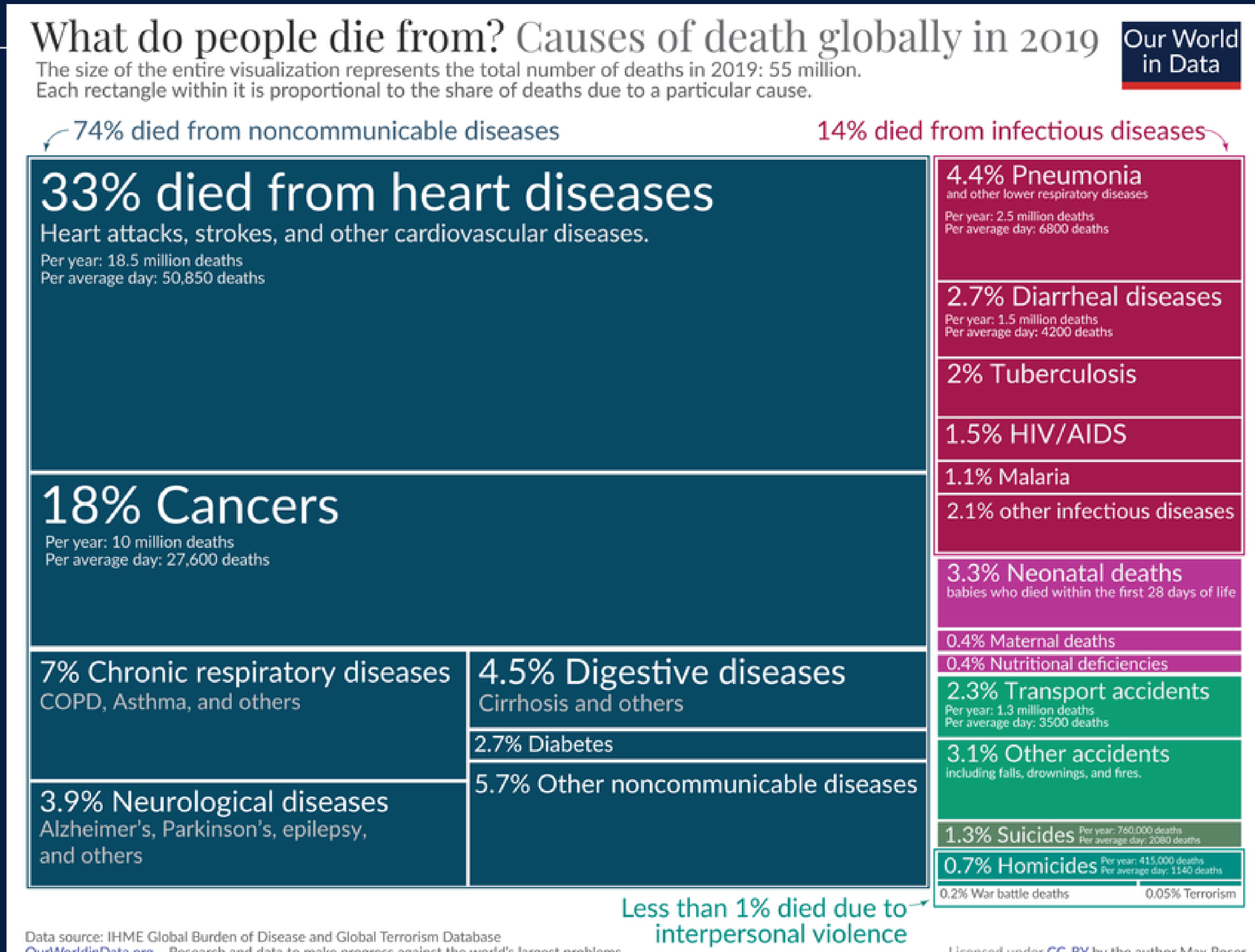
EKG signal processing for heart disease classification

What’s an EKG?



Electrocardiogram (ECG or EKG)

Why?


What do people die from? Causes of death globally in 2019
The size of the entire visualization represents the total number of deaths in 2019: 55 million.
Each rectangle within it is proportional to the share of deaths due to a particular cause.
Our World in Data
74% died from noncommunicable diseases
14% died from infectious diseases
33% died from heart diseases
Heart attacks, strokes, and other cardiovascular diseases.
Per year: 18.5 million deaths
Per average day: 50,850 deaths
18% Cancers
Per year: 10 million deaths
Per average day: 27,600 deaths
7% Chronic respiratory diseases
COPD, Asthma, and others
4.5% Digestive diseases
Cirrhosis and others
2.7% Diabetes
3.9% Neurological diseases
Alzheimer's, Parkinson's, epilepsy, and others
5.7% Other noncommunicable diseases
4.4% Pneumonia
and other lower respiratory diseases
Per year: 2.5 million deaths
Per average day: 6800 deaths
2.7% Diarrheal diseases
Per year: 1.5 million deaths
Per average day: 4200 deaths
2% Tuberculosis
1.5% HIV/AIDS
1.1% Malaria
2.1% other infectious diseases
3.3% Neonatal deaths
babies who died within the first 28 days of life
0.4% Maternal deaths
0.4% Nutritional deficiencies
2.3% Transport accidents
Per year: 1.3 million deaths
Per average day: 3500 deaths
3.1% Other accidents
including falls, drownings, and fires.
1.3% Suicides Per year: 760,000 deaths Per average day: 2080 deaths
0.7% Homicides Per year: 415,000 deaths Per average day: 1140 deaths
0.2% War battle deaths
0.05% Terrorism
Less than 1% died due to interpersonal violence
Data source: IHME Global Burden of Disease and Global Terrorism Database

