



University | School of
of Glasgow | Computing Science

THE AWARDS
2020

UNIVERSITY
OF THE YEAR

Grad-CAM in Time-Series Classification

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Lecturer (Assistant Professor)

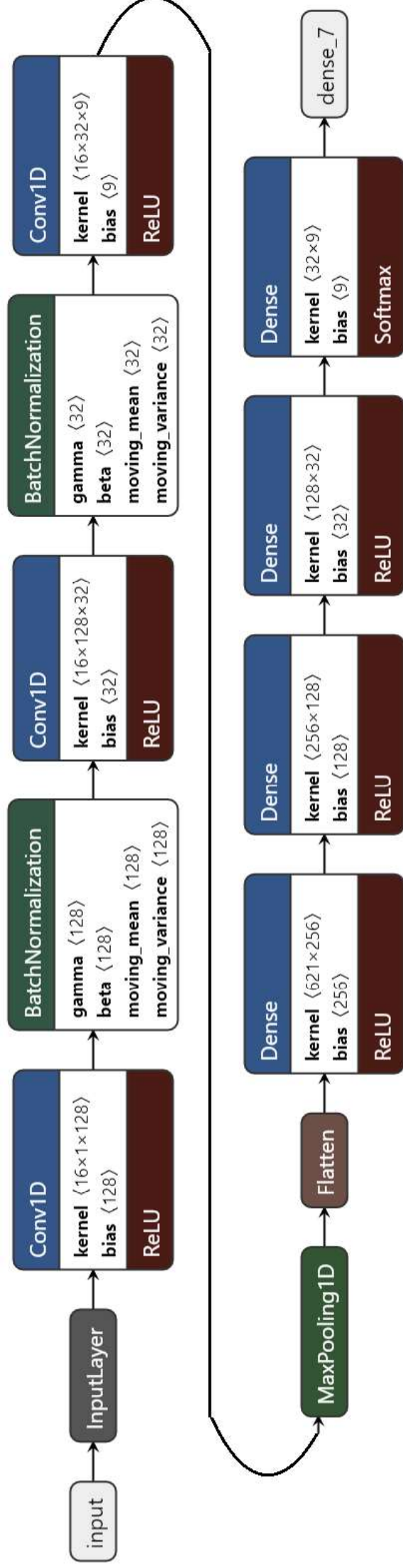
Lead of the Computing Technologies for Healthcare Theme

