Artificial Intelligence in Health Care

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Advisory Board IEEE Indonesia Section
Advisory Board Tokopedia-AI Center of Excellent, Fasilkom UI
Advisory Board " Asosiasi Dosen Metodologi Penelitian Indonesia"

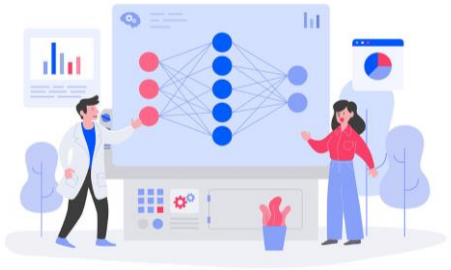
Presentation **Outline**

Artificial Intelligence

Definition of AI

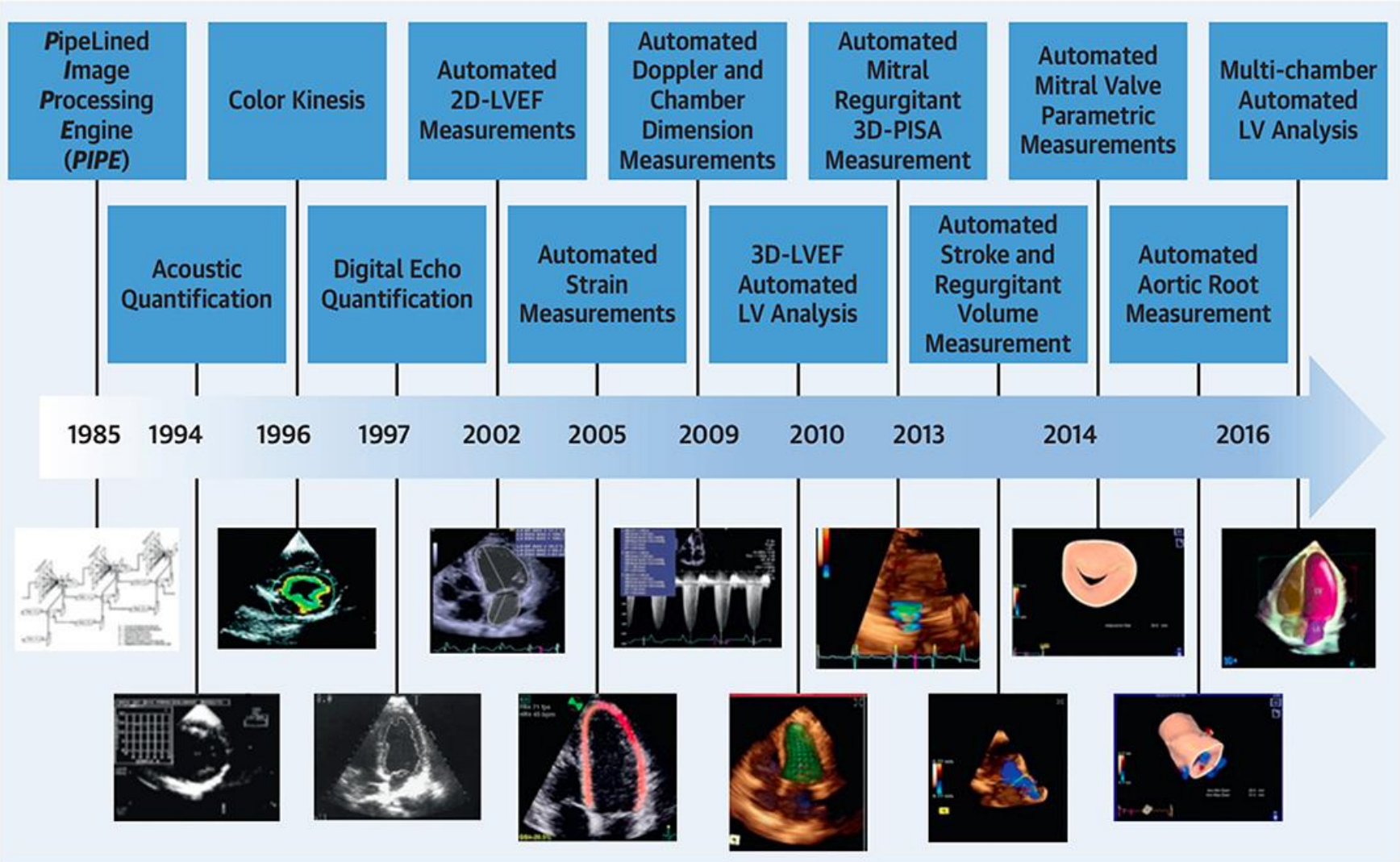
- …. making a machine behave in ways that would be called intelligent if a human were so behaving. McCarthy, Minsky, Rochester & Shannon, 1956.

Computing Intelligence	Perceptual Intelligence	Cognitive Intelligence
Capable of storing and computing:	**Capable of listening and seeing:**	**Capable of understanding and thinking:**
Machine can compute and transfer information as human beings do	Machine can listen and see, make judgement, and take simple action	Machine can understand, think, and make decision like human beings
Example: Neural Network	Example: Face Recognition	Example: Autonomous Driving Car

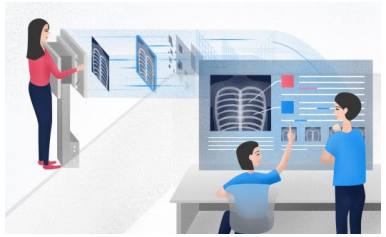


A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, August 31, 1955, AI Magazine, Vol. 27(4), 2006
Adapted from Slide "Pattern Recognition: Statistics to Deep Networks" Anil K. Jain, Michigan State University, ICACSIS-IWBIS 2020
https://medium.com/@amitpaka/three-stages-of-ai-9d2df56dbd08-

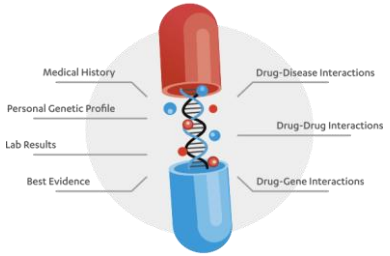
Temporal progression in automated quantification in echocardiography. (Adapted from Nolan et al.)



