KHRS Scientific Session
June 04th , 2021

Role of Artificial Intelligence in the prediction and management of AF

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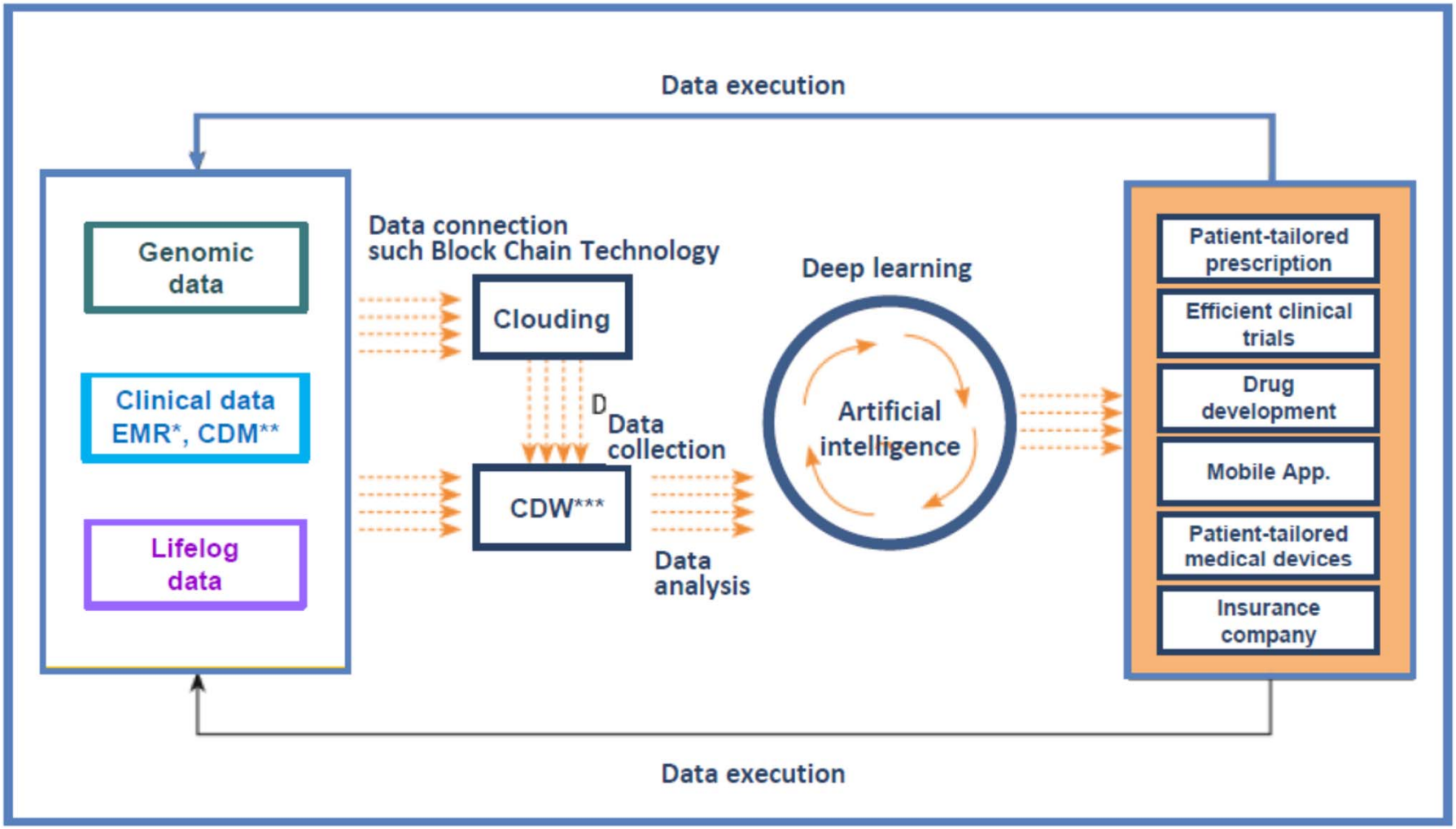
Korean Heart Rhythm Society
COI Disclosure

Name of First Author:

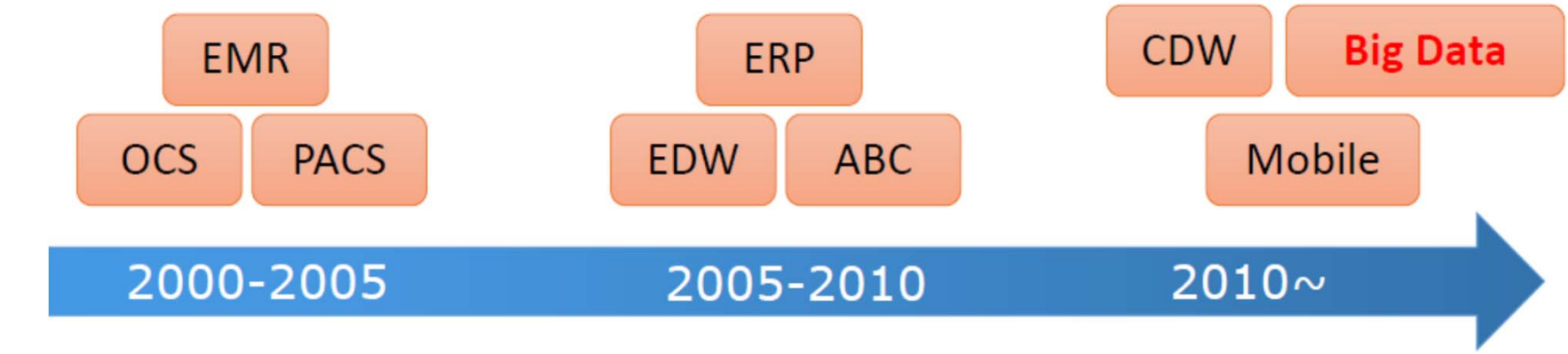
The authors have no financial conflicts of interest to disclose concerning the presentation

1. Artificial Intelligence & 4th Industrial Revolution

AI & Big Data in Future of Healthcare



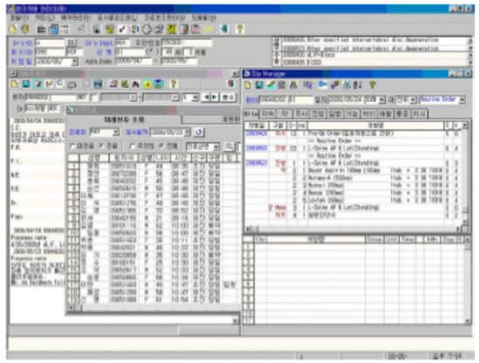
4th Industrial Revolution in Clinical Field



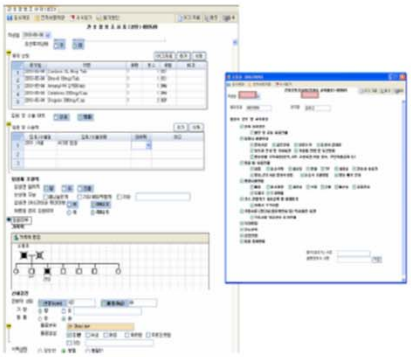
Next Step for 4th industrial revolution

Clinical Data Expansion

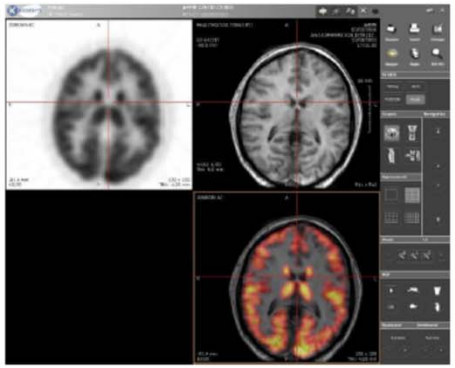
Traditional Clinical Data



OCS



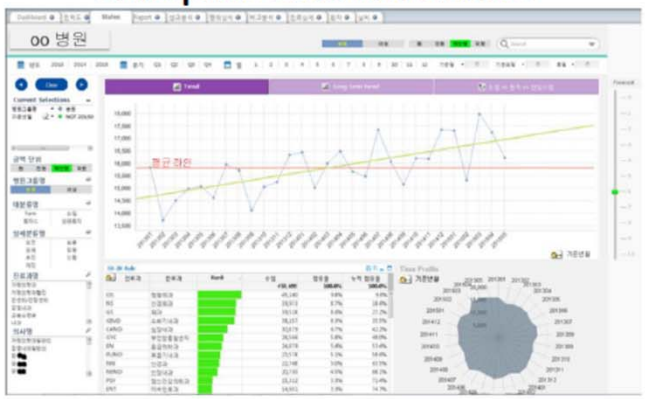
EMR



PACS

Clinical Data Warehouse

Enterprise Data Warehouse



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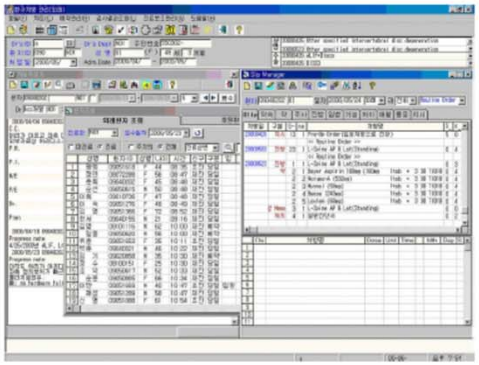