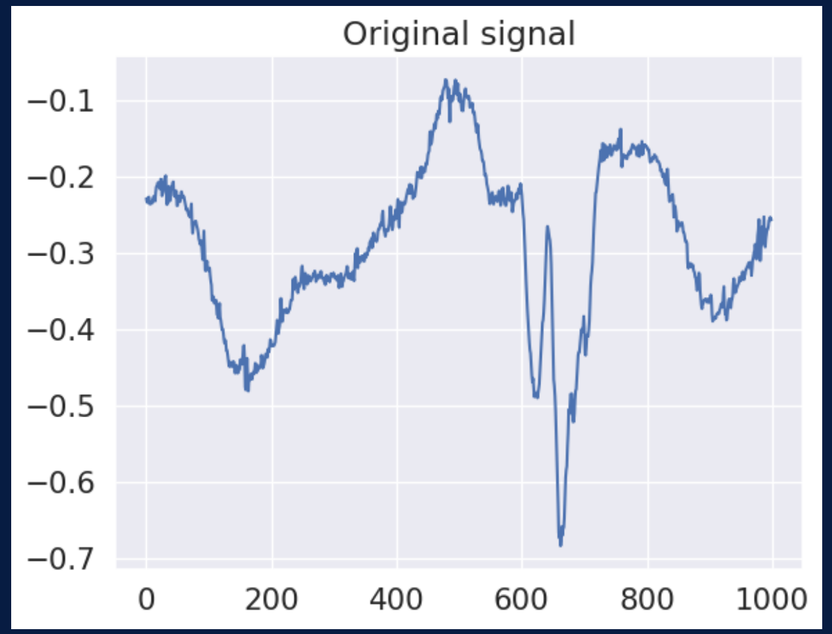
Clasificar 14 tipos de arritmias cardiacas a partir de beats en señales de EKGs

