YONSEI UNIVERSITY

일상 속 급성 심질환 진단을 위한 ResNet 기반 딥러닝 모델 개발 (Wearable Device를 중심으로)

Developing ResNet based DL Model on wearable device for diagnosing Acute Coronary Syndrome

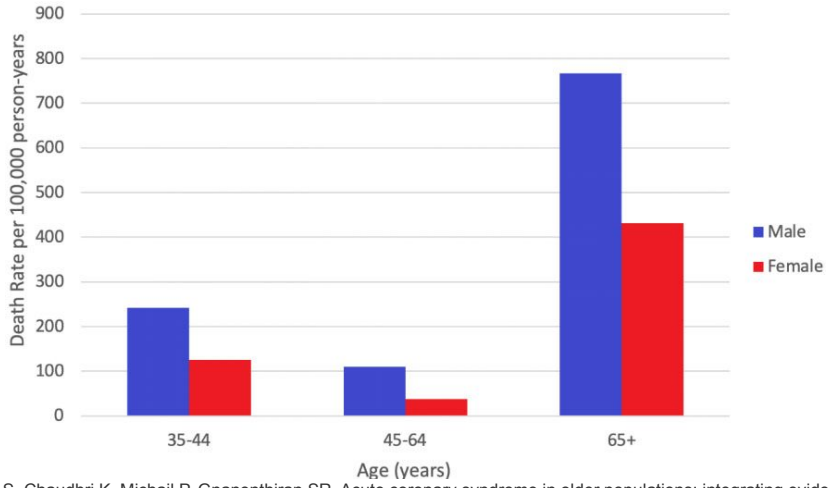
ECG Challenge Team 3

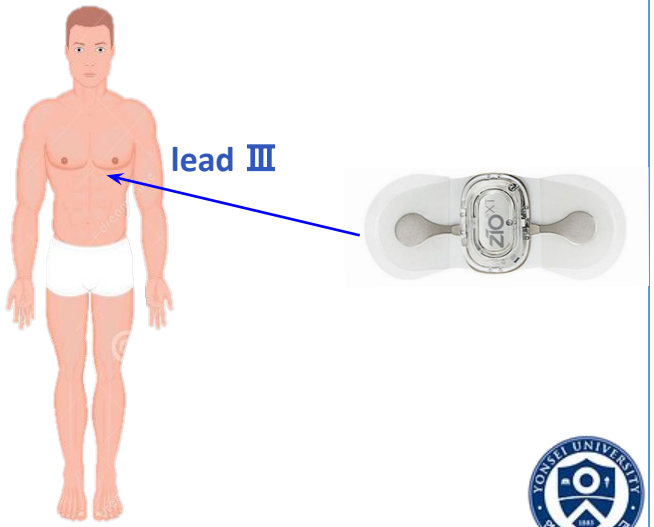
ChangDae Lee(CTM 17), Youngjun Na(MED 18), Hyerim Kim(MED 20), Jungwoo Kim(SIT 22)

Task: Wearable device for Acute Coronary Syndrome

18 million deaths/yr

Age↑, Male, Obesity, Underlying cardiovascular disease
⇒ Incidence, Fatality ↑
⇒ 고위험군 환자의 급성 상황에 대한 지속적 감시 필요!





Li S, Chaudhri K, Michail P, Gnanenthiran SR. Acute coronary syndrome in older populations: integrating evidence into clinical practice. *Vessel Plus* 2022;6:62. http://dx.doi.org/10.20517/2574-1209.2022.17

Acute Coronary Syndrome on ECG

① Non-ST-elevation myocardial infarction (NSTEMI)