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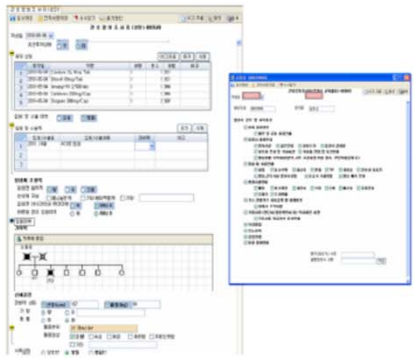

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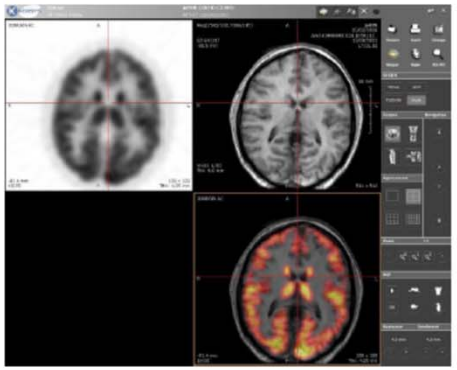

PACS

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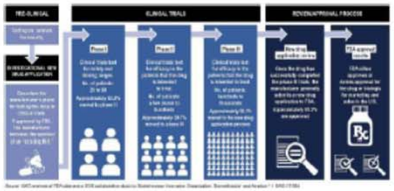
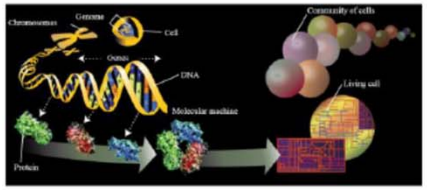
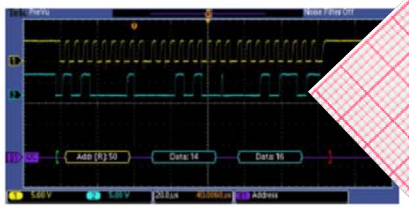
Research Data

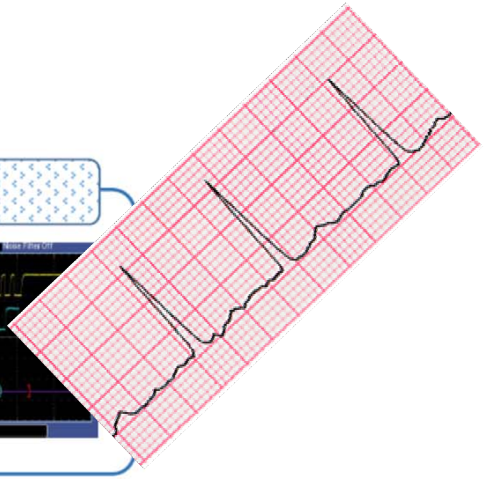


Genomics Data



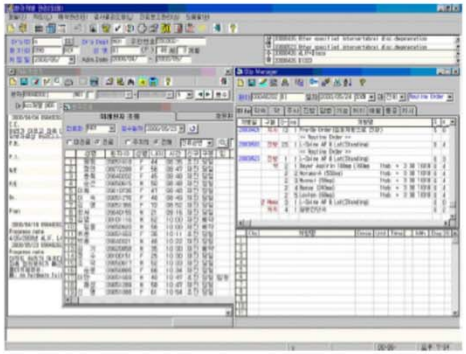
Signal Data



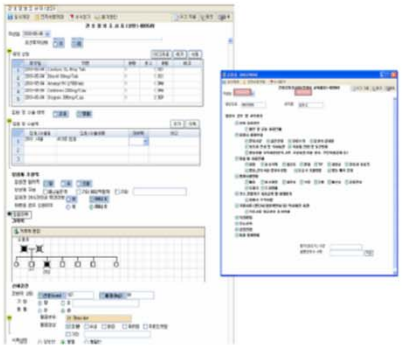


Clinical Data Expansion

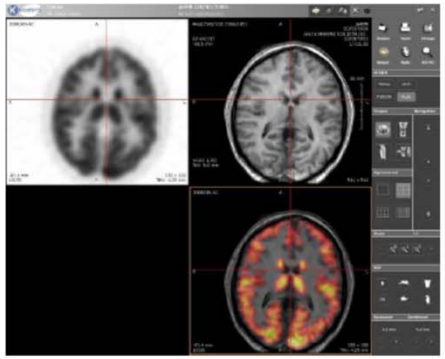
Traditional Clinical Data



OCS



EMR



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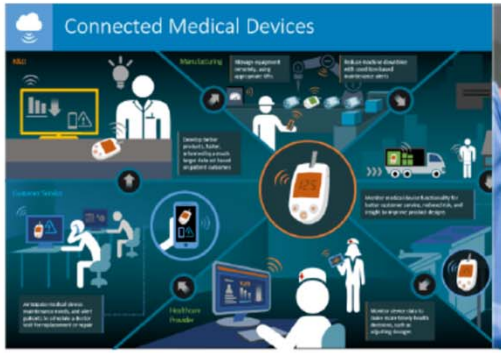
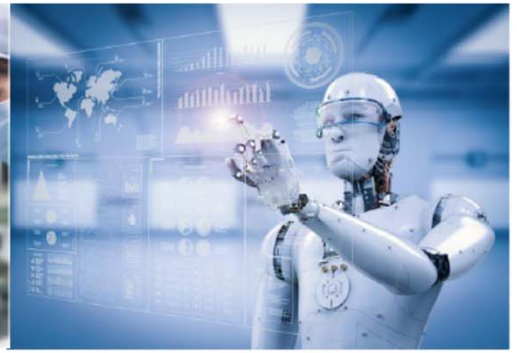
IoT

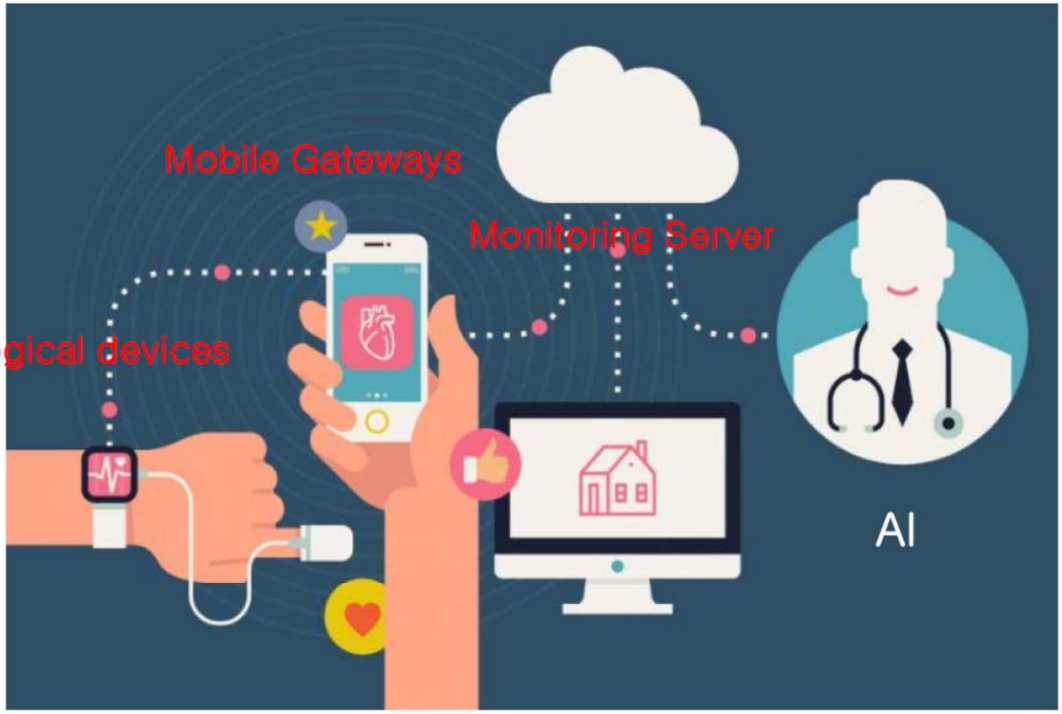


VR

AI



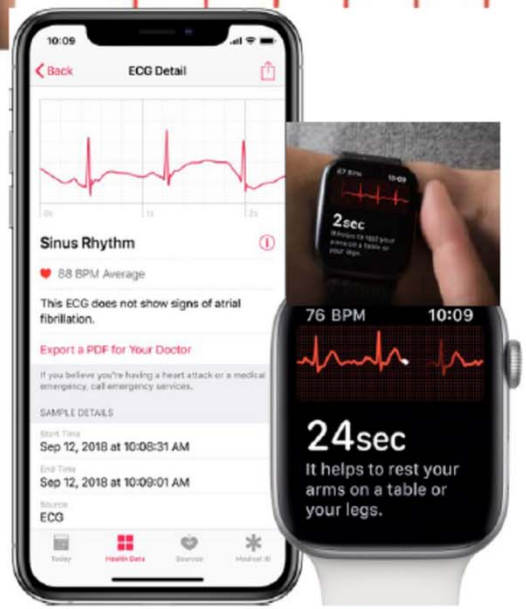
Smart Device for ECG monitoring based on AI