General Framework of AI in Medicine



Automatic Diagnosis



Decision Support

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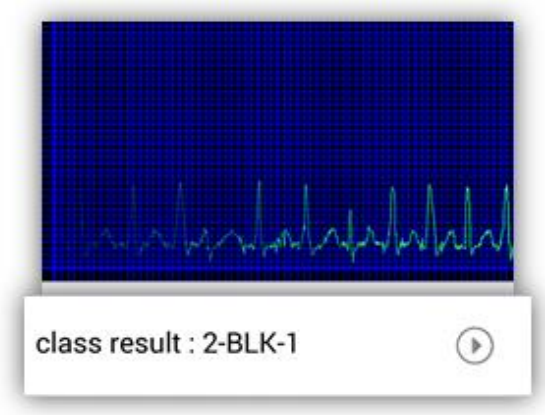


Problem Identification

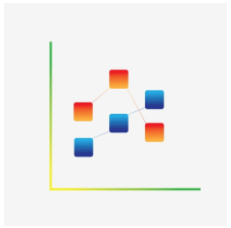
Data Requirement Design

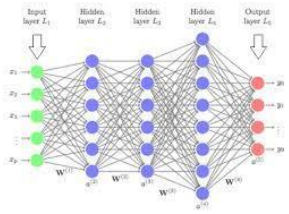
Data Preprocessing

Data Analytics

Visualization & Evaluation

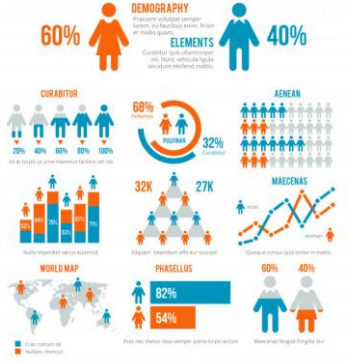
- Data Cleansing
- Data Dimension Reduction
- Data Normalization
- …





- Classification/Regression
- Machine Learning
  - Supervised
  - Unsupervised
- Deep Learning
- …

Demographic Data



Clinical Data

Imaging Data

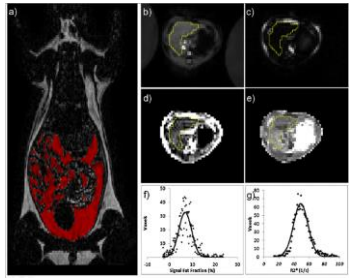


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Illustration Source:

https://petuum.medium.com/on-the-automatic-generation-of-medical-imaging-reports-7d0a7748fe3d

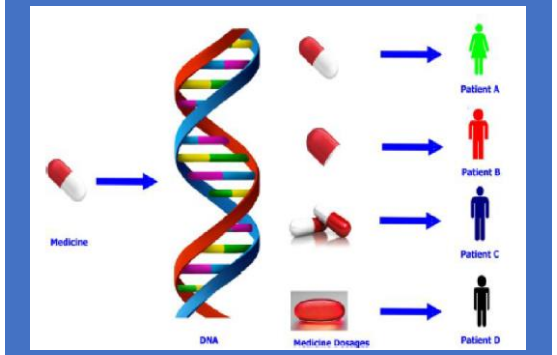
https://www.genxys.com/content/wp-content/uploads/2017/05/GenXys_Illustration_June2017_c.png

https://image.freepik.com/free-vector/business-statistics-graph-demographics-population-chart-people-modern...

https://www.researchgate.net/profile/Monica-Lind-2/publication/233394999/figure/fig1/AS:

Problem Identification: Intelligent Healthcare

Medicine Mining



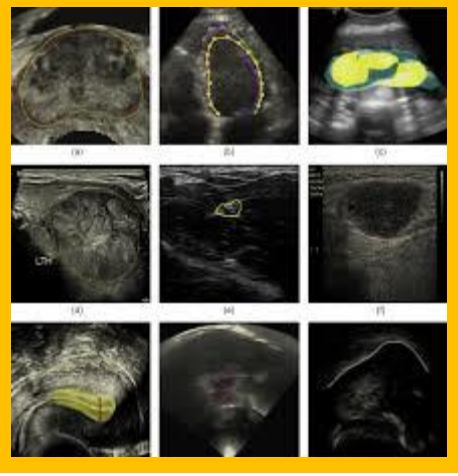
Health Management

Hospital Management

Assistance for Medical Research

Virtual Assistant

Medical Image



Assistance for Diagnosis And Treatment

Disease Risk Forecast

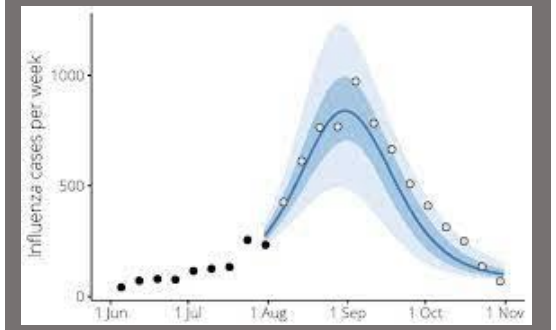


Illustration Source:

https://techvidvan.com/tutorials/top-8-applications-of-artificial-intelligence-in-healthcare/https://hbr.org/2018/05/10-promising-ai-applications-in-health-care
https://petuum.medium.com/on-the-automatic-generation-of-medical-imaging-reports-7d0a7748fe3d
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https://res-4.cloudinary.com/the-university-of-melbourne/image/upload/s--X8x4c9tU--/c_limit,f_auto,q_75,w_892

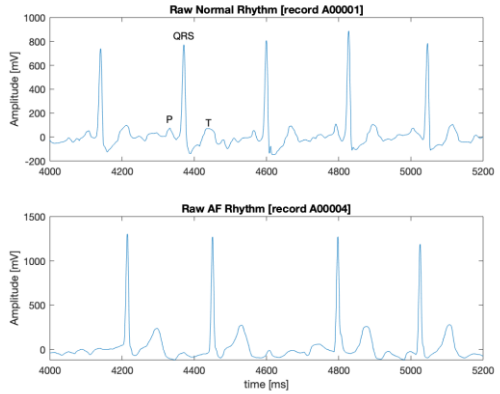
Data Requirement Design: Glossary

- **Dataset** : a collection of data used by our method
- **Sample** : every data record
- **Feature** : Attribute that reflects the condition of a sample
- **Training set**: data used in the training process. The process of forming a model from data is called training / learning
- **Test Set**: The model that has been created needs to be tested using a data set called a test set.