<https://www.gla.ac.uk/schools/computing/staff/fanideligianni>

WORLD
CHANGING
GLASGOW

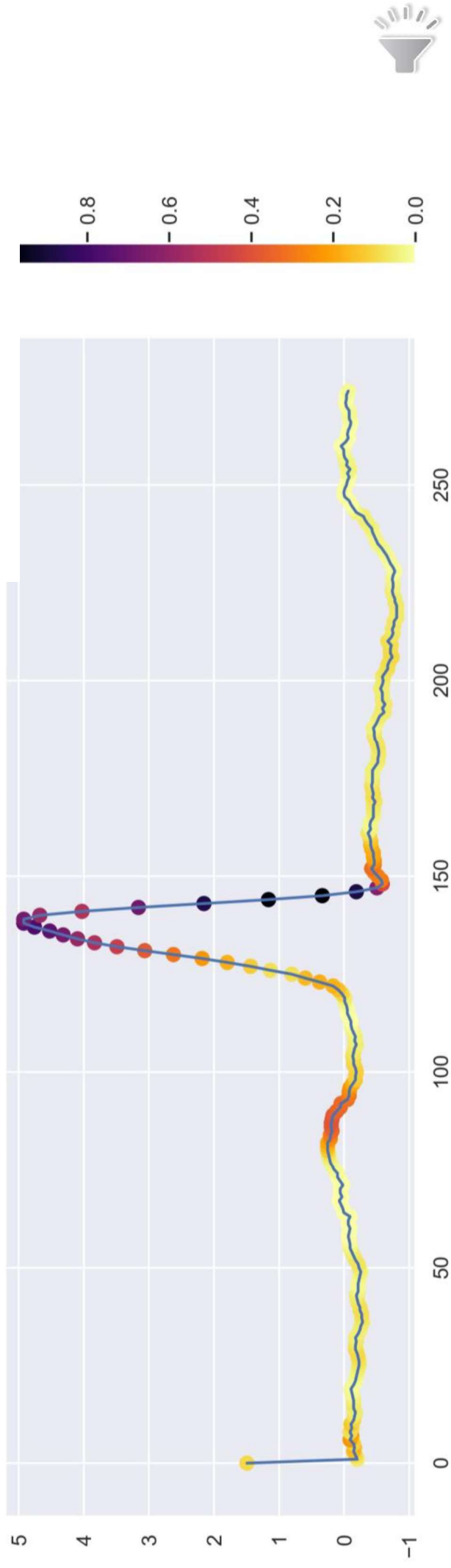


CNN Architecture



Grad-CAM Example

True label:1.0 Probability of label 1.0: 0.99973637

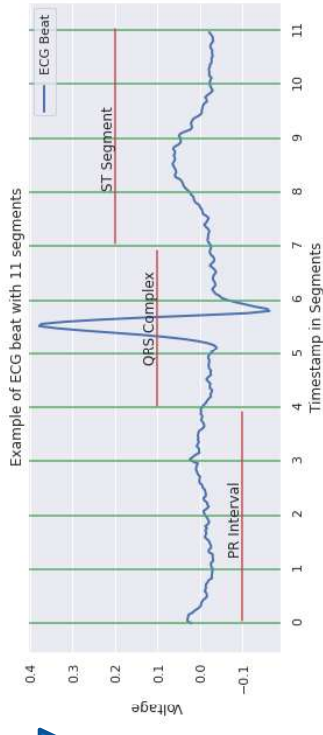


CNN Holdout Beats Confusion Matrix

	N	L	R	V	A	F	f	/
Z	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
4	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
6	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
7	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
8	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
9	0.04%	0.00%	0.04%	0.04%	0.00%	0.00%	1.00%	98.88%