Smart Watch

A. Photoplethysmogram/Tachogram recording

B. Lead I electrocardiogram recording



Apple Watch 4
2018.9

Kardia Band(AliveCor)
$99

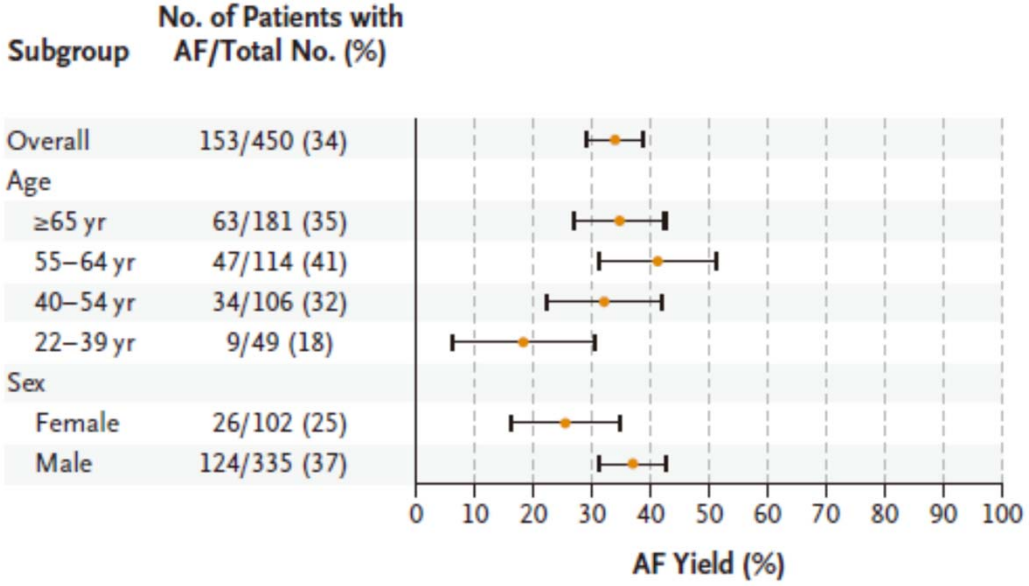
APPLE HEART study - Tachogram

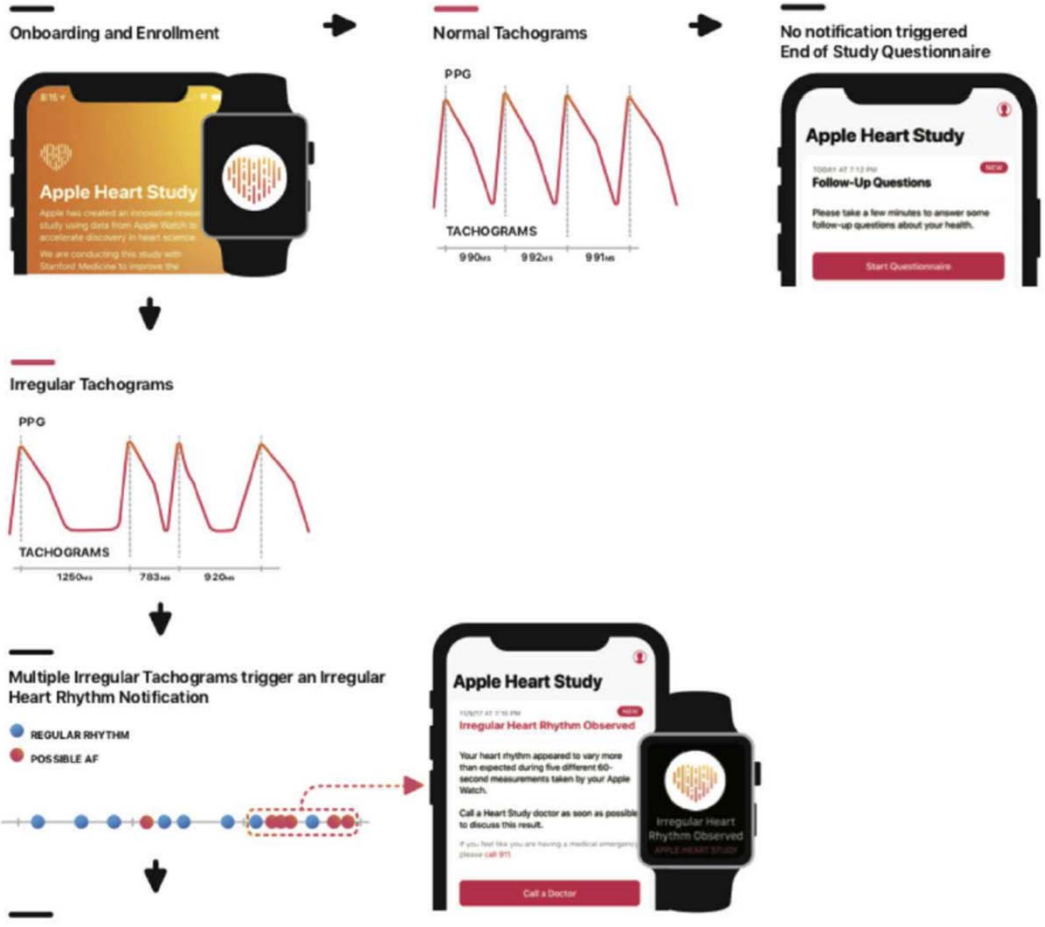
419,297 Pts -> 2,161 (0.5%) received irregular pulse notification -> 450 Pts ECG patch

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation





Smart device for automated detection of AF using AI algorithm

Kardia mobile – Alive core

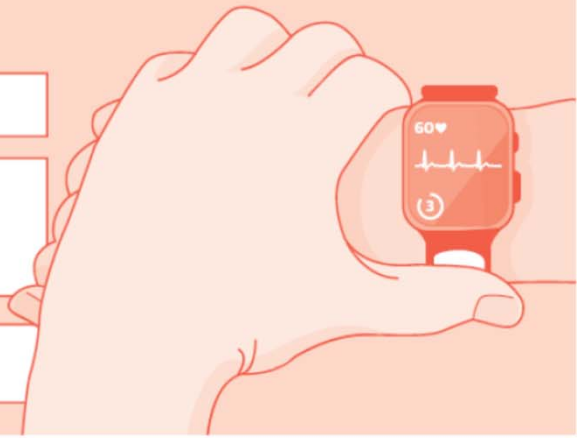
AliveCor (Mountain View, California) Kardia Band

The smartwatch strap with an electrode sensor that records heart rhythm

Patient places thumb on the sensor to record rhythm

The application utilizes an algorithm to differentiate sinus rhythm (SR) from atrial fibrillation (AF), or would label the recording as unclassified if it does not meet certain criteria

The app informs the patient if AF is detected; the results are transmitted to the patient's physician



Method for interpreting the recording:	% of patients with interpretable results	Accuracy of AF diagnosis compared to 12 lead electrocardiogram
App algorithm only	66%	93% sensitivity; 84% specificity
Physician only	87%	99% sensitivity; 83% specificity
Recordings labeled as "unclassified" by the app algorithm when reviewed	100%	100% sensitivity; 80% specificity

J Am Coll Cardiol 2018;29:2381

Patch type Ambulatory continuous ECG monitoring using AI analysis

Mobile App

Cardio Physician Web

Patch type ECG monitoring – Report: 47/M intermittent palpitation

Patient name	Gender	Date of birth
김	-	-

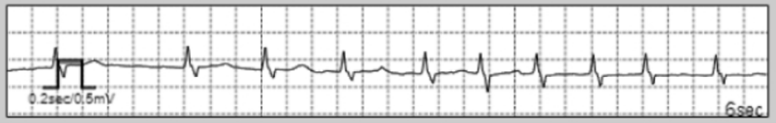
Hookup Date	Hookup Time	Duration	Code
2021-01-14	11:03:00	72:00:00	20210114