Data Requirement Design: Example of Dataset

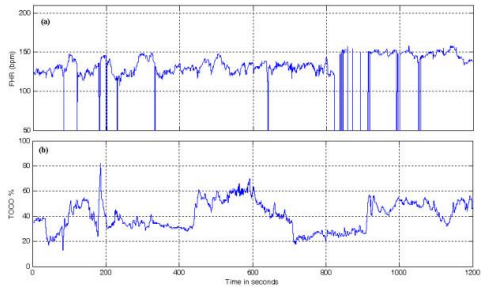
Signals Dataset

ECG Signals



https://dl.acm.org/doi/fullHtml/10.1145/3421558.3421560

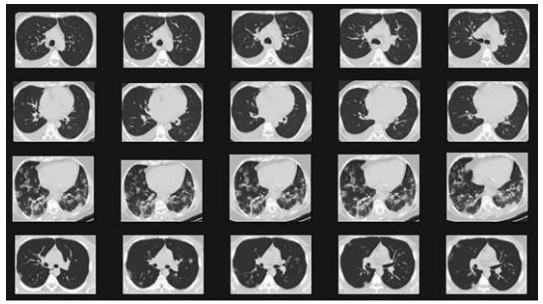
CTG Signals



Krupa, Niranjana et.al . (2011). Antepartum fetal heart rate feature extraction and classification using empirical mode decomposition and support vector machine. Biomedical engineering online. 10. 6. 10.1186/1475-925X-10-6.

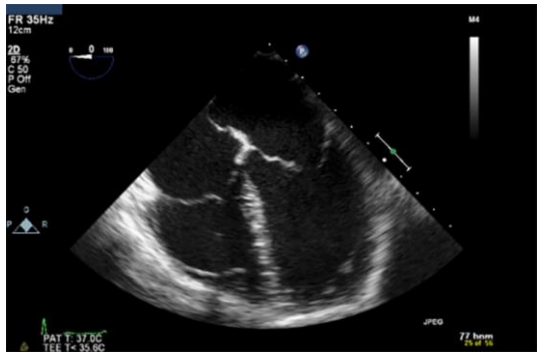
Image Dataset

CT Scan



Chahar, Vijay & Jaiswal, Aayush & Gianchandani, Neha & Singh, Dilbag & Kaur, Manjit. (2020). Classification of the COVID-19 infected patients using DenseNet201 based deep transfer learning. Journal of biomolecular Structure & Dynamics. 10.1080/07391102.2020.1788642.

Echo



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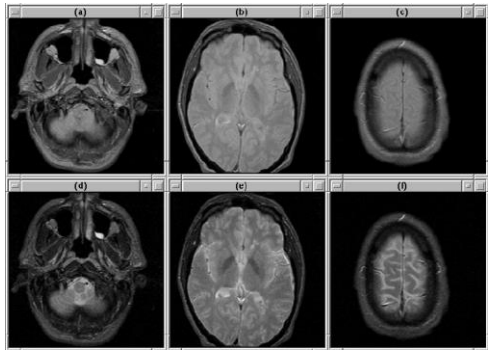
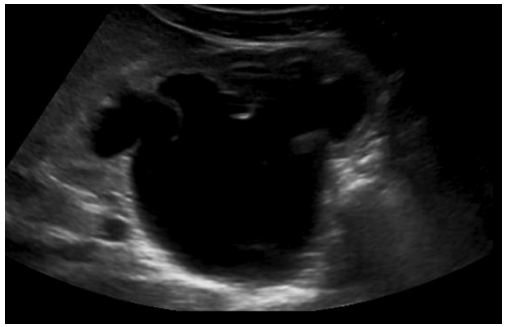
MRI



https://www.cs.sfu.ca/~stella/papers/blairthesis/main/node48.html

USG



Sivanesan, Umaseh & Braga, Luis & Sonnadara, Ranil & Dhindsa, Kiret. (2019). Unsupervised Medical Image Segmentation with Adversarial Networks: From Edge Diagrams to Segmentation Maps.

Type of Data:

Tabular: Medical records, Demographic, Clinical
Signals: ECG Signals, CTG Signals, EEG Signals, etc.
Images: CT Scan, USG, 3D CT Scan, etc.
Videos: Echocardiography video, USG video, etc.

Data Preprocessing:

Good AI is built on **Good Data**

Data Cleansing

Fill in missing values, and detect and eliminate cause of dataset exceptions

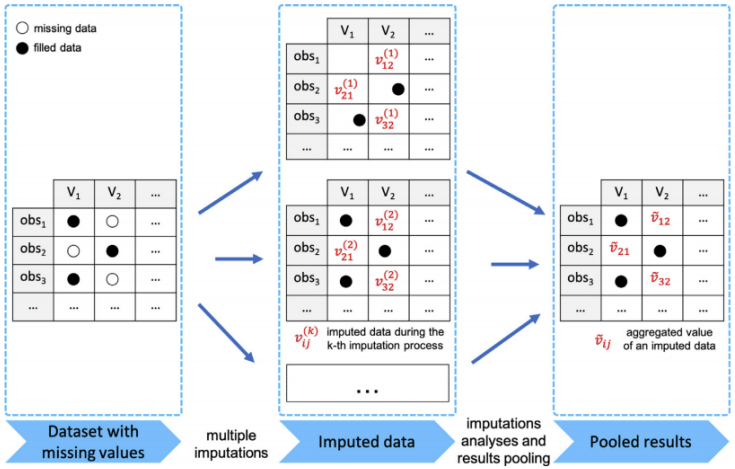
Data Normalization

Normalize data to reduce noise and improve model accuracy

Data Dimension Reduction

Simplify data attributes/features to avoid dimension explosion

Missing value imputation illustration

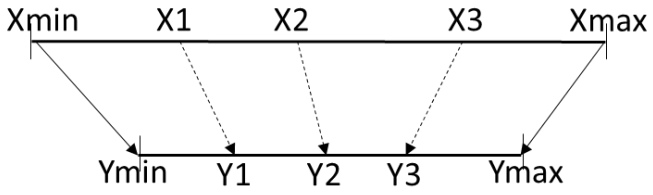


https://hal.archives-ouvertes.fr/hal-02134695/document

Data normalization illustration

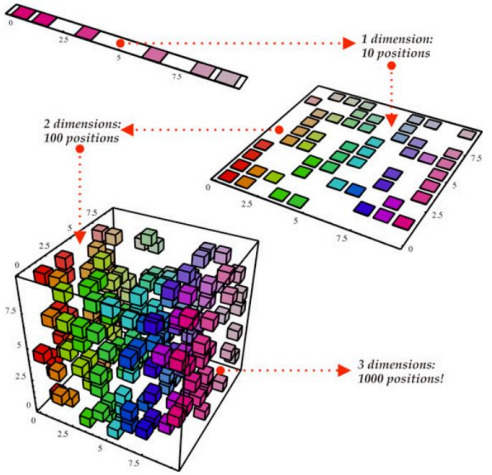
Min, Max Normalization

$$Xnew = \frac{X - Xmin}{Xmax - Xmin}$$



https://www.researchgate.net/figure/Min-max-method-of-normalization_fig1_282541174