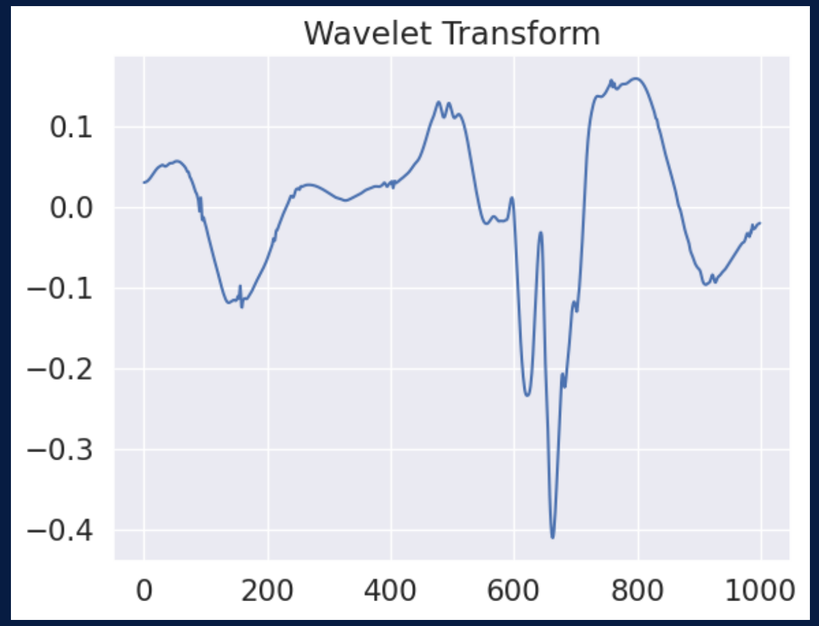
PTB Diagnostic ECG Database

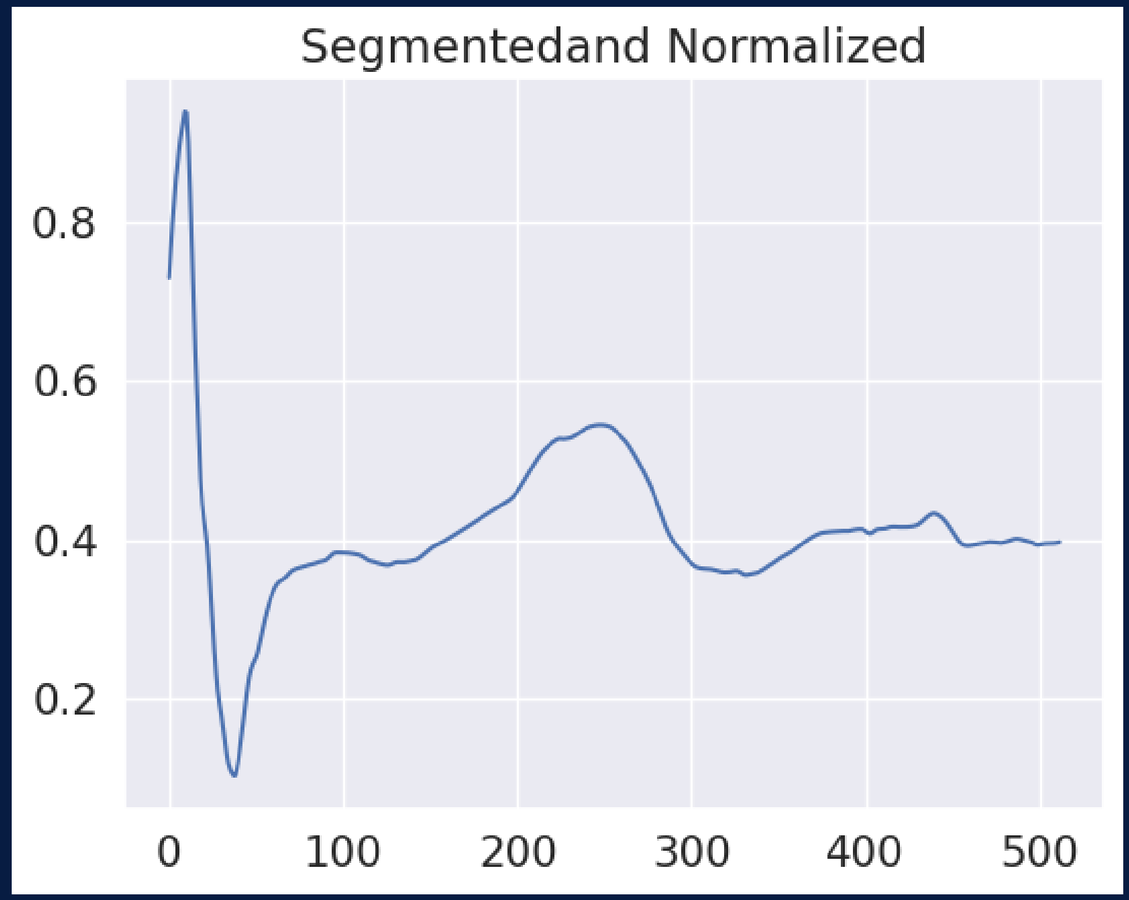
National Institutes of Health

549 recordings
290 patients

0	Bundle branch block
1	Cardiomyopathy
2	Dysrhythmia
3	Healthy control
4	Heart failure (NYHA 2)
5	Heart failure (NYHA 3)
6	Heart failure (NYHA 4)
7	Hypertrophy
8	Myocardial infarction
9	Myocarditis
10	Palpitation
11	Stable angina
12	Unstable angina
13	Valvular heart disease
14	n/a