Ordering Physician	Hookup Technician	Analysing Technician	Device Serial

Supraventricular Tachycardia

Total - Episodes

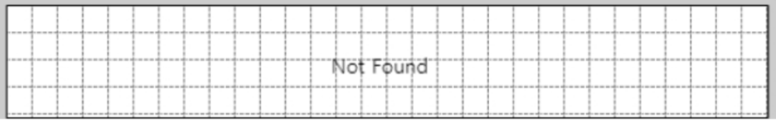
Fastest SVT (HR Range : 64 - 115 bpm : 86 Time : 2021-01-14 12:46:40)



Ventricular Tachycardia

Total - Episodes

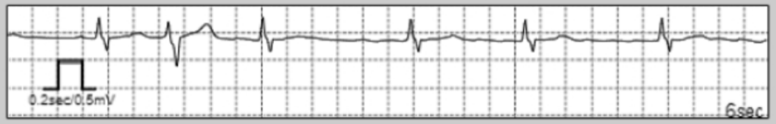
Fastest VT (HR Range : -bpm : - Time : -)



Atrial Fibrillation

Total - Episodes

Fastest AF (HR Range : 64 - 106 bpm : 76 Time : 2021-01-14 12:42:09)



General

QRS Complexes	277,962
Supraventricular Beats	54 (<0.02%)
Ventricular Beats	326 (<0.12%)
% of total time classified as noise	0.175

Heart Rate

Minimum	35 bpm	2021-01-16 05:42:05
Average	64 bpm	
Maximum	240 bpm	2021-01-16 10:39:57
Max R-R	3,840 ms	2021-01-15 01:29:57

Supraventriculars

Isolated	41
Couplets	2
Bigeminal Cycles	8
Run (Total Run beats)	1 (9)

Ventriculars

Isolated	298
Couplets	14
Bigeminal cycles	6
Runs (Total Run beats)	0 (0)

Activity Level

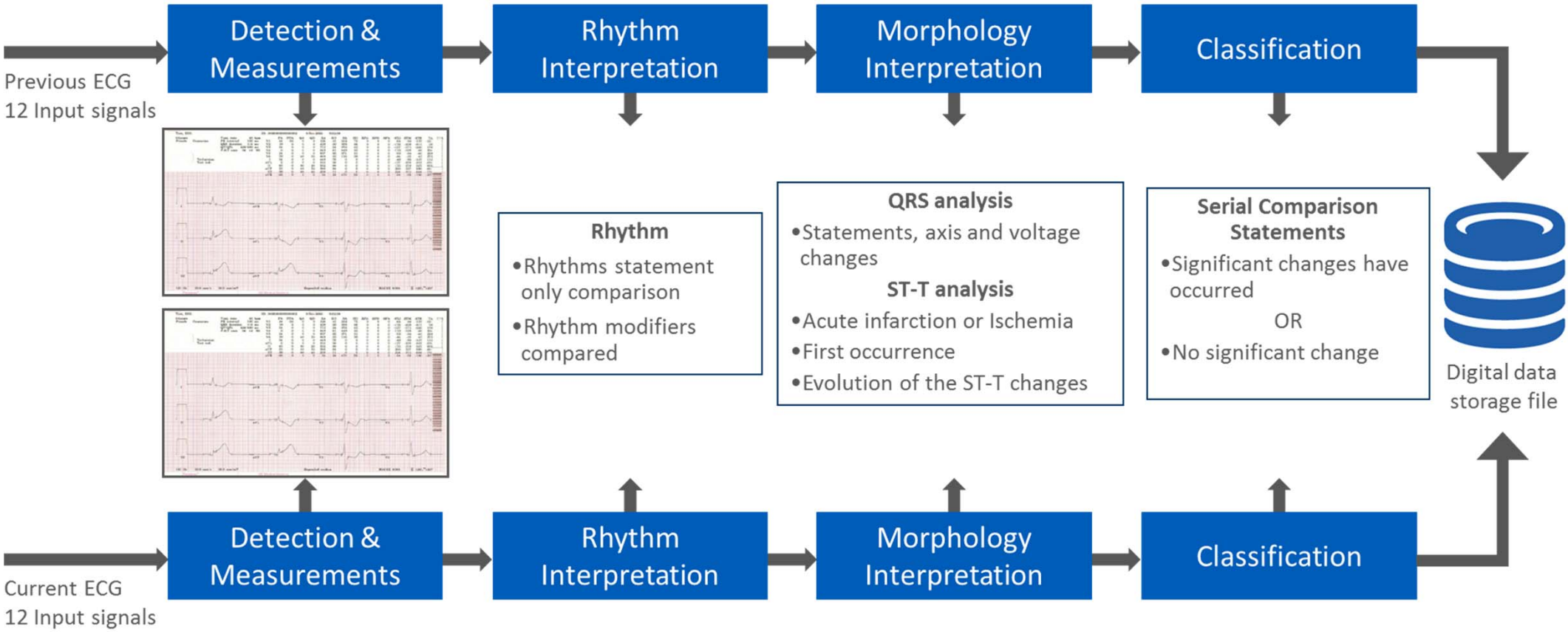
Average	1
Maximum	10

Arrhythmia

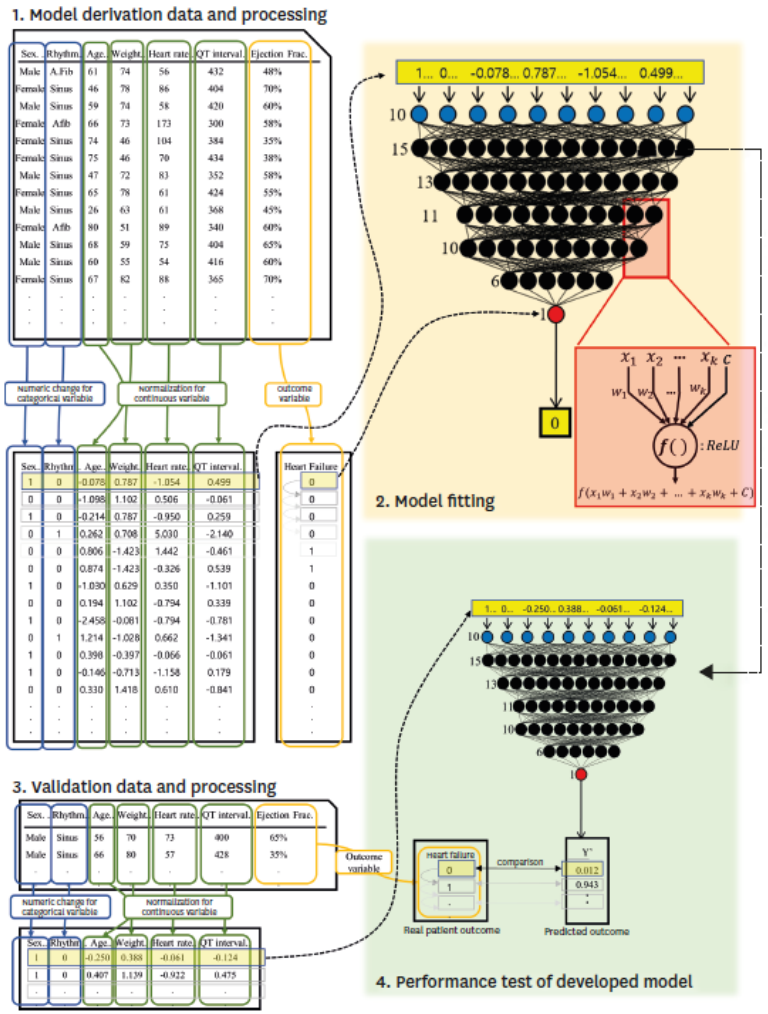
SVT	1
AF / AFL	417
VT	0
VF / VFL	0
Pauses	2249
SBR	0