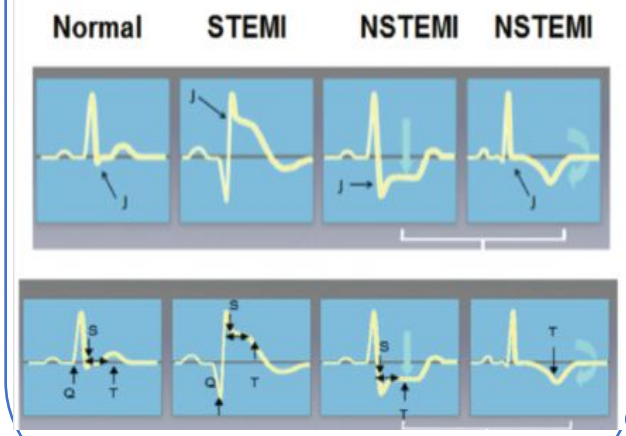
② ST-elevation MI (STEMI)

③ Unstable angina

ECG

ST segment elevation/depression

T wave inversion



Diagnostic subclass

① AMI

② IMI

③ ISCA

④ ISCI

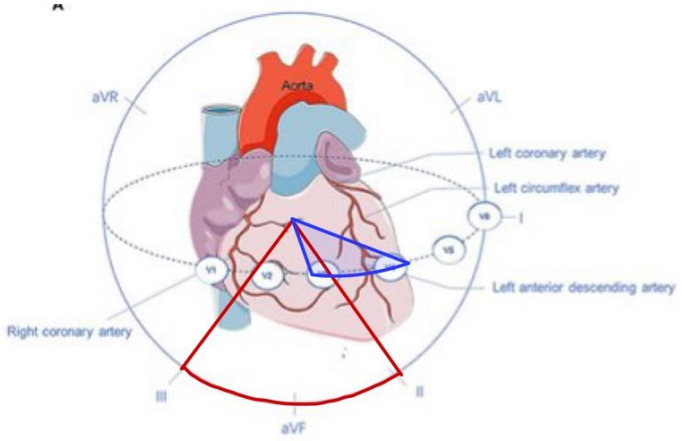
⑤ STTC

⑥ not acute heart disease

Selected Lead: Ⅲ

Wearable, one-lead device

Diagnosis _subclass	Lead
② IMI ④ ISCI	II, III, aVF
① AMI ③ ISCA	V3, V4
⑤ STTC	all



IMI (40~50%) > AMI (33%)

Inferior MI

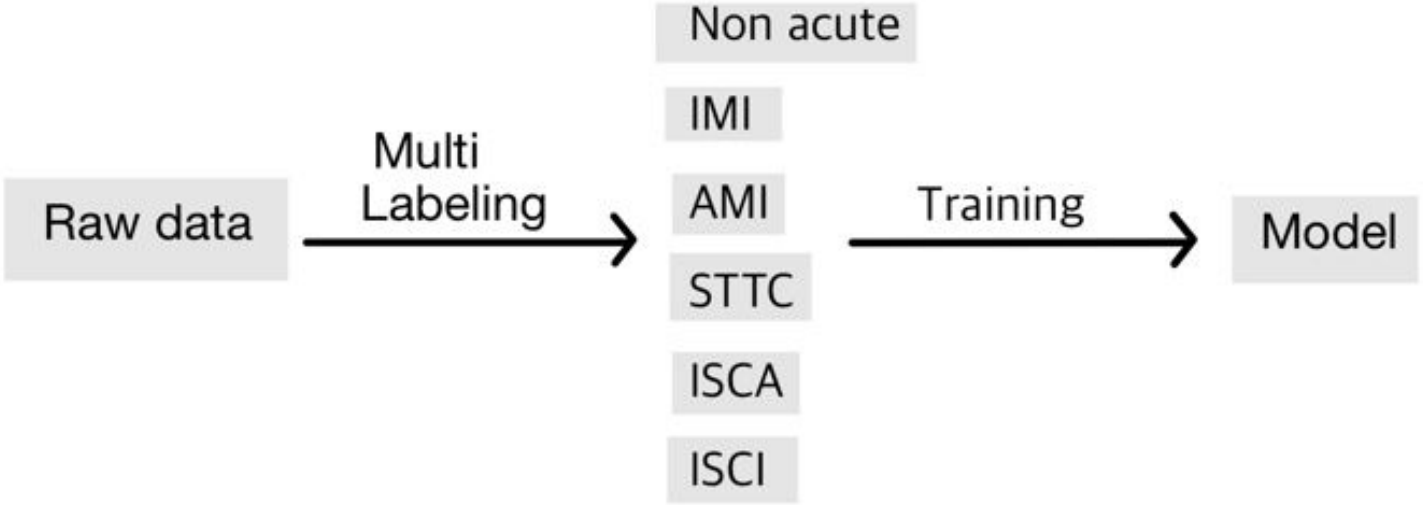
- Pathologic Q waves and evolving ST-T changes in leads II, III, aVF
- Q waves usually largest in lead III, next largest in lead aVF, and smallest in lead II

