CLASSIFICATION OF ECG IMAGES

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1. INTRODUCTION

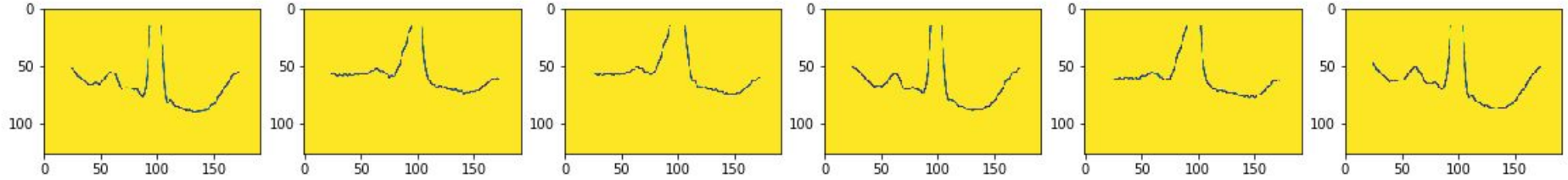
- GOAL : We want to predict behaviour of the EKG signals.
- CLIENT : Our client is healthcare providers and hospitals. Some patients need to be kept under observation and those patients are connected to EKG machines. It is impossible to put a person 7/24 to watch them. It will be better if we can obtain and analyze EKG data simultaneously to check if everything is in normal condition.
- SOLUTION : By analyzing EKG data we can inform healthcare providers immediately so they can take immediate action.

2. DATASET

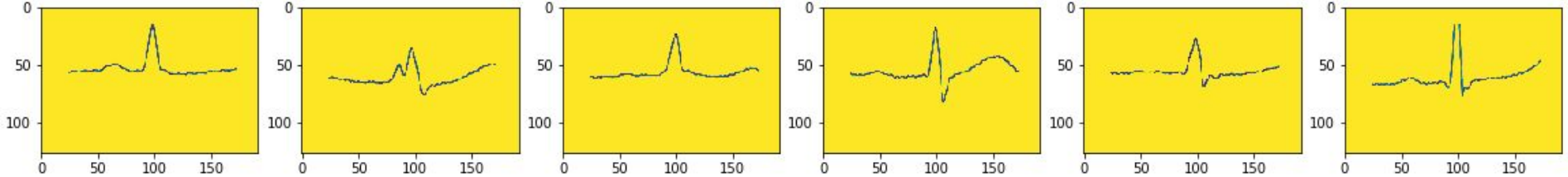
- Physionet's MIT-BIH Arrhythmia Dataset.
- Kaggle project source link: https://www.kaggle.com/analiviafr/ecg-images
- There are 109445 samples in the dataset.
- Image Resolution : 196x128.
- Five categories
  - ❏ N (Normal beat) : 90.589
  - ❏ S (Supraventricular ectopic beat) : 2.779
  - ❏ V (Ventricular ectopic beat) : 7.236
  - ❏ F (Fusion beat) : 803
  - ❏ Q (Unknown beat) : 8.038

3. EDA

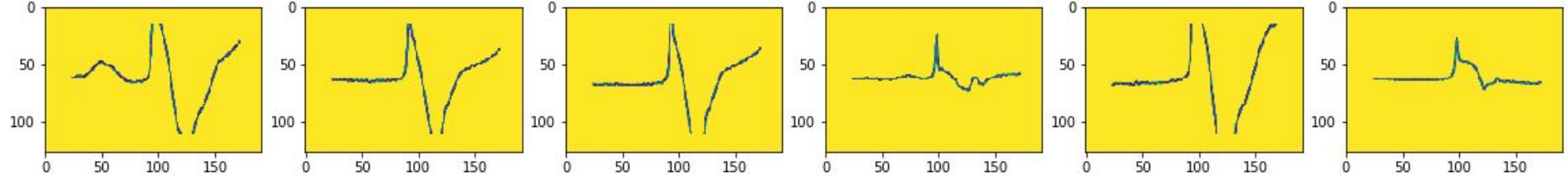
FUSION BEAT (F)



NORMAL BEAT (N)