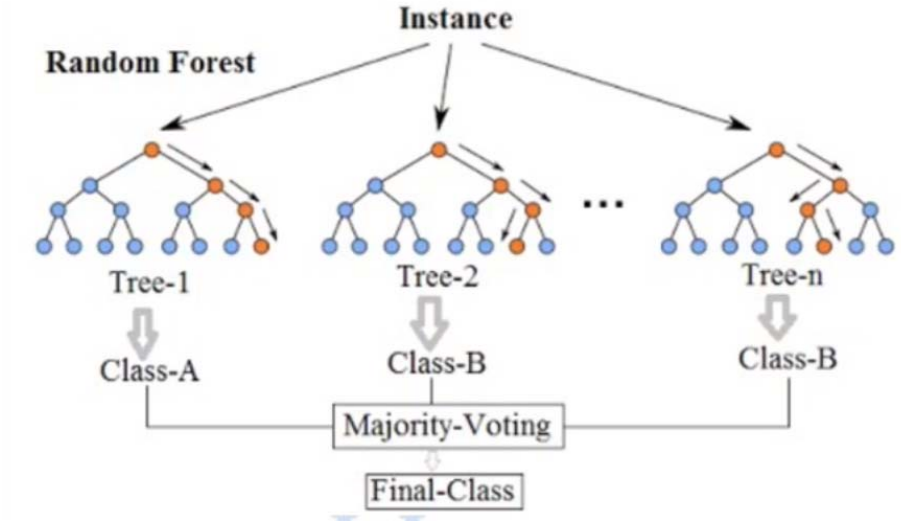
2. AI & AF/Cardiovascular Disease

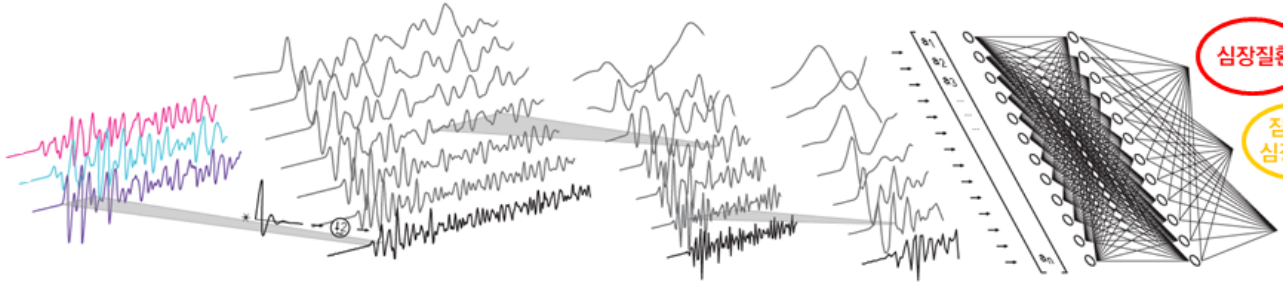
Serial Analysis of ECG



AI analysis Algorithm

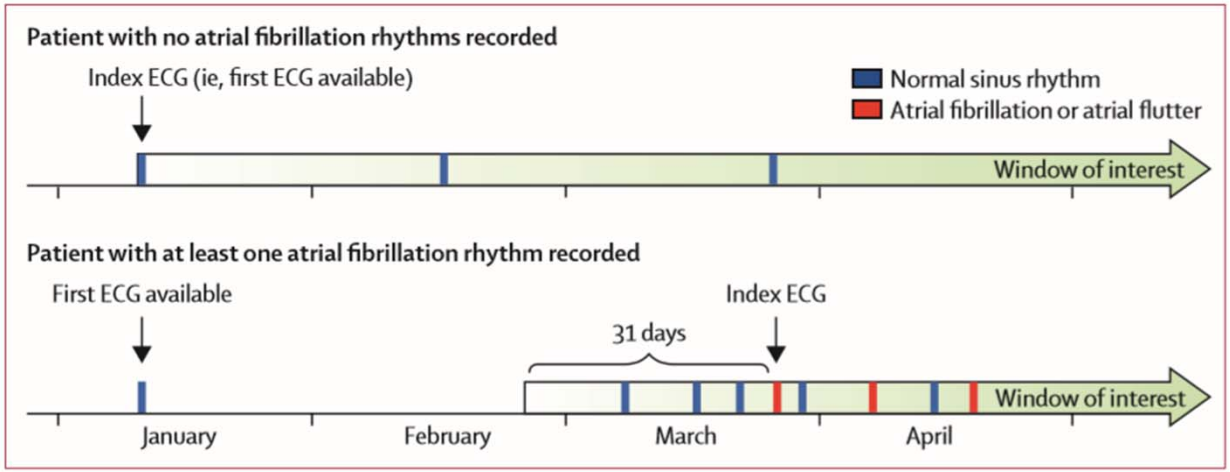


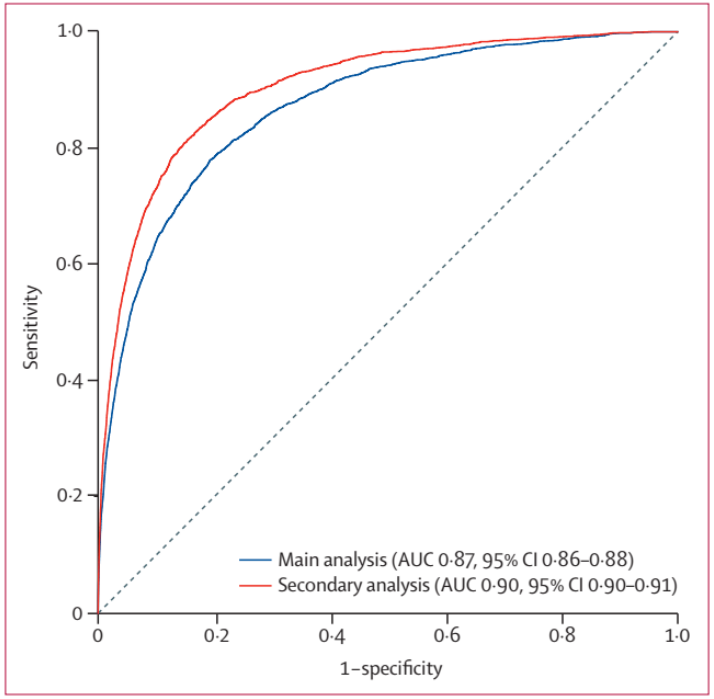




An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction

Zachi I Attia, Peter A Noseworthy*, Francisco Lopez-Jimenez, Samuel J Asirvatham, Abhishek J Deshmukh, Bernard J Gersh, Rickey E Carter, Xiaoxi Yao, Alejandro A Rabinstein, Brad J Erickson, Suraj Kapa, Paul A Friedman*