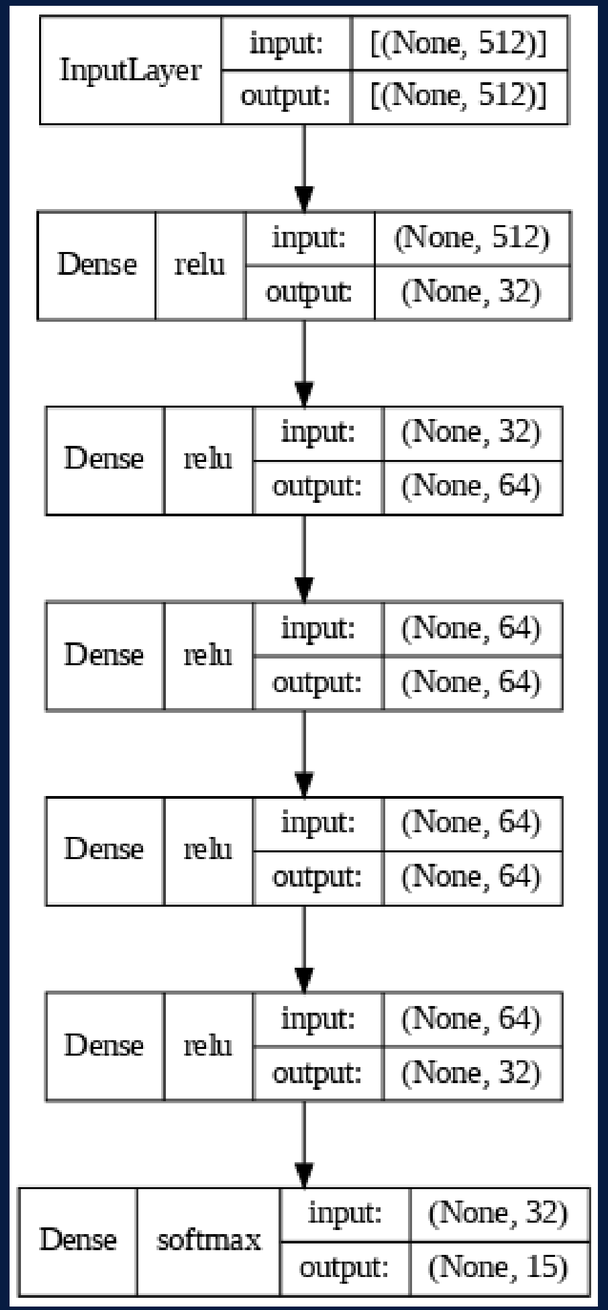




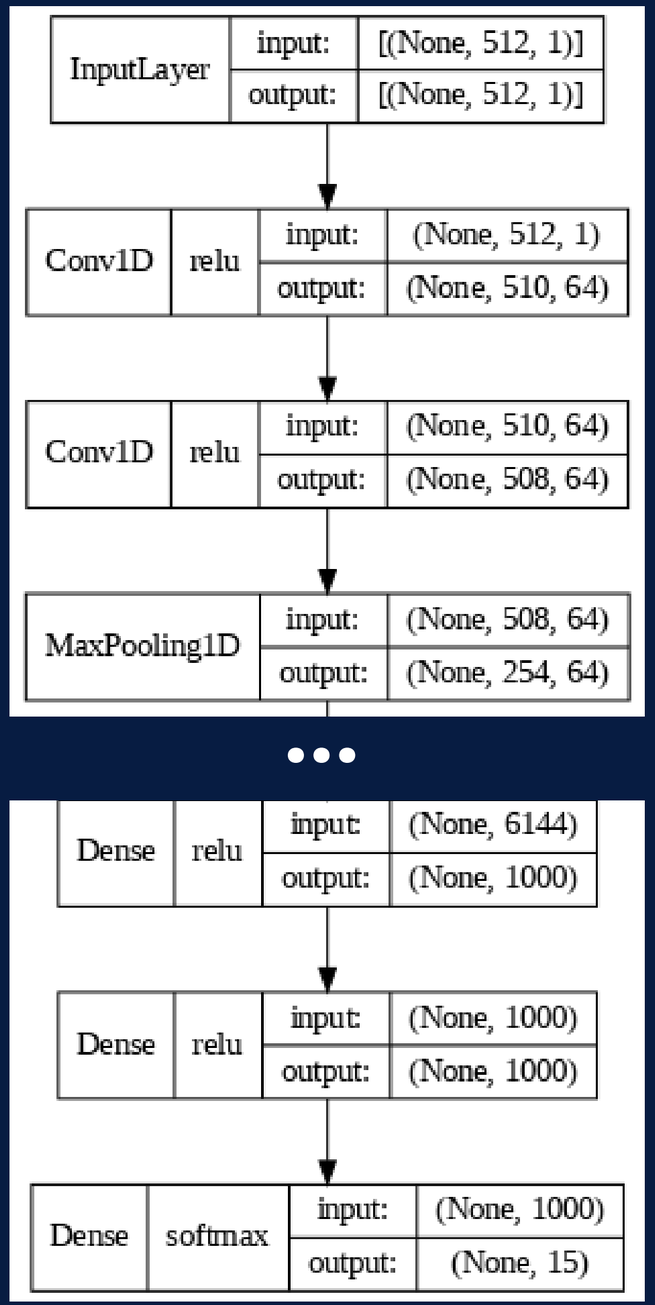
Beat (512 vals)