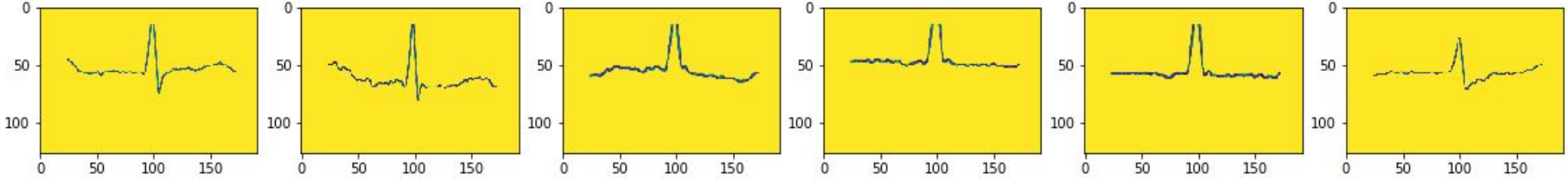


UNKNOWN BEAT (Q)

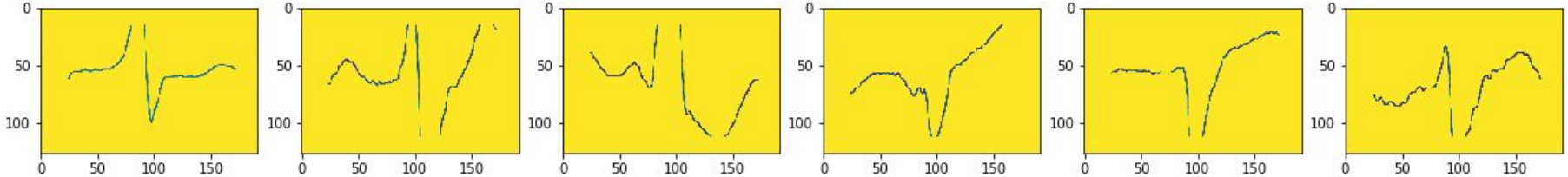


3. EDA

SUPRAVENTRICULAR ECTOPIC BEAT (S)

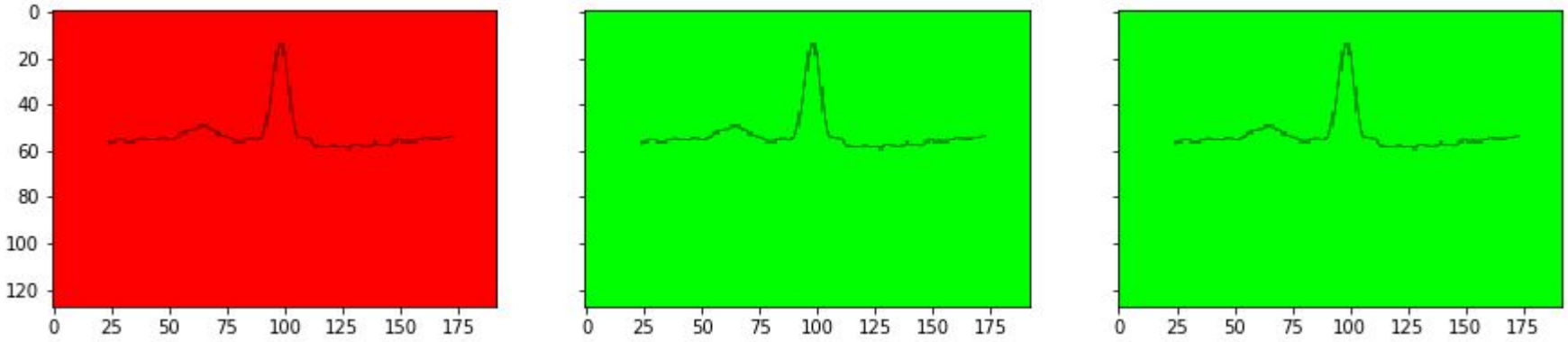


VENTRICULAR ECTOPIC BEAT (N)



3. EDA

Plot one image in 3 different channels: Red, Green, Blue



4. PREDICTIVE MODEL

MODEL DATA LOADER

Image size reduced from 196*128 to 120*120

Channel : 1

Batch size : 32

Criterion : Cross Entropy Loss

Optimizer : Stochastic Gradient Descent (SGD)