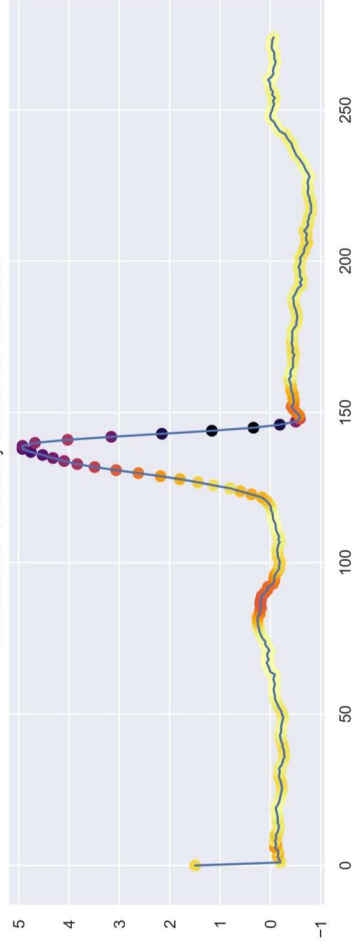


From Local to Global Explanations



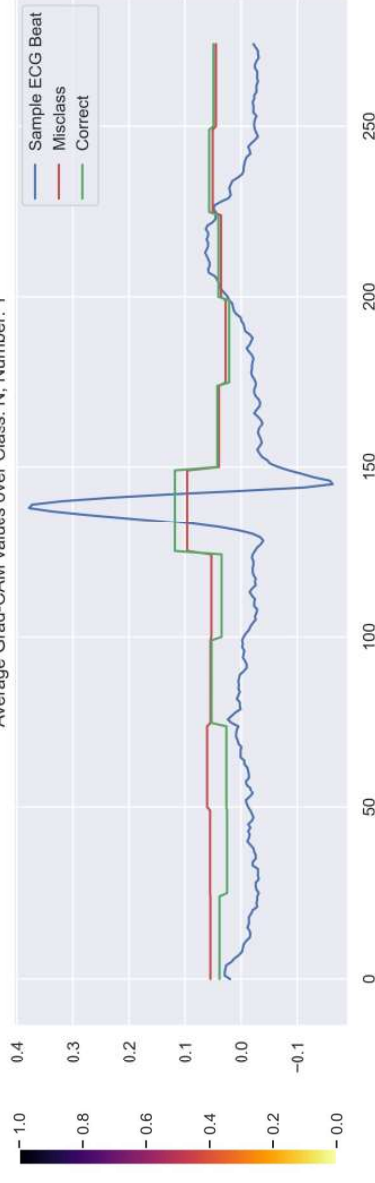
Single Beat

True label: 1.0 Probability of label 1.0: 0.99973637

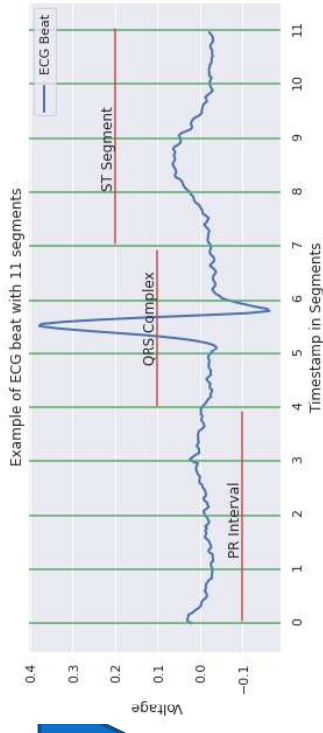


Average over class

Average Grad-CAM values over Class: N, Number: 1



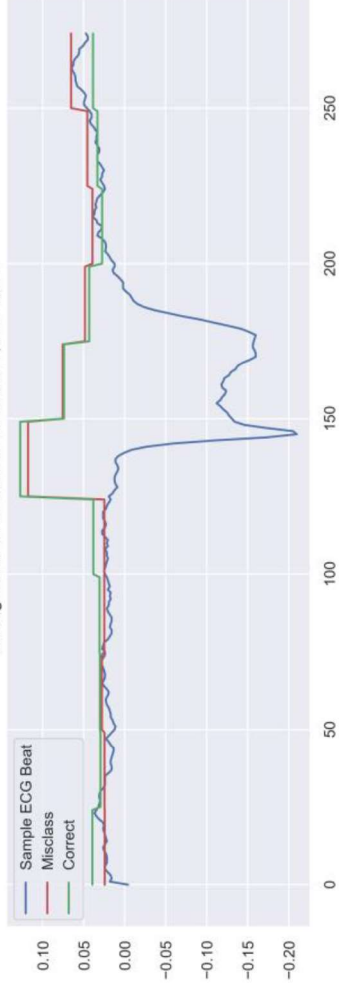
Average Explanations per Class



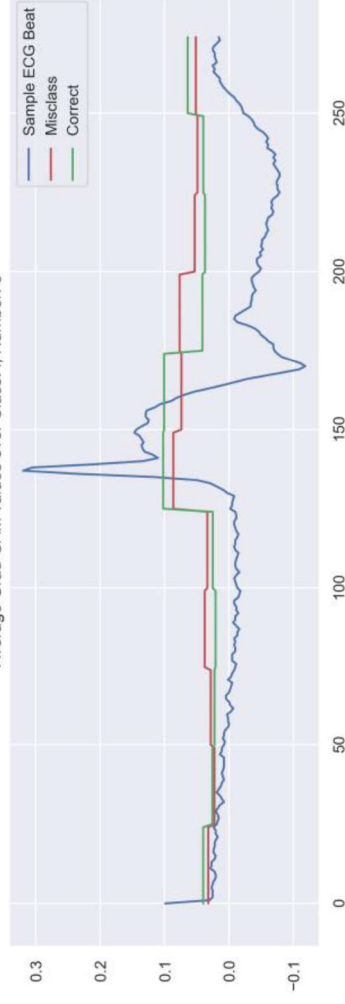
Average Grad-CAM values over Class: F, Number: 6