Aguiar Rosa S, Timóteo AT, Ferreira L, Carvalho R, Oliveira M, Cunha P, Viveiros Monteiro A, Portugal G, Almeida Morais L, Daniel P, Cruz Ferreira R. Complete atrioventricular block in acute coronary syndrome: prevalence, characterisation and implication on outcome. Eur Heart J Acute Cardiovasc Care. 2018 Apr;7(3):218-223. [PubMed]

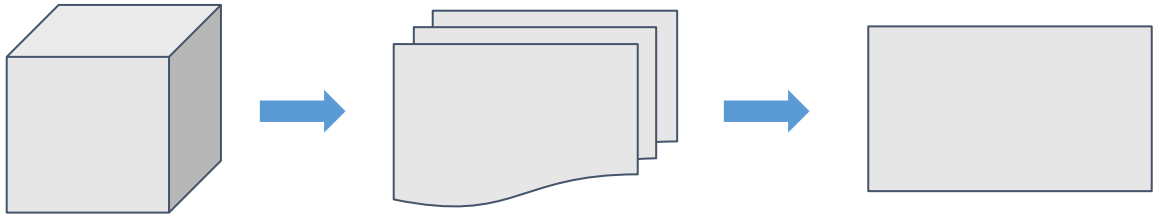
Newman JD, Shimbo D, Baggett C, Liu X, Crow R, Abraham JM, Loehr LR, Wruck LM, Folsom AR, Rosamond WD., ARIC Study Investigators. Trends in myocardial infarction rates and case fatality by anatomical location in four United States communities, 1987 to 2008 (from the Atherosclerosis Risk in Communities Study). Am J Cardiol. 2013 Dec 01;112(11):1714-9. [PMC free article] [PubMed]