Devise : GPU on Kaggle Servers

4. PREDICTIVE MODEL

FIRST MODEL ARCHITECT

1. First Convolutional Layer : 4 convolutional filters with kernel size 3*3, stride = 1, padding = 1.
2. Activation function : Rectified linear unit (ReLU)
3. Max pooling : Kernel size 2

4. Second Convolutional Layer : 4 convolutional filters with kernel size 3*3, stride = 1, padding = 1
5. Activation function : Rectified linear unit (ReLU)
6. Max pooling : Kernel size 2

7. Dropout (p = 0.5)
8. Linear layer : Input 4*30*30 output : 5 (Because we have 5 classes)

FIRST MODEL: RESULTS ON TRAIN DATA

CONFUSION MATRIX

	ACTUAL				
PREDICTIONS	N	Q	S	V	F
	71650	546	1451	1042	373
	150	5781	3	99	3
	234	2	734	35	1
	412	100	35	4567	75
	25	1	0	46	190

RECALL, PRECISION, F1-SCORE

Classes	Recall	Precision	F1-Score
N	0.99	0.95	0.97
Q	0.90	0.96	0.93
S	0.33	0.73	0.45
V	0.79	0.88	0.83
F	0.3	0.73	0.42

FIRST MODEL: RESULTS ON TEST DATA

CONFUSION MATRIX

	ACTUAL				
PREDICTIONS	N	Q	S	V	F
	17959	127	381	299	96
	26	1476	0	43	1
	49	0	169	5	0
	80	14	6	1093	33
	4	0	0	7	3

RECALL, PRECISION, F1-SCORE

Classes	Recall	Precision	F1-Score
N	0.99	0.95	0.97
Q	0.91	0.95	0.93
S	0.30	0.76	0.43
V	0.76	0.89	0.82
F	0.19	0.74	0.31

4. PREDICTIVE MODEL

FORTH MODEL ARCHITECT

1. First Convolutional Layer : 4 convolutional filters with kernel size 3*3, stride = 1, padding = 1.
2. Activation function : Rectified linear unit (ReLU)
3. Max pooling : Kernel size 2

4. Second Convolutional Layer : 4 convolutional filters with kernel size 5*5, stride = 1, padding = 1
5. Activation function : Rectified linear unit (ReLU)
6. Max pooling : Kernel size 2

7. Dropout (p = 0.5)
8. Linear layer : Input 4*30*30 output : 5 (Because we have 5 classes)

FORTH MODEL: RESULTS ON TRAIN DATA

CONFUSION MATRIX

	ACTUAL				
PREDICTIONS	N	Q	S	V	F
	27781	2426	832	2165	248
	3994	317	133	335	35
	5705	471	164	406	51
	11495	1100	341	1044	117
	2349	2116	753	1839	191

RECALL, PRECISION, F1-SCORE

Classes	Recall	Precision	F1-Score
N	0.38	0.83	0.52
Q	0.05	0.07	0.06
S	0.07	0.02	0.04
V	0.18	0.07	0.10
F	0.30	0.01	0.01

FORTH MODEL: RESULTS ON TEST DATA

CONFUSION MATRIX

	ACTUAL				
PREDICTIONS	N	Q	S	V	F
	6892	595	224	510	43
	1060	69	30	70	10
	1463	124	52	113	7
	2803	304	71	263	43
	5900	516	179	491	58

RECALL, PRECISION, F1-SCORE

Classes	Recall	Precision	F1-Score
N	0.38	0.83	0.52
Q	0.69	0.06	0.05
S	0.09	0.03	0.04
V	0.18	0.08	0.11
F	0.36	0.01	0.02

5. CONCLUSION

- 4 different models are tested.
- The first model which has the less complexity than others gives the best results.
- Reported scores for classes: N, Q, S, V, F are Recall: 0.99, 0.90, 0.33, 0.79, 0.3; Precision: 0.95, 0.96, 0.73, 0.88, 0.73; F1-Score: 0.97, 0.93, 0.45, 0.83, 0.42.
- Forth model reported scores for classes: N, Q, S, V, F are Recall: 0.38, 0.04, 0.09, 0.18, 0.36; Precision: 0.83, 0.06, 0.03, 0.08, 0.01; F1-Score: 0.52, 0.05, 0.04, 0.11, 0.02.
- Second model and third models' Recall, Precision, and F1-Scores are less than first and forth models' scores.