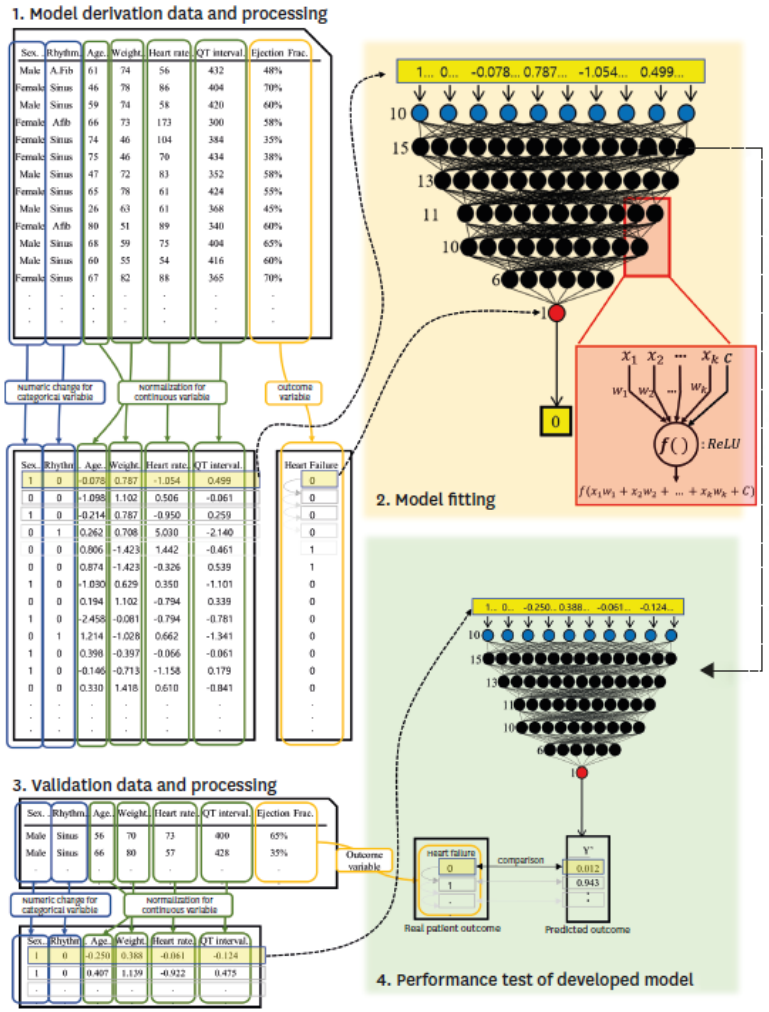
Lancet. 2019 ;394:861-867

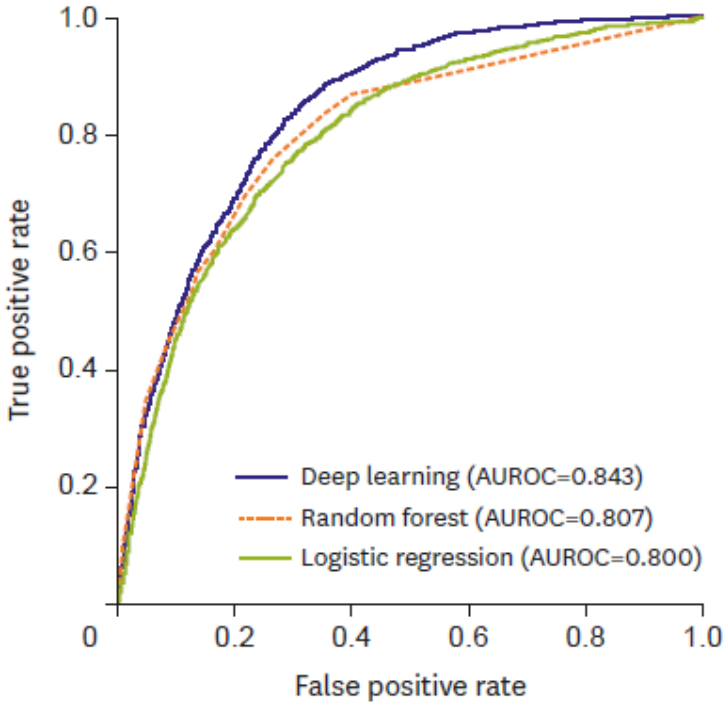
Korean Circ J. 2019 Jul;49(7):629-639
https://doi.org/10.4070/kcj.2018.0446
pISSN 1738-5520·eISSN 1738-5555

kcj
Korean Circulation Journal

Original Article

Development and Validation of Deep-Learning Algorithm for Electrocardiography-Based Heart Failure Identification





Korean Circ J. 2020 Jan;50(1):72-84
https://doi.org/10.4070/kcj.2019.0105
pISSN 1738-5520·eISSN 1738-5555

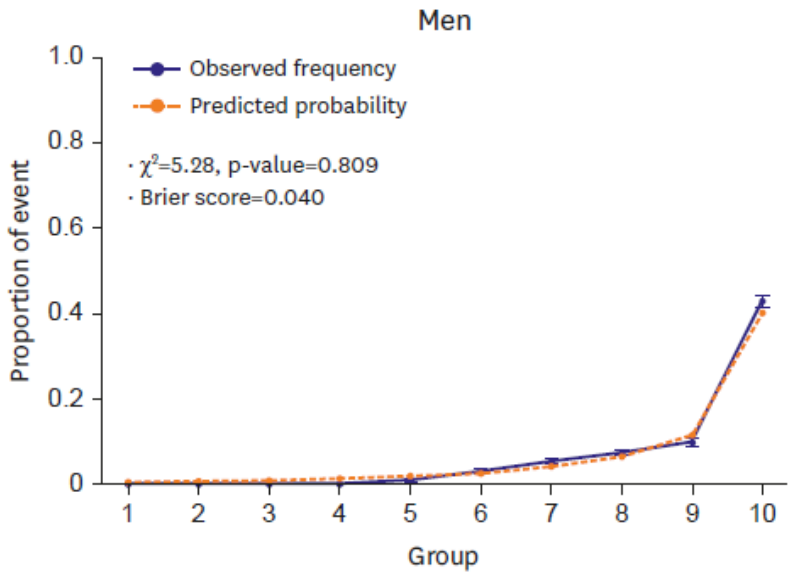
kcj
Korean Circulation Journal

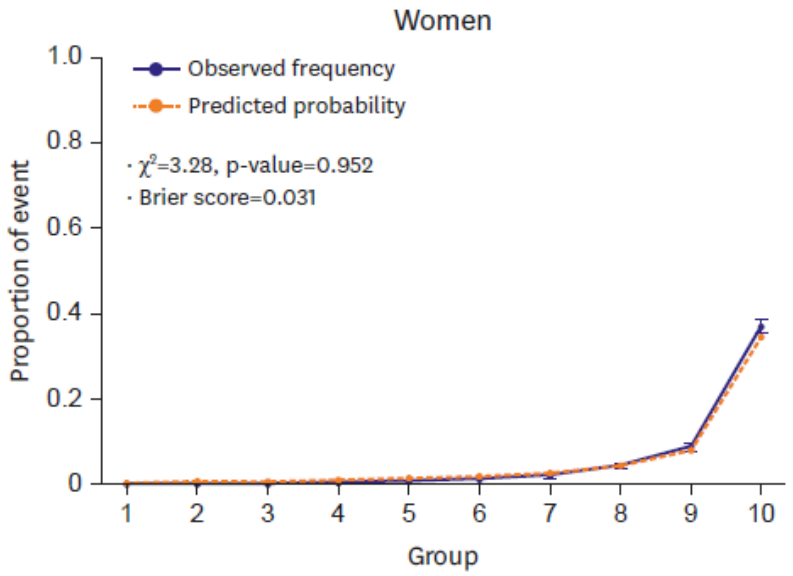
Original Article

Check for updates

Development and External Validation of a Deep Learning Algorithm for Prognostication of Cardiovascular Outcomes