Dimension reduction illustration



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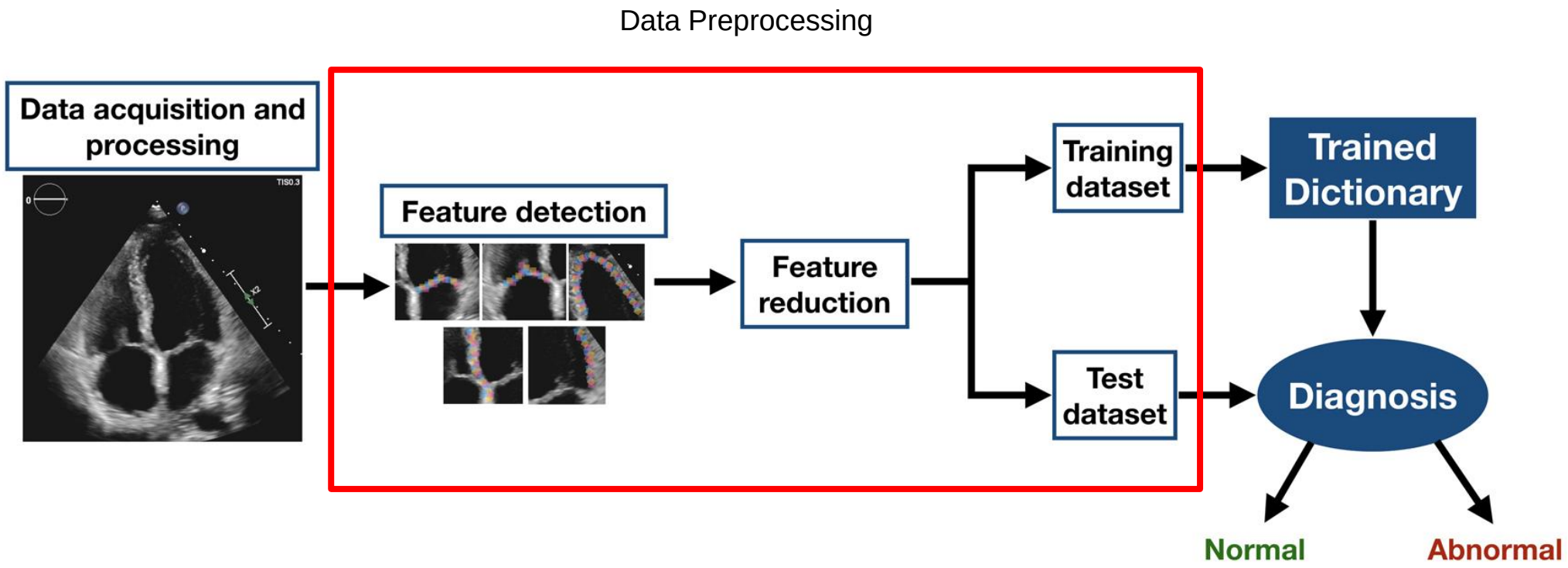
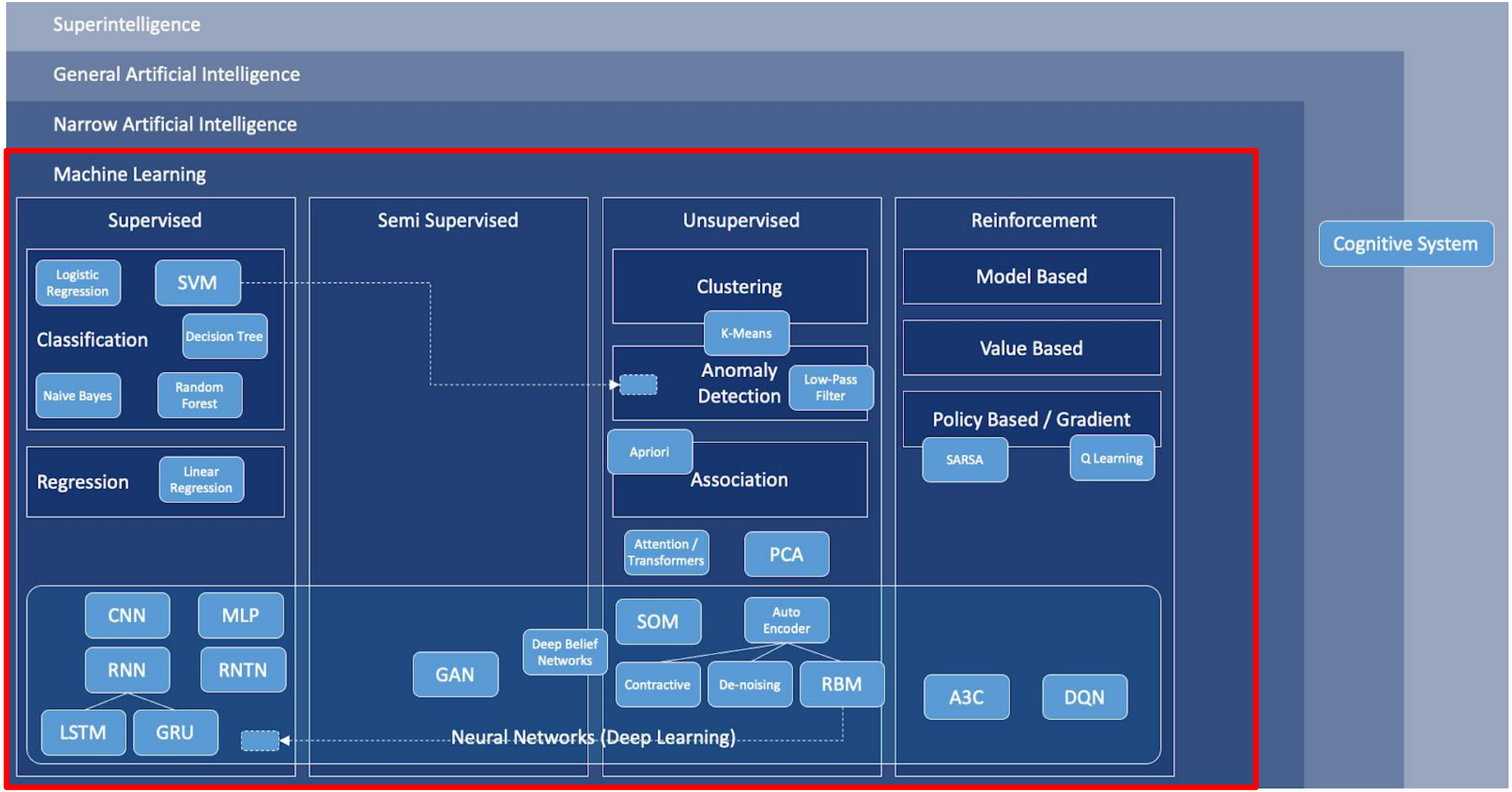
Example for Data Preprocessing