https://ecg.utah.edu/lesson/9

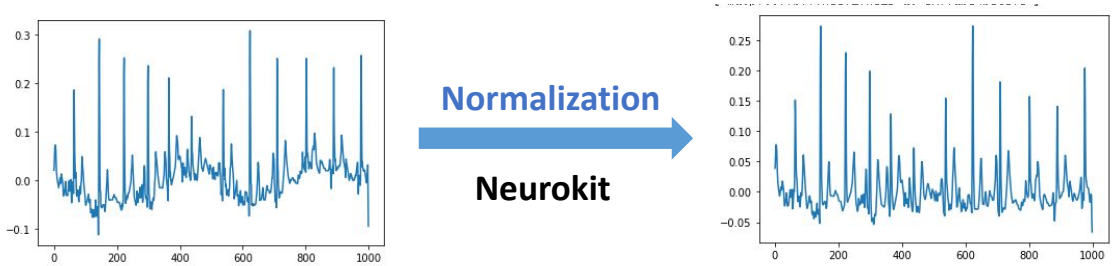
Data Processing Outline



Data Pre-processing

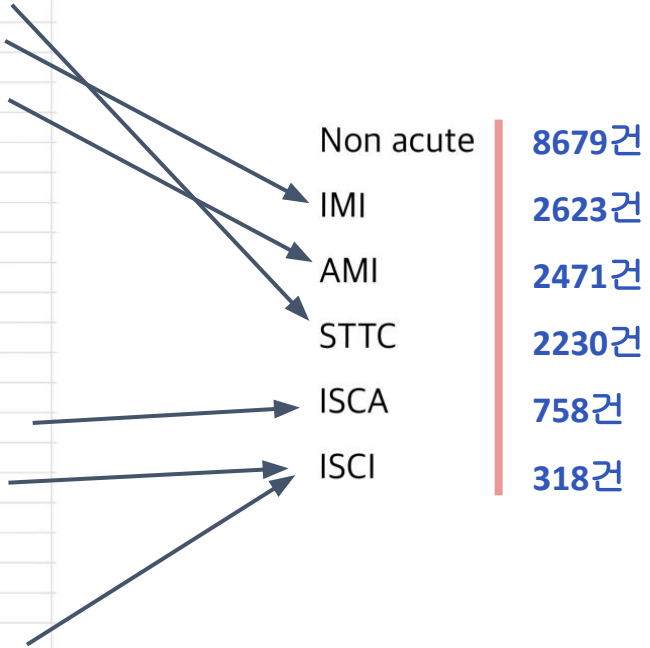


(17079, 1000, 12) (17079, 1000) X 12 leads lead Ⅲ

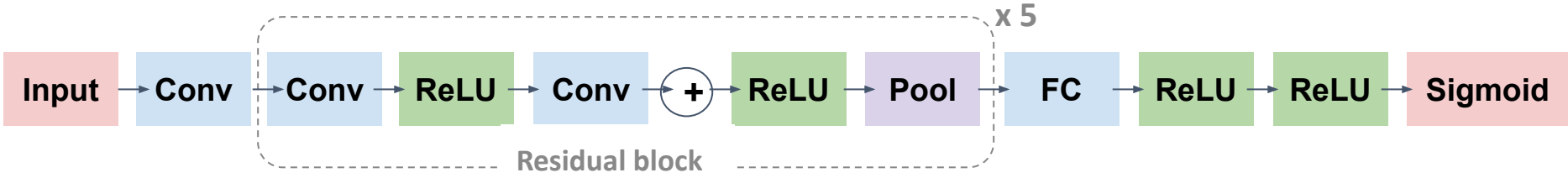


Multi-Labeling

	diagnostic_subclass
['NORM']	7274
['STTC']	1519
['IMI']	993
['LVH']	793
['AMI']	587
['AMI', 'IMI']	409
['LAFB/LPFB']	338
['CLBBB']	288
['IRBBB']	264
['NORM', 'IRBBB']	197
['LAFB/LPFB', 'AMI']	192
['ISCA']	168
['LVH', 'IMI']	143
['AMI', 'LVH']	137
['STTC', 'LVH']	123
['ISCA', 'IMI']	116
['STTC', 'IMI']	100
['ISCI']	92
['ISCI', 'ISCA']	90
['CRBBB']	78
['NORM', 'IVCD']	77
['IMI', 'IVCD']	74
['AMI', 'ISCA']	72
['IVCD']	71
['LAFB/LPFB', 'IMI']	70