Architecture Model

DNN

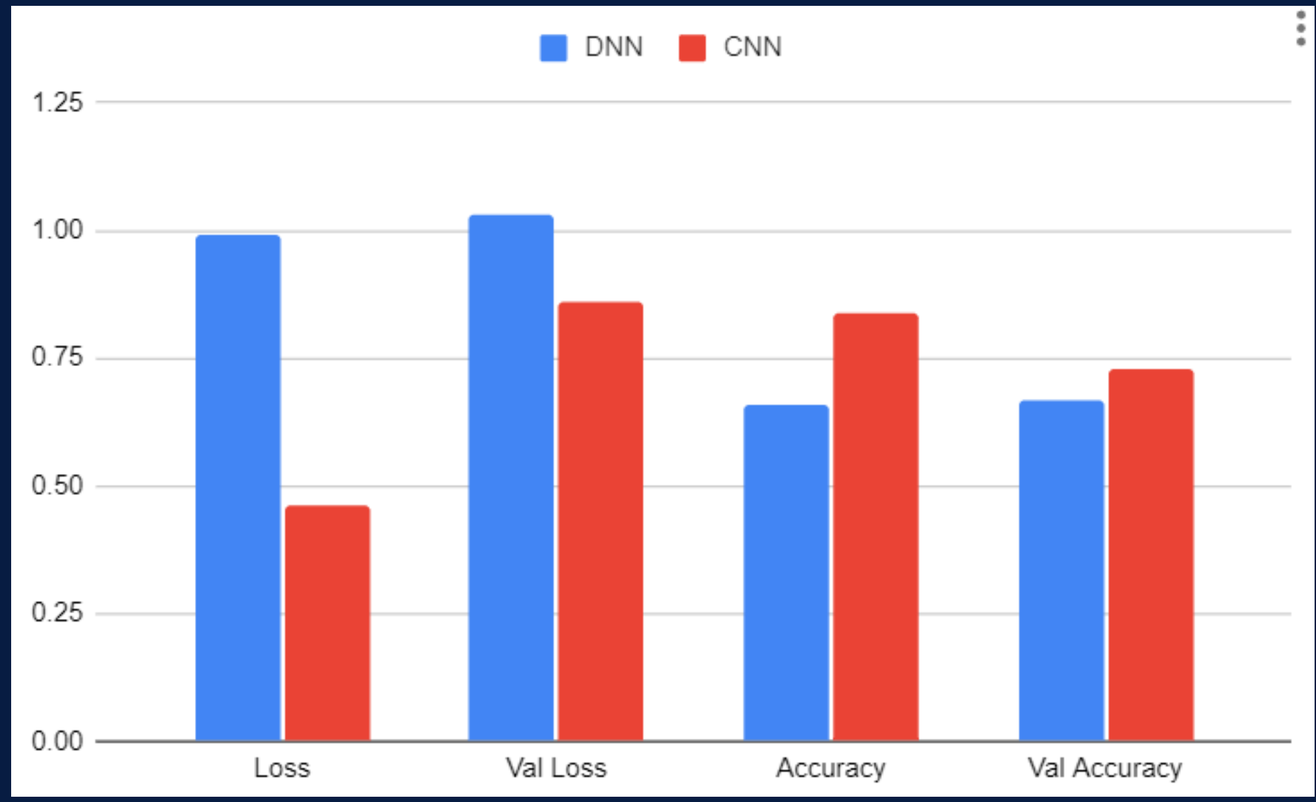


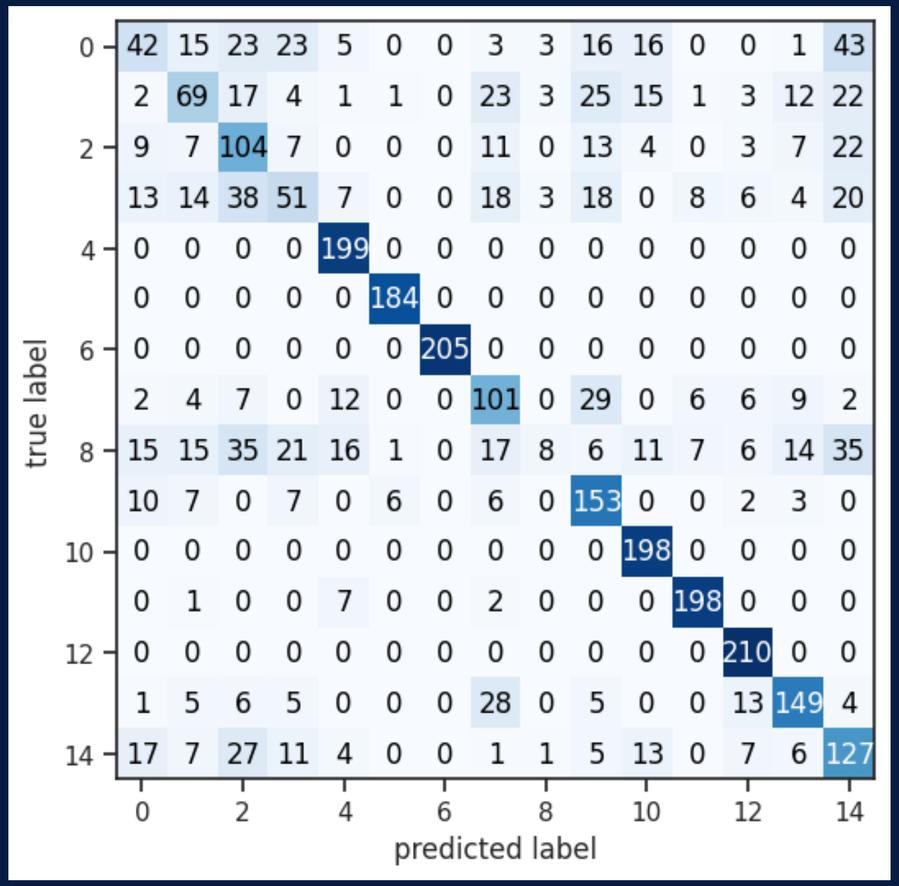
CNN



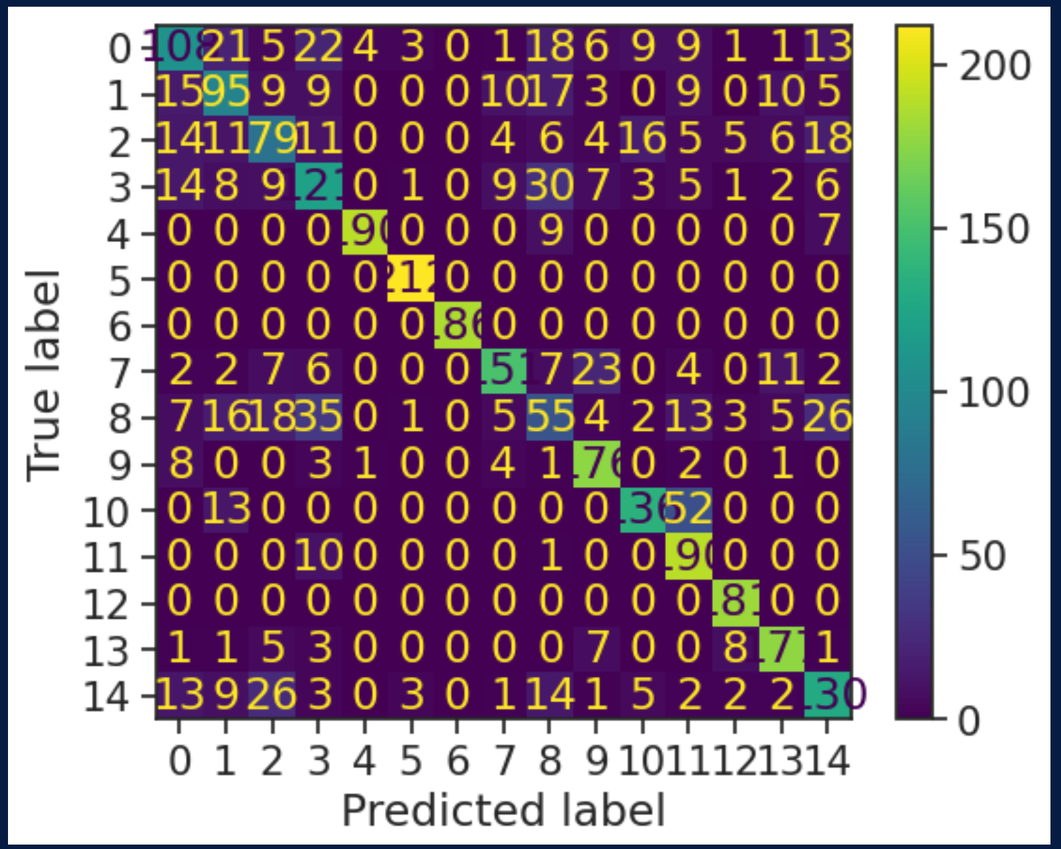
Results

Ephoc	48	10
Loss	0.9901	0.4595
Val Loss	1.0304	0.8605
Accuracy	0.6571	0.84
Val Accuracy	0.666	0.729
	DNN	**CNN**