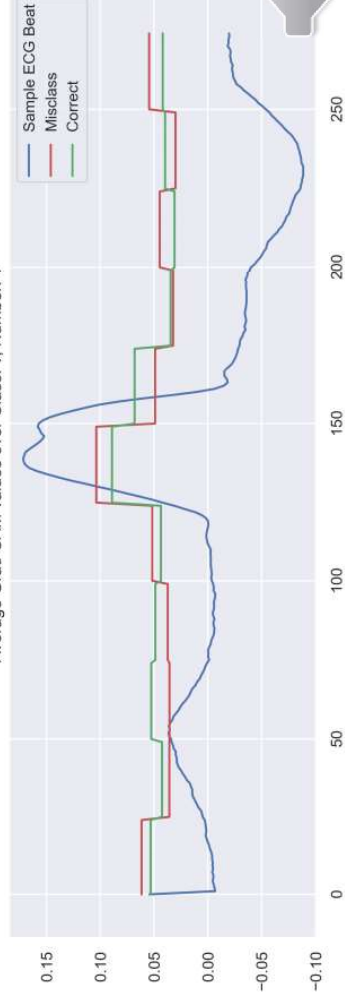
Average Grad-CAM values over Class: ff, Number: 7



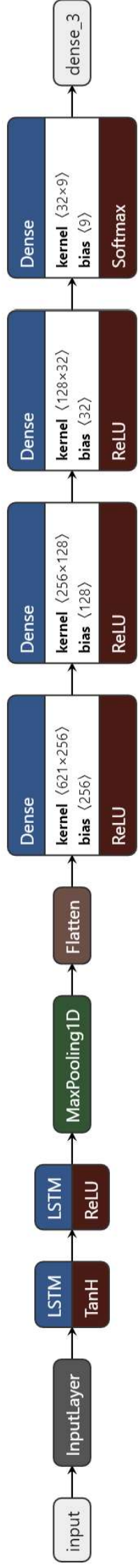
Average Grad-CAM values over Class: I, Number: 8