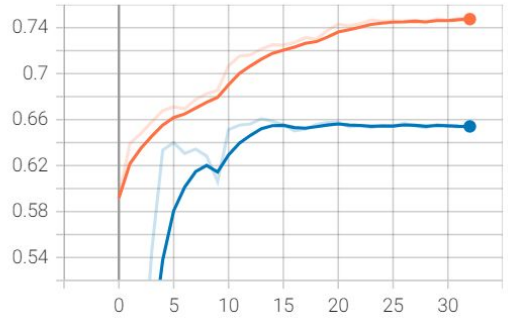


Model Architecture

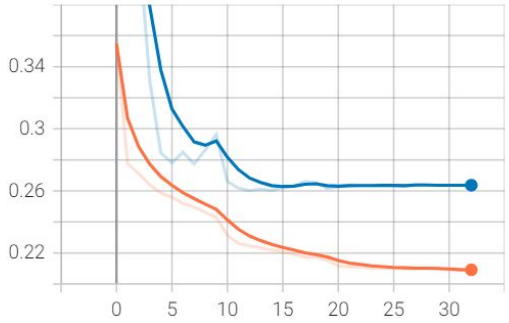


Result

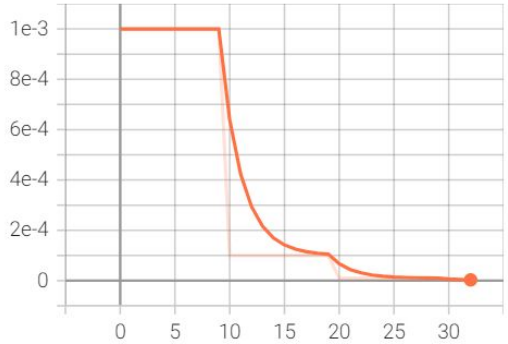
epoch_accuracy
tag: epoch_accuracy



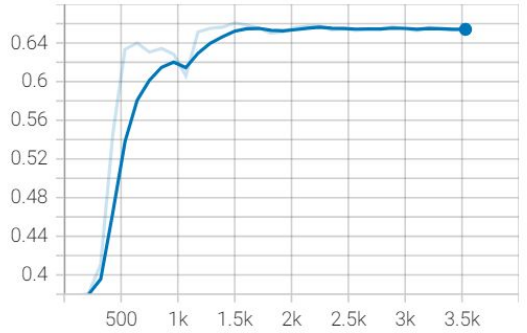
epoch_loss
tag: epoch_loss



epoch_lr
tag: epoch_lr



evaluation_accuracy_vs_iterations
tag: evaluation_accuracy_vs_iterations



Result - Binary Classification

		Predicted		
		accute	not_accute	
Actual	accute	1856	598	2454
	not_accute	736	1111	1847
		2592	1709	4301

Accuracy	**0.690**
Precision(양성예측도)	**0.716**
Recall(민감도)	**0.756**
f1 Score	**0.735**
특이도	**0.602**
음성예측도	**0.650**

Result - Multi-labeled Classification

Precision(양성예측도)	0.560
Recall(민감도)	0.811
F1 Score	0.663
Hamming loss	0.140

*Threshold 0.2

Implications

① Apply in 24h wearable ECG device

② Strengthening of Disease Response and Recovery

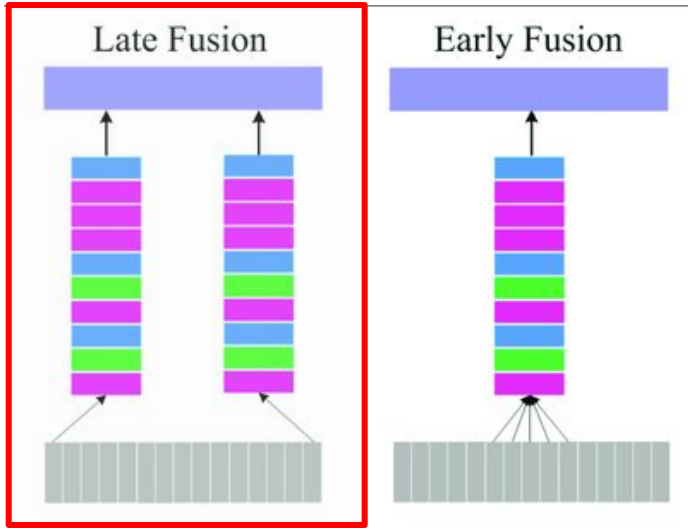
```
y = ReLU()(y)
```

Recommendations

① Additional lead, V3

Diagnosis _subclass	Lead
② IMI ④ ISCI	II, III, aVF
① AMI ③ ISCA	V3, V4
⑤ STTC	all

-> 보다 명확한 data 학습으로 accuracy 개선 기대



-독립적인 data processing, prediction 후 combine
-임상의가 ecg를 해석하는 방식과 유사

Thank You for Listening!