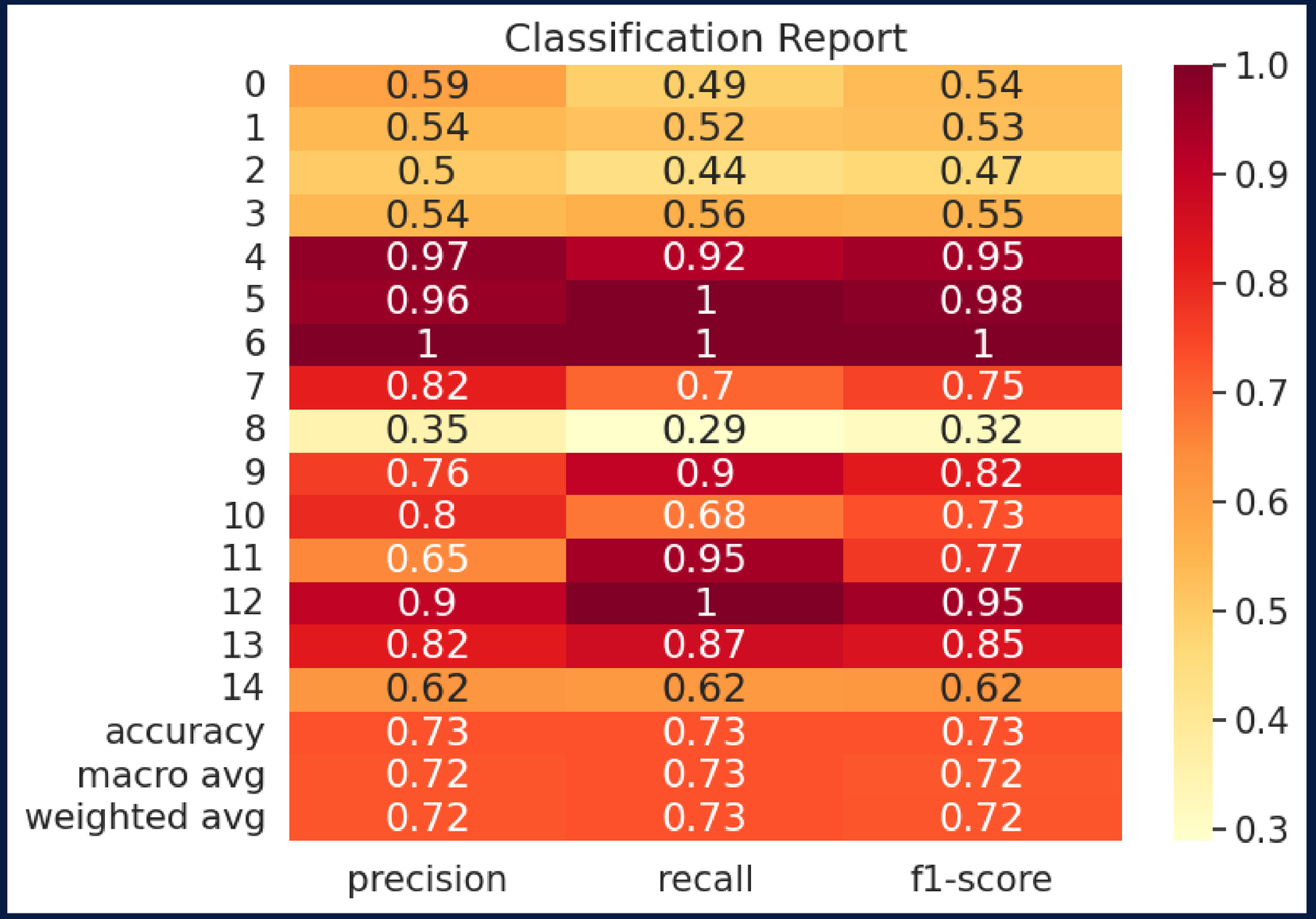



true label
predicted label
0 42 15 23 23 5 0 0 3 3 16 16 0 0 1 43
2 69 17 4 1 1 0 23 3 25 15 1 3 12 22
2 9 7 104 7 0 0 0 11 0 13 4 0 3 7 22
13 14 38 51 7 0 0 18 3 18 0 8 6 4 20
4 0 0 0 0 199 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 184 0 0 0 0 0 0 0 0 0
6 0 0 0 0 0 0 205 0 0 0 0 0 0 0 0
2 4 7 0 12 0 0 101 0 29 0 6 6 9 2
8 15 15 35 21 16 1 0 17 8 6 11 7 6 14 35
10 7 7 0 7 0 6 0 6 0 153 0 0 2 3 0
0 0 0 0 0 0 0 0 0 0 198 0 0 0 0
12 0 1 0 0 7 0 0 2 0 0 0 198 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 210 0 0
1 5 6 5 0 0 0 28 0 5 0 0 13 149 4
14 17 7 27 11 4 0 0 1 1 5 13 0 7 6 127
0 2 4 6 8 10 12 14