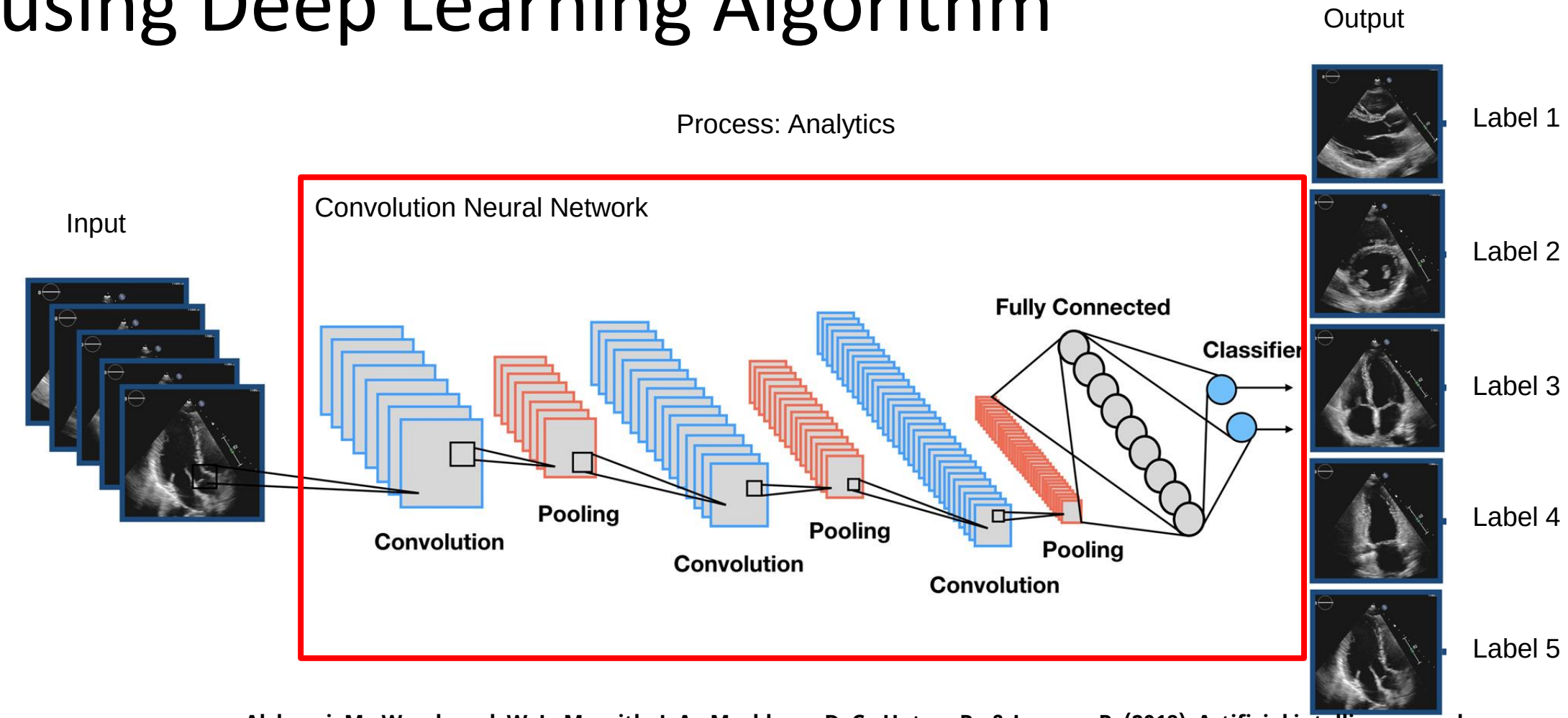
Alsharqi, M., Woodward, W. J., Mumith, J. A., Markham, D. C., Upton, R., & Leeson, P. (2018). Artificial intelligence and echocardiography, *Echo Research and Practice*, *5*(4), R115-R125. Retrieved Jun 4, 2021, from https://erp.bioscientifica.com/view/journals/echo/5/4/ERP-18-0056.xml

Data Analytics:



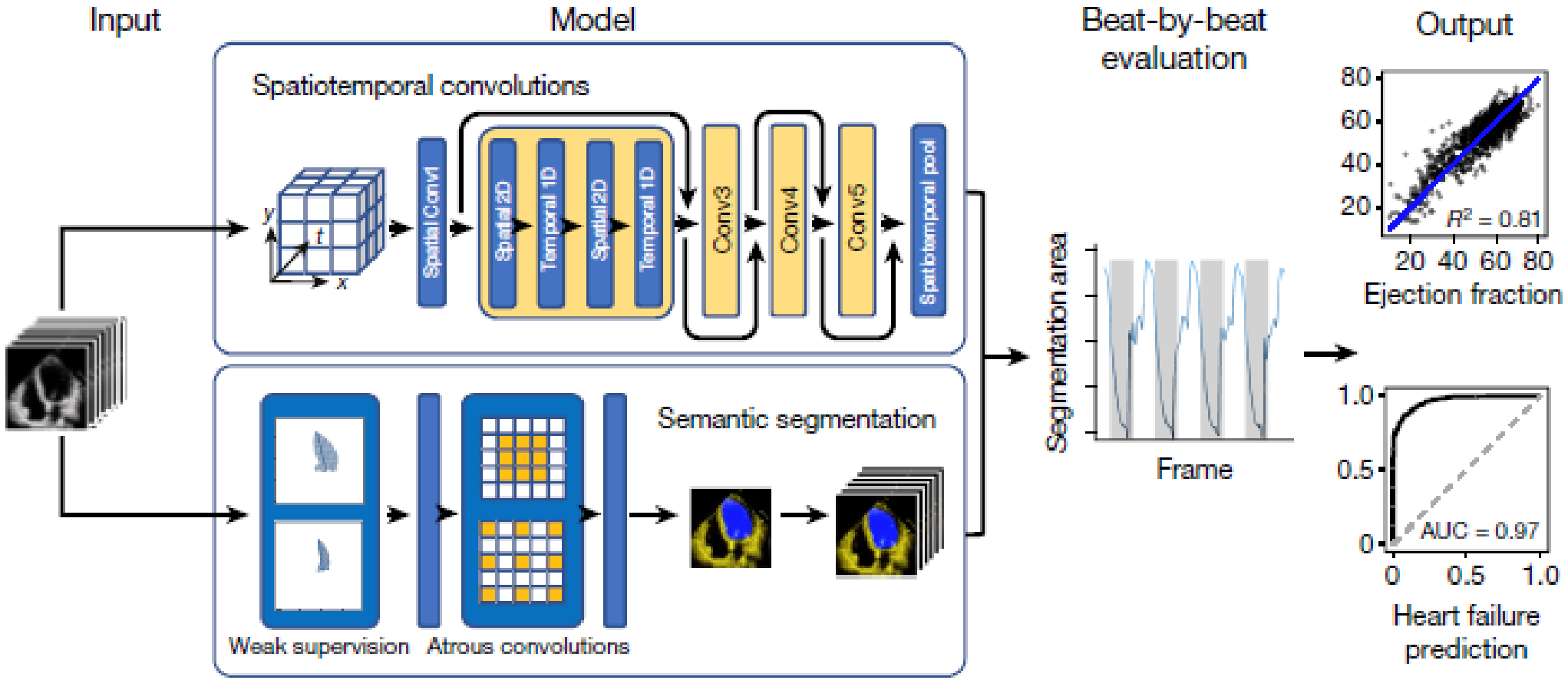
Abbreviations: SVM – Support Vector Machine, CNN – Convolutional Neural Network, RNN – Recurrent Neural Network, LSTM – Long Short-Term Memory, GRU – Gated Recurrent Units, MLP – Multilayer Perceptron, RNTN – Recursive Neural Tensor Network GAN – General Adversarial Network, PCA – Principal Component Analysis, SOM – Self-Organizing Map, RBM – Restricted Boltzmann Machine, SARSA – State-Action-Reward-State-Action, DQN – Deep Q Network, A3C – Asynchronous Advantage Actor Critic