A. Internal validation





3. Prediction of AF/CVD based on AI

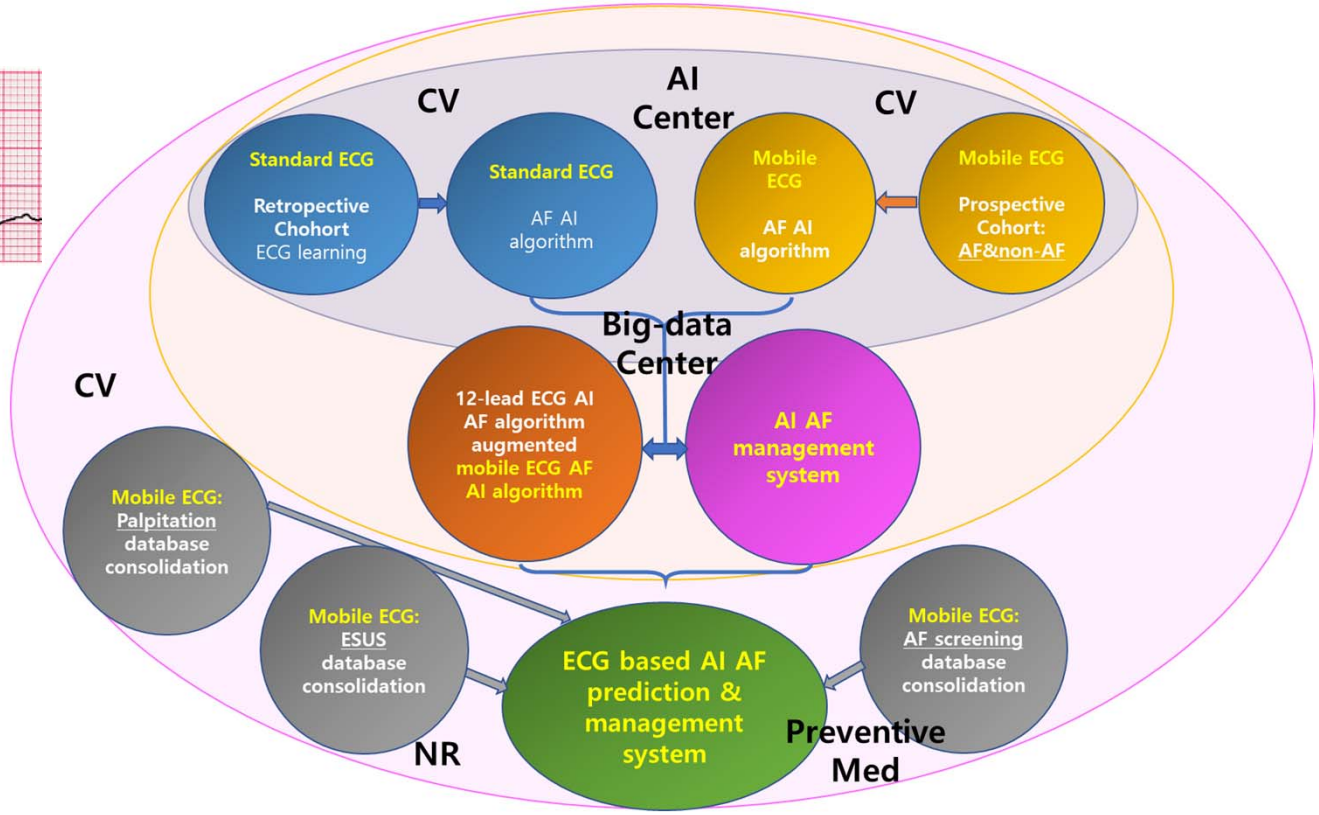
Human vs. AI

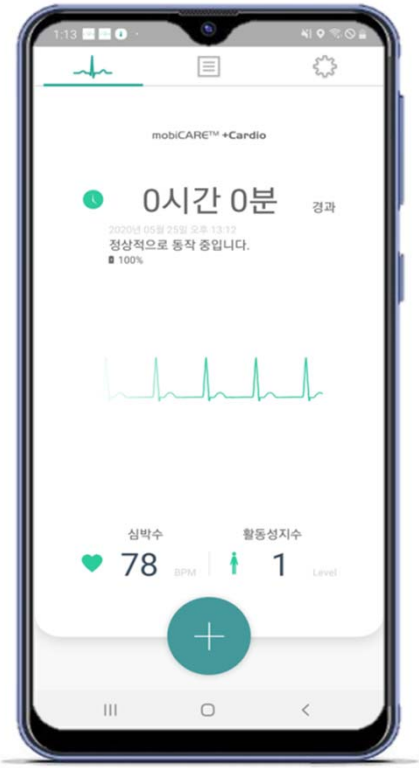

프로 9단 이세돌
인간 대 인공지능의 대결
1967년 체스 체스 프로그램 '맥헥' vs 철학자 휴버트 드레퓌스 맥헥 승
1996년 체스 IBM 수퍼컴퓨터 '딥블루' vs 체스 세계챔피언 개리 카스파로프 카스파로프 승 (3승 2무 1패)
1997년 체스 IBM 수퍼컴 '디퍼블루' vs 카스파로프 디퍼블루 승 (2승 3무 1패)
2011년 퀴즈 IBM 수퍼컴 '왓슨' vs 퀴즈 챔피언 제닝스·루터 왓슨 우승
2013년 장기 장기 프로그램 '어웨이크' vs 일본 프로기사 연합 어웨이크 승 (3승 1무 1패)
2015년 포커 포커 프로그램 '클라우디코' vs 프로 포커선수 4명 프로 선수 승리
2015년 바둑 구글 '알파고' vs 프로 바둑기사 판후이(2단) 알파고 승 (5승 무패)
2016년 3월 바둑 알파고 vs 프로 9단 이세돌 ?
AlphaGo

Entirely trust AI Algorithm?

2021년도 신진연구 신규과제
연구계획서

Integrated standard and mobile ECG atrial fibrillation prediction and management system based on artificial intelligence





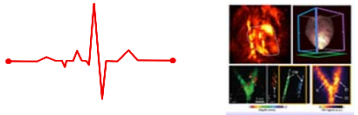
2021년도 기초연구실지원 연구개발계획서

양식A101

① 부처사업명(대)	기초연구사업	④ 보안등급(보안, 일반)	일반
② 사업명(중)	기초연구실지원	⑤ 과제성격(기초, 응용, 개발)	기초
③ 세부사업명(소)	융합형		
⑥ 총괄(상위) 과제명			
⑦ 과제명	국 문	인공지능 기반 한국 특화형 심장 질환 조기 예측 및 관리	
	영 문	Korea-specific early prediction and management for heart disease based on artificial intelligence	

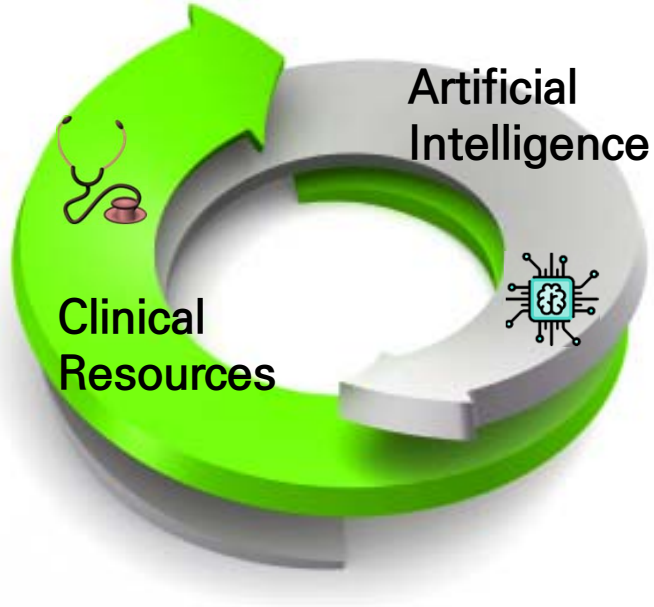
- Clinical Data

CNUH CV



- Dx & Tx guideline

CNUH CV

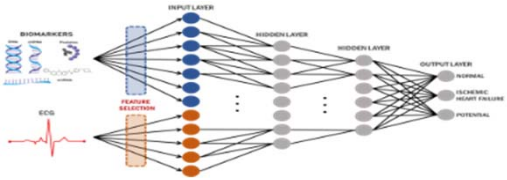


CVD prediction system with Big-data

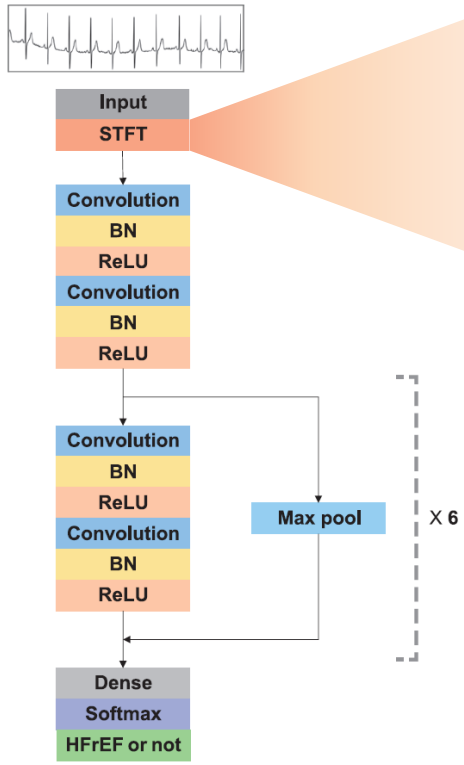
CNU big-data Center

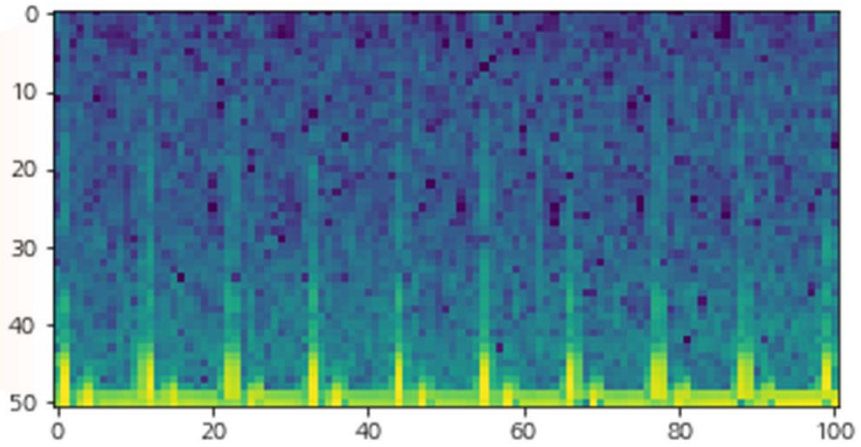
Pt management system With AI

CNU AI Center



Convolutional Network Analysis (CNN)