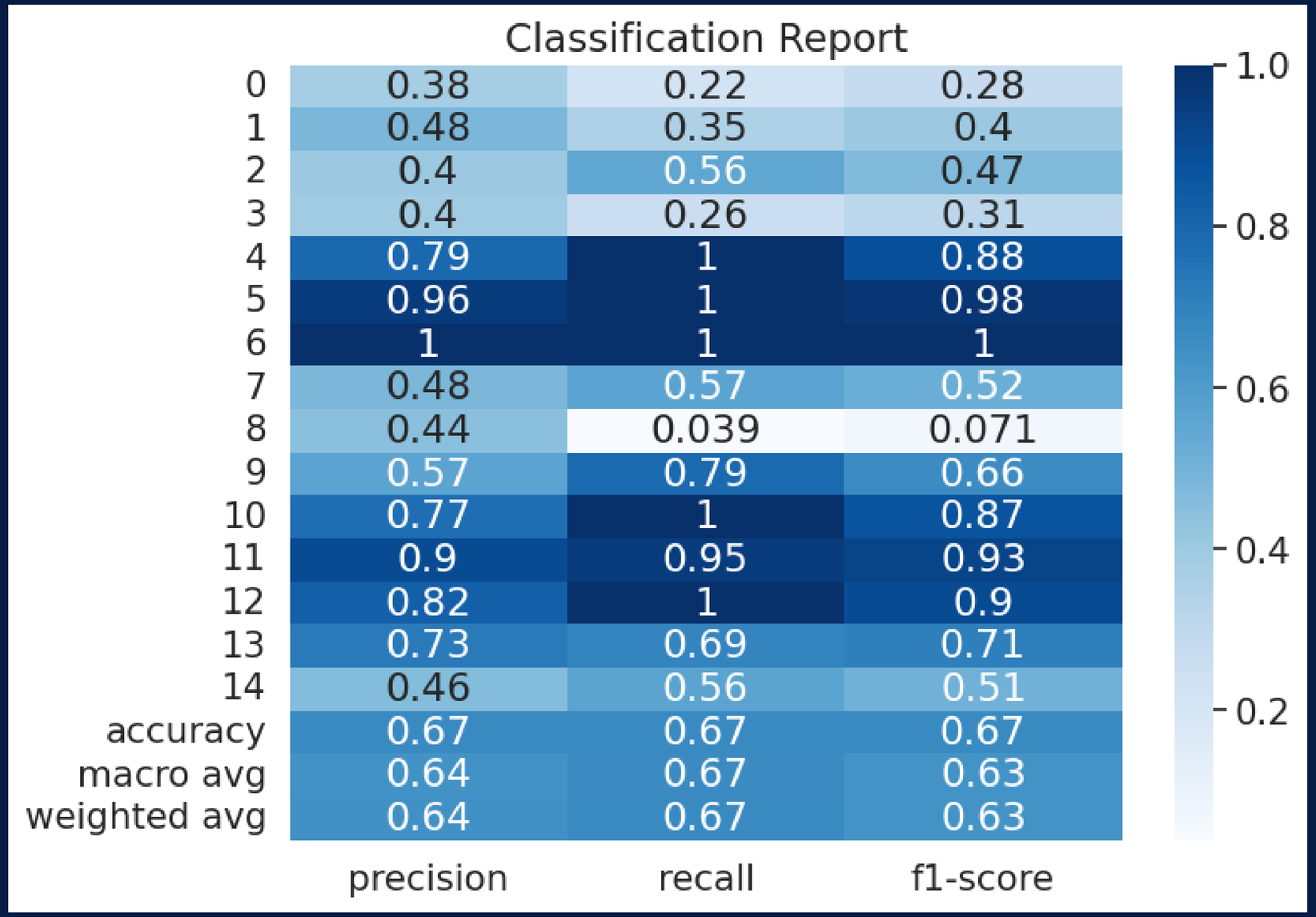
DNN


True label
Predicted label
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
200
150
100
50
0

CNN


Classification Report
0 0.59 0.49 0.54
1 0.54 0.52 0.53
2 0.5 0.44 0.47
3 0.54 0.56 0.55
4 0.97 0.92 0.95
5 0.96 1 0.98
6 1 1 1
7 0.82 0.7 0.75
8 0.35 0.29 0.32
9 0.76 0.9 0.82
10 0.8 0.68 0.73
11 0.65 0.95 0.77
12 0.9 1 0.95
13 0.82 0.87 0.85
14 0.62 0.62 0.62
accuracy 0.73 0.73 0.73
macro avg 0.72 0.73 0.72
weighted avg 0.72 0.73 0.72
precision
recall
f1-score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3

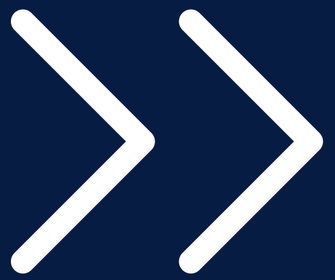
CNN


Classification Report
0 0.38 0.22 0.28
1 0.48 0.35 0.4
2 0.4 0.56 0.47
3 0.4 0.26 0.31
4 0.79 1 0.88
5 0.96 1 0.98
6 1 1 1
7 0.48 0.57 0.52
8 0.44 0.039 0.071
9 0.57 0.79 0.66
10 0.77 1 0.87
11 0.9 0.95 0.93
12 0.82 1 0.9
13 0.73 0.69 0.71
14 0.46 0.56 0.51
accuracy 0.67 0.67 0.67
macro avg 0.64 0.67 0.63
weighted avg 0.64 0.67 0.63
precision
recall
f1-score
1.0
0.8
0.6
0.4
0.2

DNN

Forward

- Mejoramiento de la presicion del modelo
- Coneccion con otros datos médicos
- Integracion con dispositivos wearbles