Example for Echocardiography Classification using Deep Learning Algorithm



Alsharqi, M., Woodward, W. J., Mumith, J. A., Markham, D. C., Upton, R., & Leeson, P. (2018). Artificial intelligence and echocardiography, *Echo Research and Practice*, *5*(4), R115-R125. Retrieved Jun 4, 2021, from https://erp.bioscientifica.com/view/journals/echo/5/4/ERP-18-0056.xml

Example for Echocardiography Segmentation using Deep Learning Algorithm : **EchoNet-Dynamic Algorithm**



The model first predicts the ejection fraction for each cardiac cycle using spatiotemporal convolutions with residual connections generates frame level semantic segmentations of the left ventricle using weak supervision from expert human tracings. These outputs are combined to create beat-to-beat predictions of the ejection fraction and to predict the presence of heart failure with reduced ejection fraction. AUC, area under the curve.

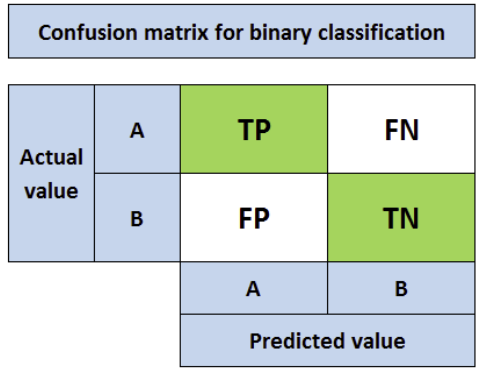
David Ouyang, Bryan He, Amirata Ghorbani, Neal Yuan, Joseph Ebinger, Curt P. Langlotz, Paul A. Heidenreich, Robert A. Harrington, David H. Liang, Euan A. Ashley, and James Y. Zou. **Nature**, March 25, 2020.

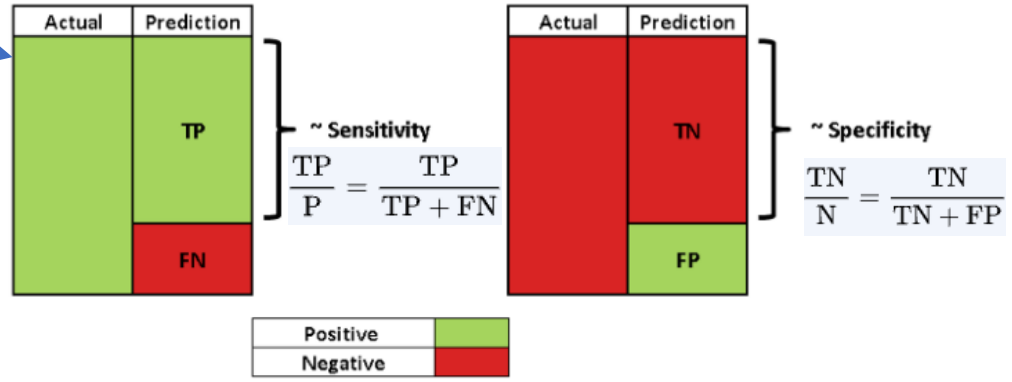
Visualization and Evaluation

Classification/Prediction Problem:

- Classification accuracy
- Confusion Matrix
- Precision and Recall
- F1 Score
- Sensitivity and Specificity
- ROC and AUC
- Etc.

$$Accuracy = \frac{Number\ of\ correct\ predictions}{Number\ of\ all\ predictions}$$





Barriers to AI implementation

Large-scale, labeled datasets with high quality CT image data are required for training and testing new algorithms

Bias can arise in AI algorithms over time, through learning from disparities in patient demographics or healthcare systems

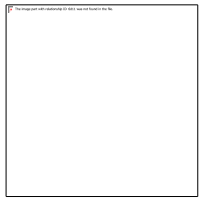
AI algorithms can **often be viewed as "black boxes"** which autonomously learn and make decisions

There is **the legal consideration of clinical clearance** for AI powered software applications.

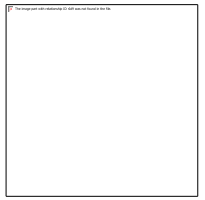
Lin, A., Kolossváry, M., Motwani, M., Išgum, I., Maurovich-Horvat, P., Slomka, P. J., & Dey, D. (2021). Artificial intelligence in cardiovascular CT: Current status and future implications. Journal of Cardiovascular Computed Tomography, January. https://doi.org/10.1016/j.jcct.2021.03.006

Future **Implications**

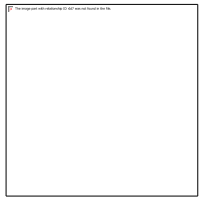
AI will be integrated into “the system” and **improve the efficiency of clinical workflow**.



AI can be used **to predict** diseases that will occur in the future.



AI can **be able to guide patient therapy** considering clinical factors and other supporting data to form **an accurate decision support**



Lin, A., Kolossváry, M., Motwani, M., Išgum, I., Maurovich-Horvat, P., Slomka, P. J., & Dey, D. (2021). Artificial intelligence in cardiovascular CT: Current status and future implications. Journal of Cardiovascular Computed Tomography, January. https://doi.org/10.1016/j.jcct.2021.03.006

OUR PROGRESS OF AI IN MEDICINE

Heart beat Classification

ECardio

E-Cardio is an integrated system that helps people to examine their cardiovascular health, without having to meet a doctor. This is especially useful in a situation like Indonesia.