Average Grad-CAM values over Class: V, Number: 4



GRAD-CAM-based LSTM Visualisation

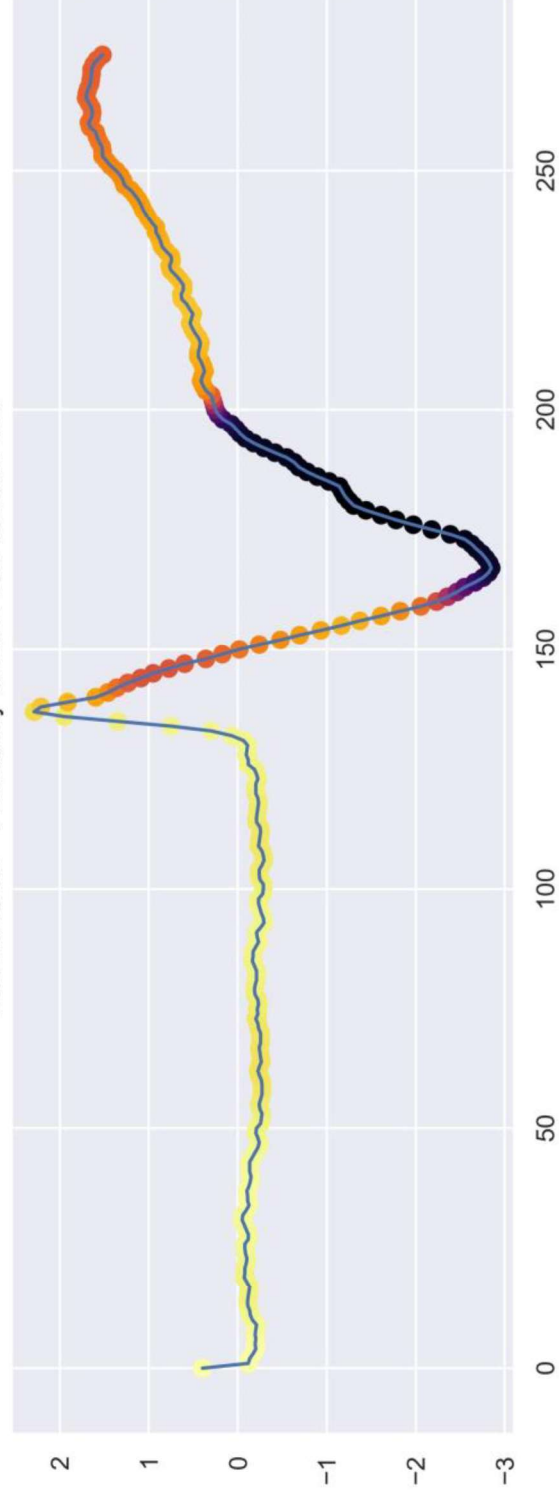


GRAD-CAM-based LSTM Visualisation

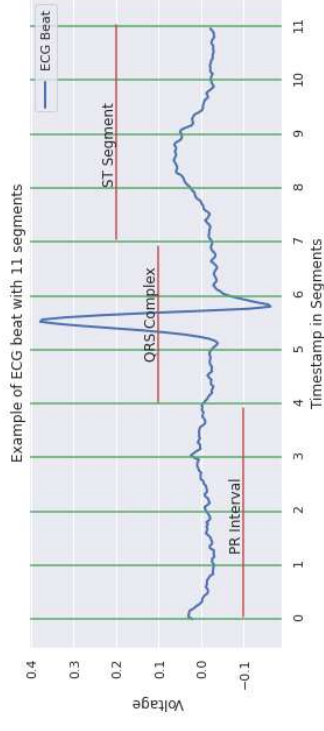
LSTM Holdout Beats Confusion Matrix

	N	L	R	V	A	F	f	/
N	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
L	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
R	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
V	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
F	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
f	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
/	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.25%	99.67%

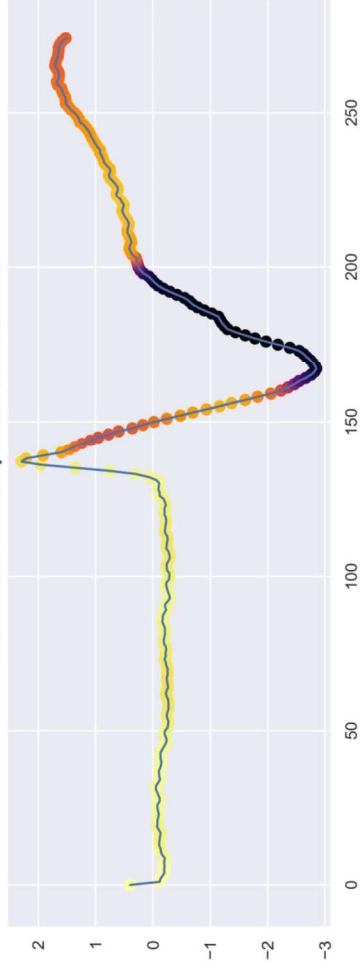
True label:8.0 Probability of label 8.0: 0.99997115