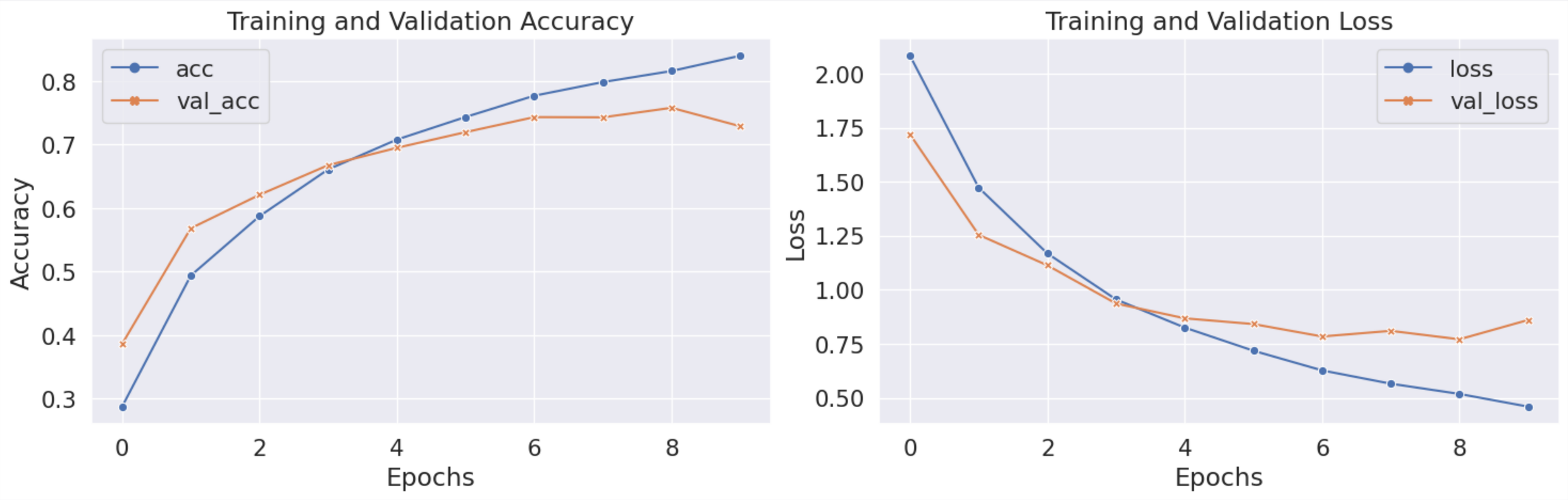
Referencias

Ge D, Srinivasan N, Krishnan SM. Cardiac arrhythmia classification using autoregressive modeling. Biomed Eng Online. 2002 Nov 13;1:5. doi: 10.1186/1475-925x-1-5. PMID: 12473180; PMCID: PMC149374.

Bousseljot R, Kreiseler D, Schnabel, A. Nutzung der EKG-Signaldatenbank CARDIODAT der PTB über das Internet. Biomedizinische Technik, Band 40, Ergänzungsband 1 (1995) S 317

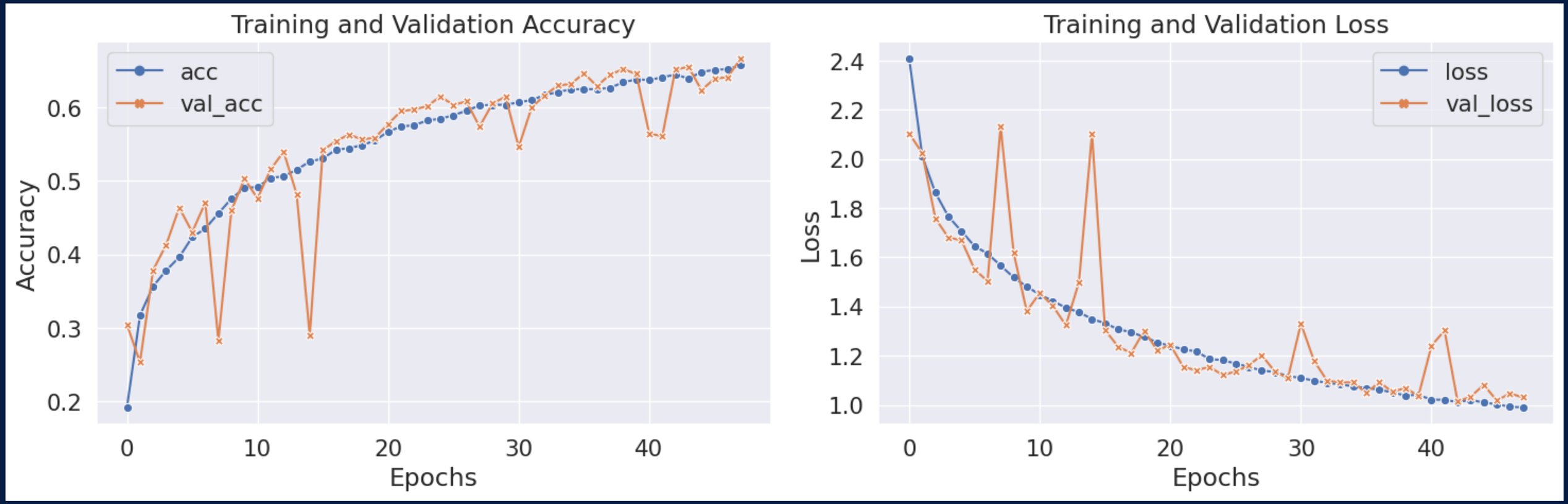
Thanks!

Anexos


Training and Validation Accuracy
acc
val_acc
Accuracy
0.8
0.7
0.6
0.5
0.4
0.3
0
2
4
6
8
Epochs
Training and Validation Loss
loss
val_loss
Loss
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0
2
4
6
8
Epochs

CNN

Anexos


Training and Validation Accuracy
acc
val_acc
Accuracy
0.2
0.3
0.4
0.5
0.6
0
10
20
30
40
Epochs
Training and Validation Loss
loss
val_loss
Loss
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
0
10
20
30
40
Epochs

DNN

Comparison results with the state of the art.

Authors	Class	Feature	Method	Performance results (%)			
				Acc.	Sens.	Spec.	Pre.
Rajkumar, Ganesan & Lavanya (2019)	8	rhythm	1D-CNN	93.60	–	–	–
Yıldırım, Pławiak & Rajendra Acharya (2018)	17	rhythm	1D-CNN	91.30	83.90	–	85.4
Nannavecchia et al. (2021)	21	beat	1D-CNN	89.51	87.79	–	86.78

Our Model Accuracy 72.9