1

Sensors

The system utilizes sensors to measure a person's heartbeat and will visualize and store the heartbeat data in an Android smartphone

2

Classification

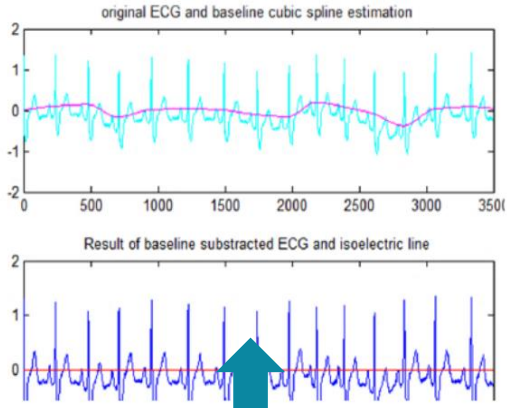
The system could also provide an **automatic classification of the person's cardiovascular health**. In addition to that, the system also sends the person's data to a doctor.

3

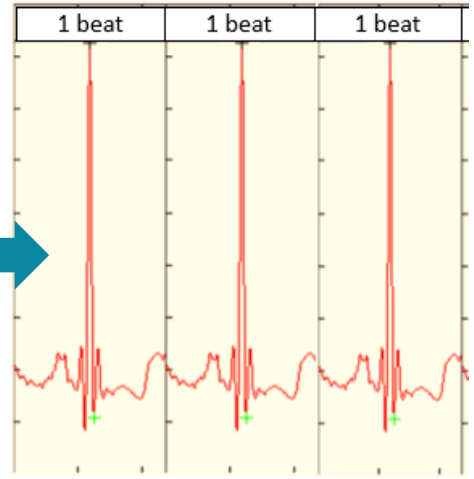
Transmission

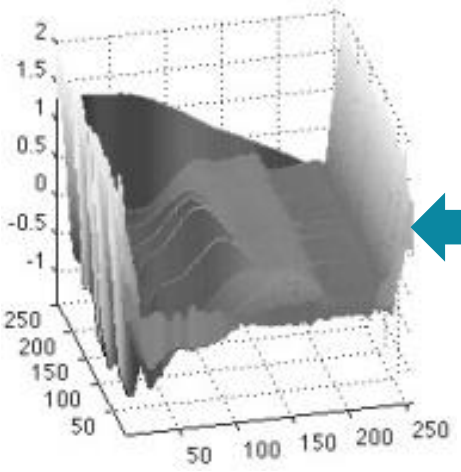
Developed a method for ECG signal compression to be transmitted via cellular signal

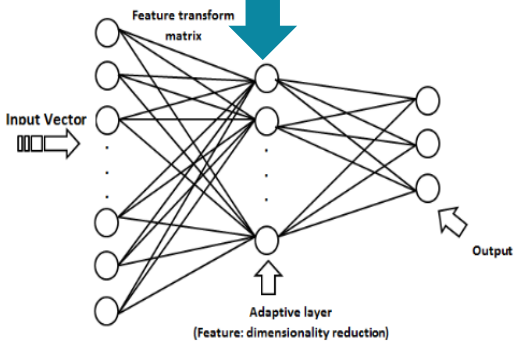
AI- Based Heart Beat Classification



ECG Data → Baseline Wander Removal → Beat Segmentation & Normalization → Wavelet → Dimension Reduction → ANN Classification → 2D SPIHT Compression