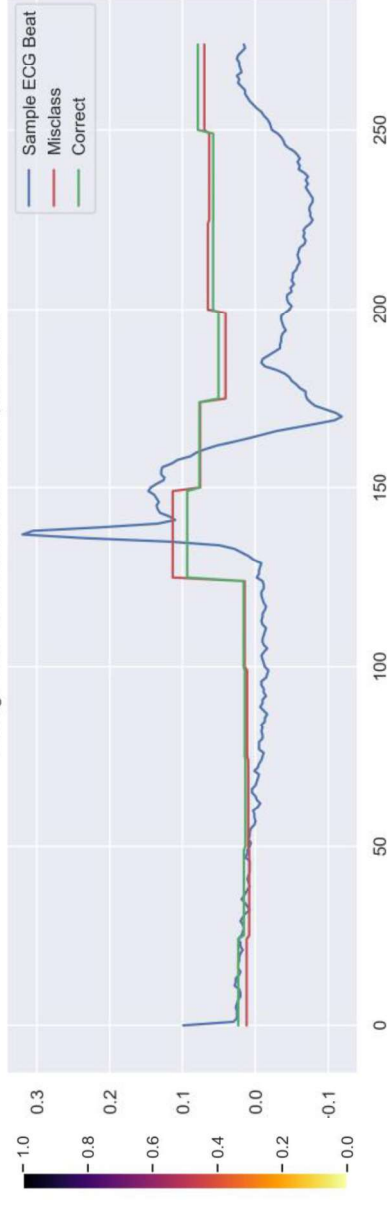
Average LSTM Heatmaps



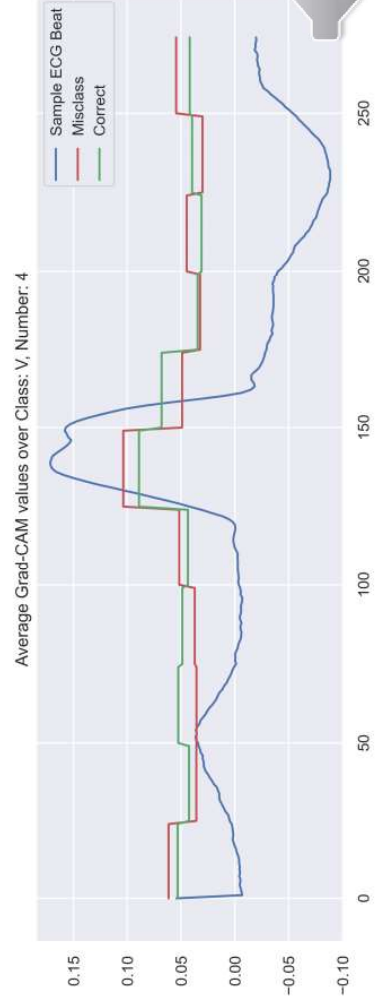
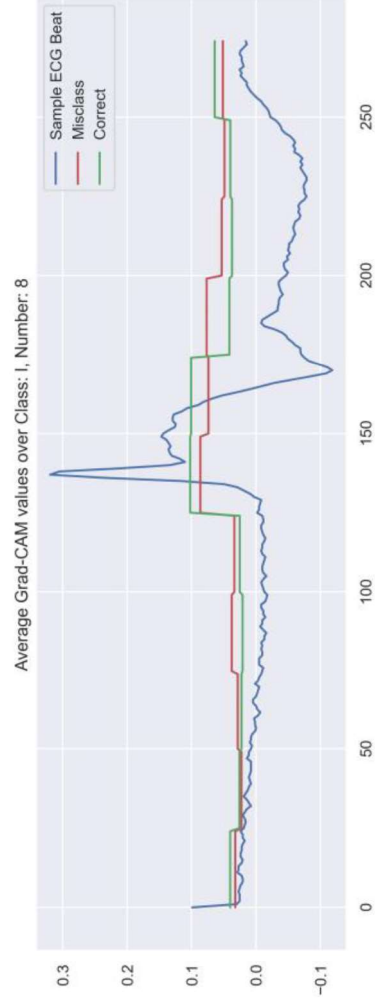
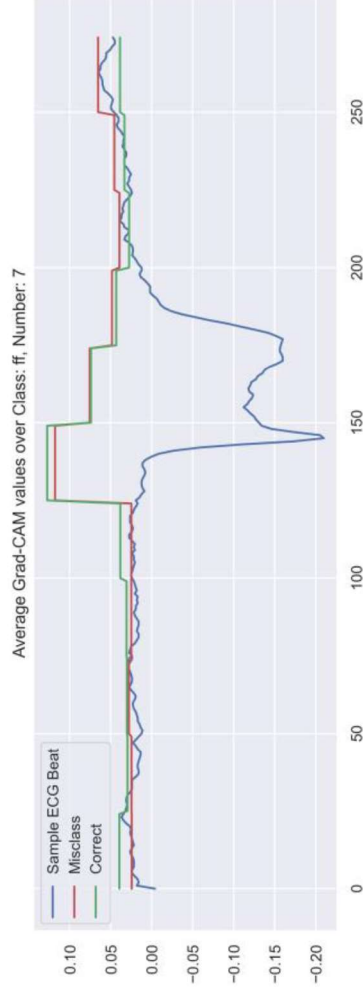
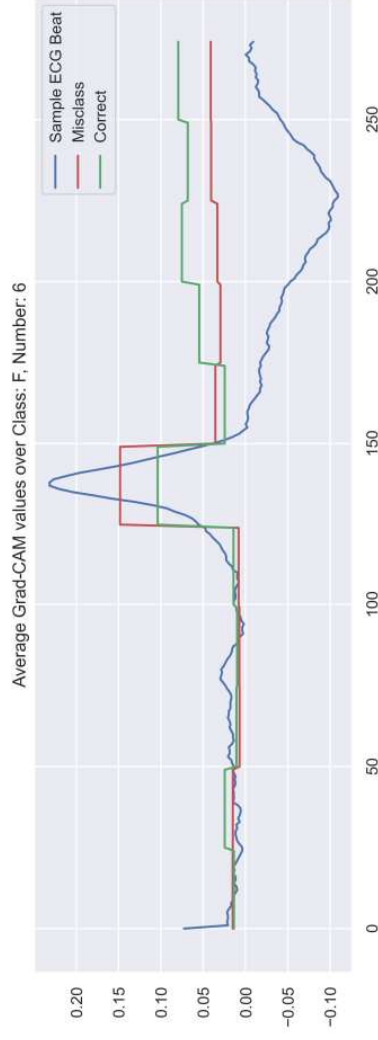
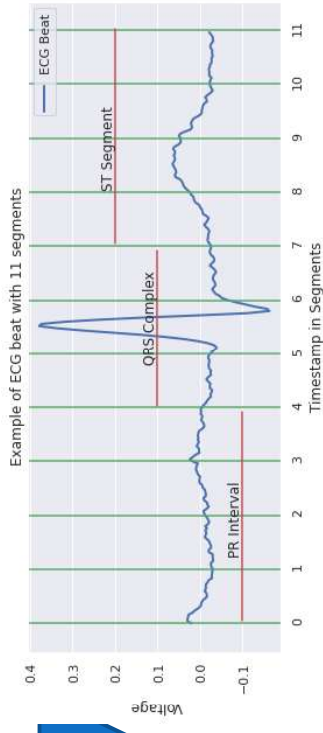
True label: 8.0 Probability of label 8.0: 0.99997115



Average Grad-CAM values over Class: I, Number: 8



Average Explanations per Class



Summary

- Grad-CAM provided plausible explanations without the need to change the deep neural network architecture
- A variation of Grad-CAM has been applied to an LSTM model with convincing results
- Further work is needed to understand how explanations compare across different methods



References

- Zhou et al. 'Learning Deep Features for Discriminative Localization', CVPR, 2016.
- Selvaraju et al. 'Grad-CAM: Visual Explanations from Deep Networks via Gradient-based Localization', International Journal of Computer Vision, 2019.
- Wang et al. 'Time Series Classification from Scratch with Deep Neural Networks: A Strong Baseline', International Joint Conference on Neural Networks (IJCNN), 2017.
- Yola et al. 'Improving ECG Classification Interpretability using Saliency Maps', IEEE BIBE, 2020.