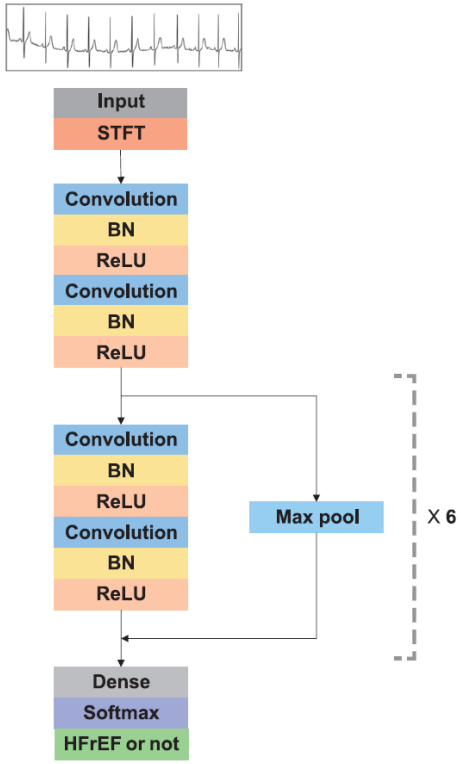


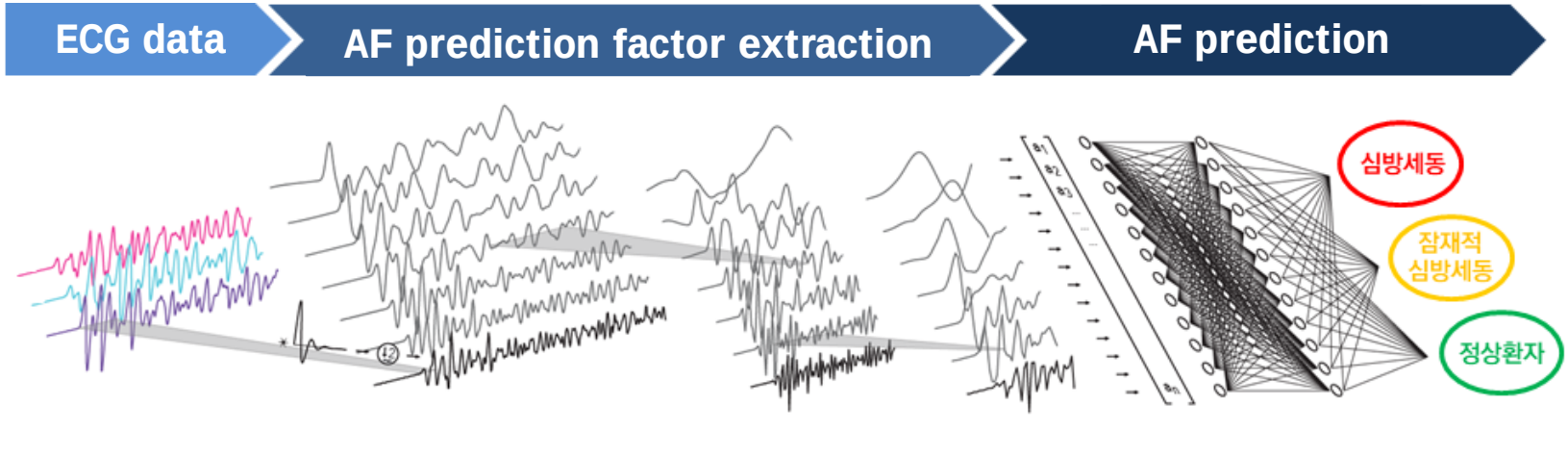
$$\tilde{X}_m^{w,z}(\omega_k) = \sum_{n=-N/2}^{N/2-1} \tilde{x}_m^{w,z}(n) e^{-j\omega_k nT}$$

$$\tilde{x}_m^{w,z}(n) \triangleq \begin{cases} \tilde{x}_m^w(n), & |n| \le M_h \triangleq \frac{M-1}{2} \\ 0, & M_h < n \le \frac{N}{2} - 1 \\ 0, & -\frac{N}{2} \le n < -M_h \end{cases}$$

$$\tilde{x}_m(n) \triangleq x(n + mR), \qquad n = -M_h, \ldots, -1, 0, 1, \ldots, M_h$$

Convolutional Network Analysis (CNN)





Which factors can explain prediction?

AI Explainable Model

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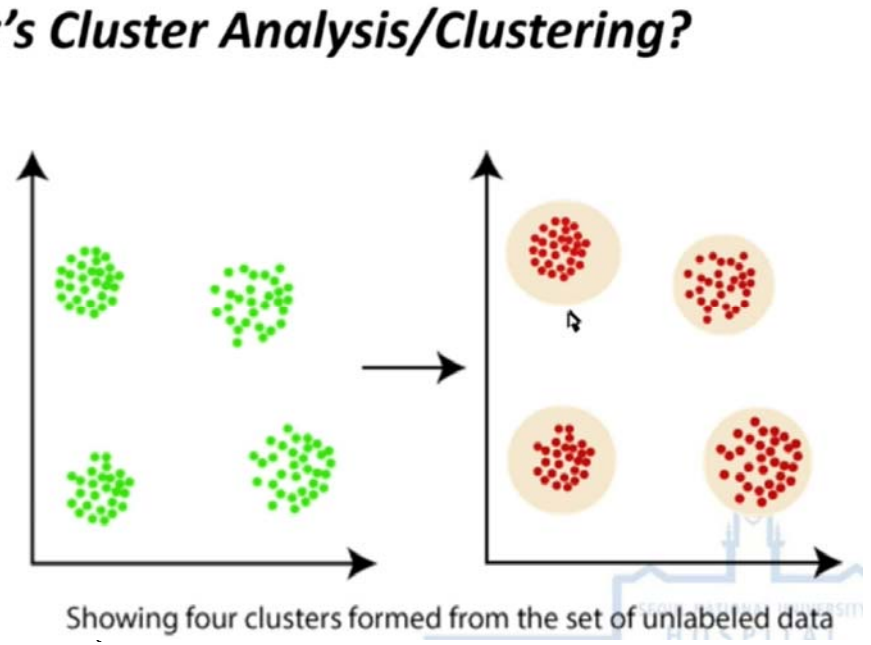


Explainable Model for Prediction and Prevention

Different Insights from Different Data Source…

Different Materials (Data)

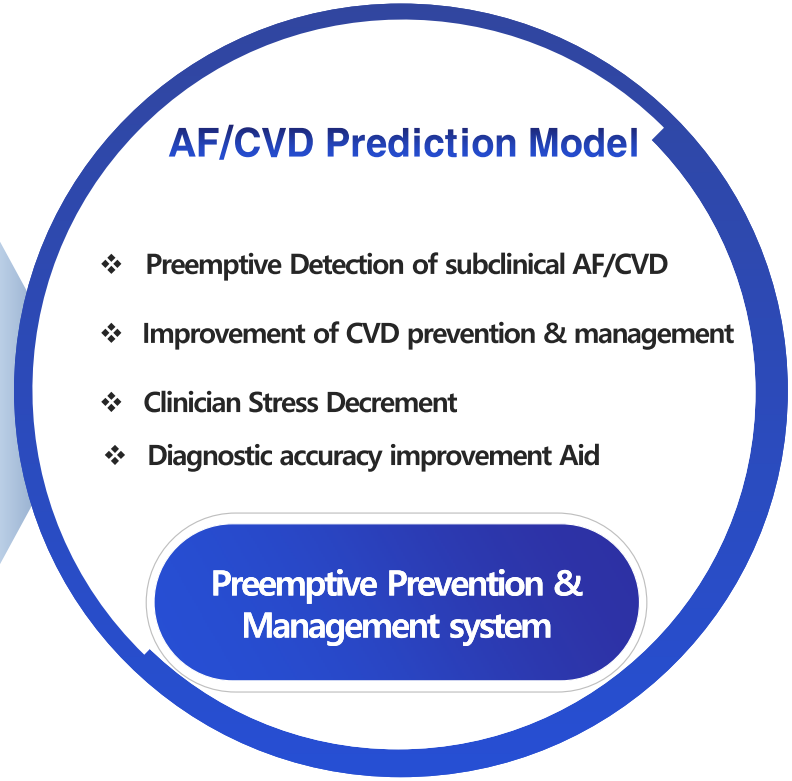
- Who will benefit from a earlier prevention strategy

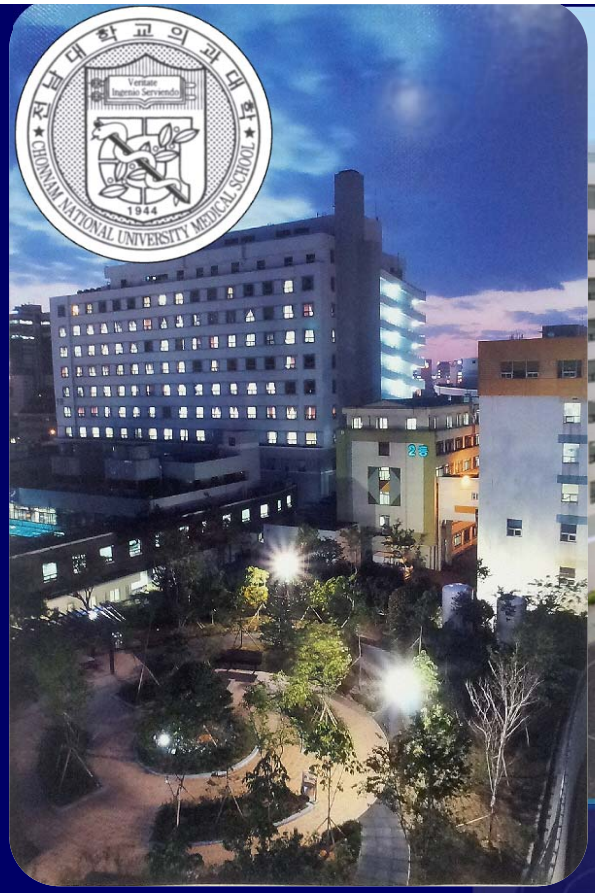
Wrap-up & Summary

Big data with Clinical Data

Prediction Algorithm for AF/CVD with AI

Risk & Disease Management Algorithm for AF/CVD with AI





Thank you for your attention !!