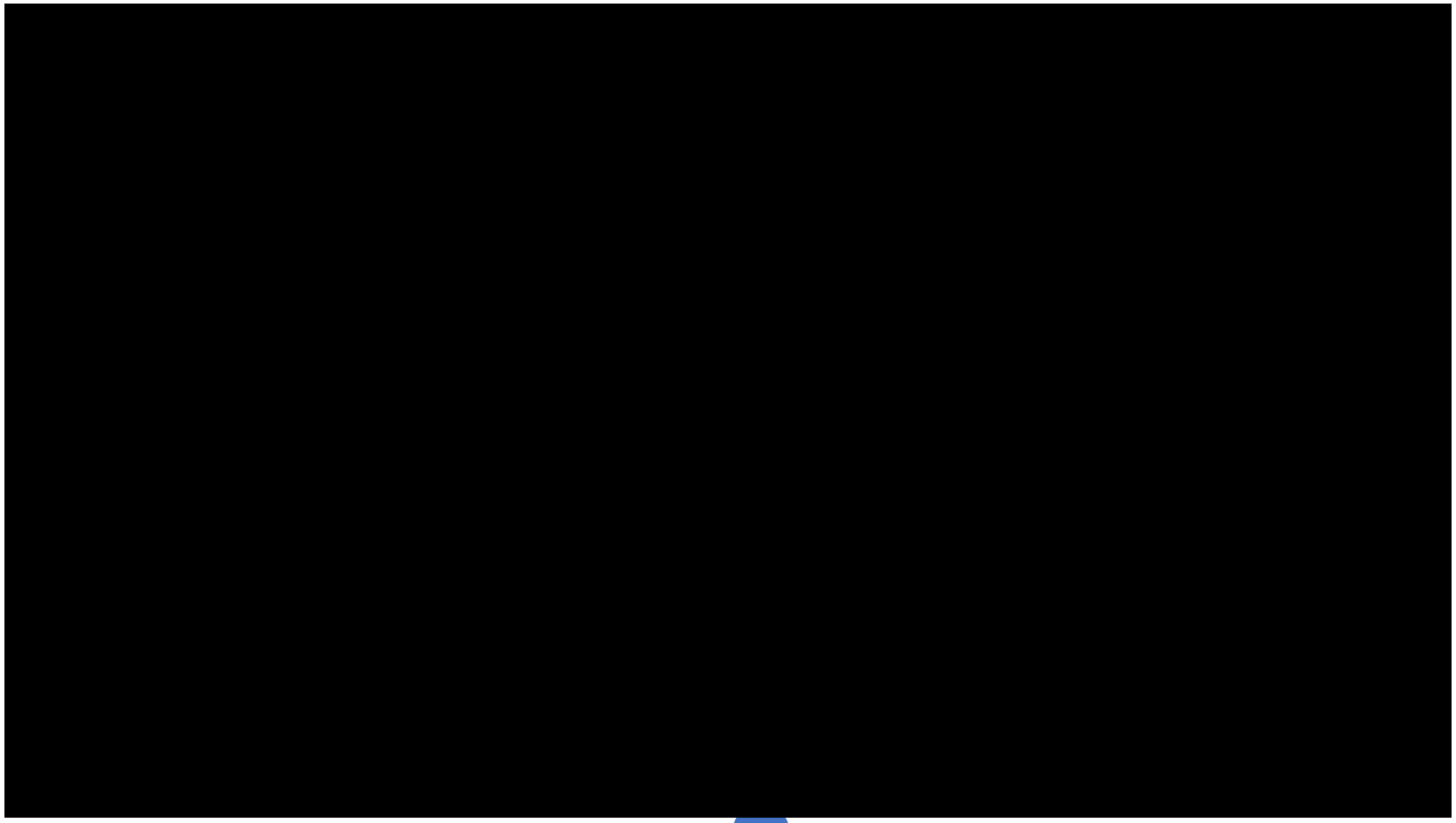




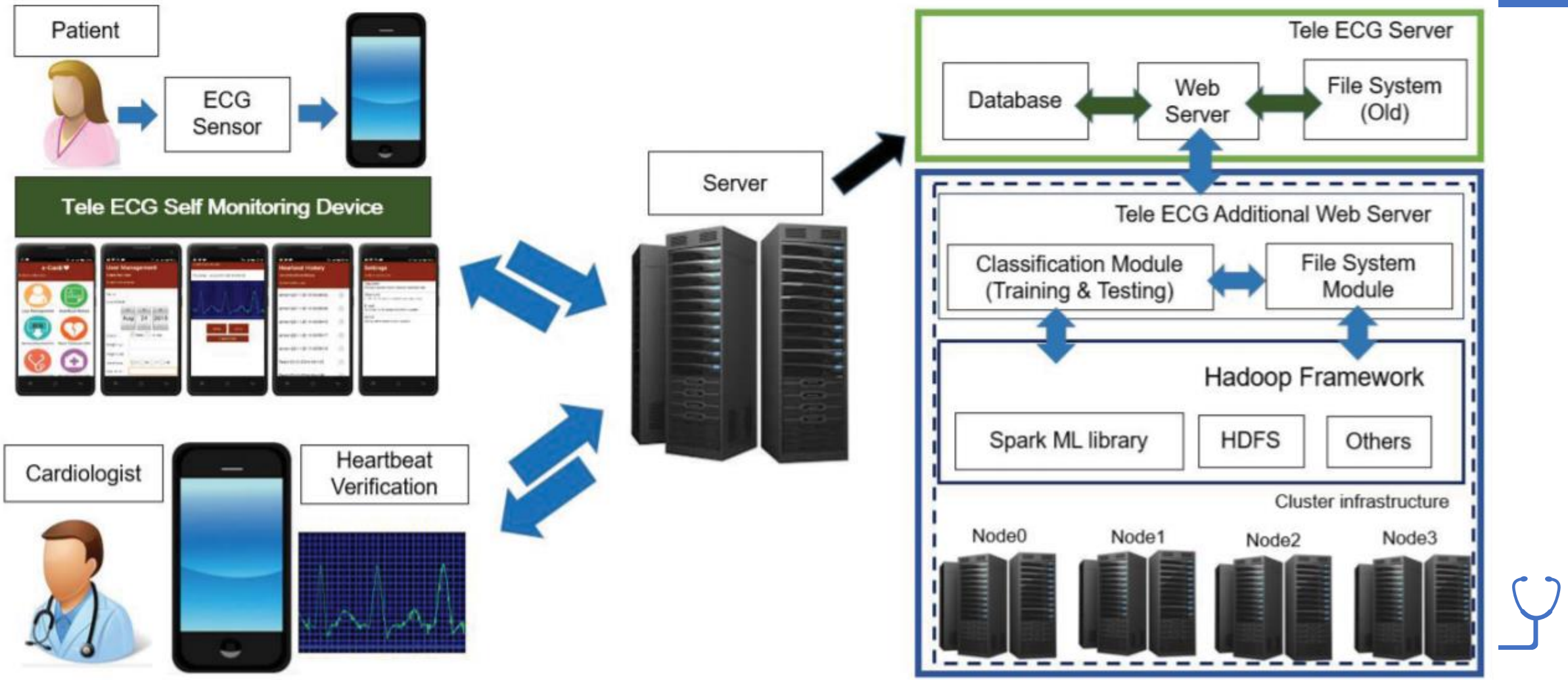


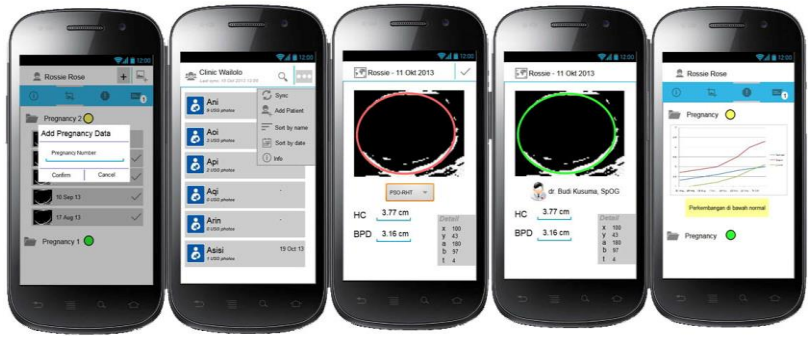
Heart Beat Classification - System

Tele-ECG Demo (Video)



Implement AI Application in Big Data Framework





Ultrasonography Fetal Monitoring

USG System

In our Tele-USG, a complete system have been developed. The main feature of our system is detecting body parts of the fetus to reduce the risk of death in pregnancy by monitoring the growth rate of the fetus.

1. **Fetal Organ Segmentation**
2. **Fetal Organ Approximation**
3. **Fetal Biometric Measurement**

Product Video

AI-Based Fetal Detection

Smartphone

Ultrasound Image

Human

Fetal Organ Segmentation (Boosting Clasifier)

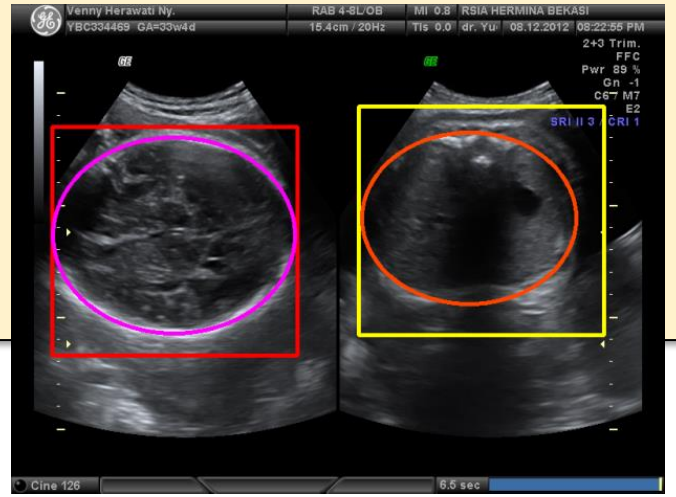
Fetal Curve Approximation (Hough Transform)

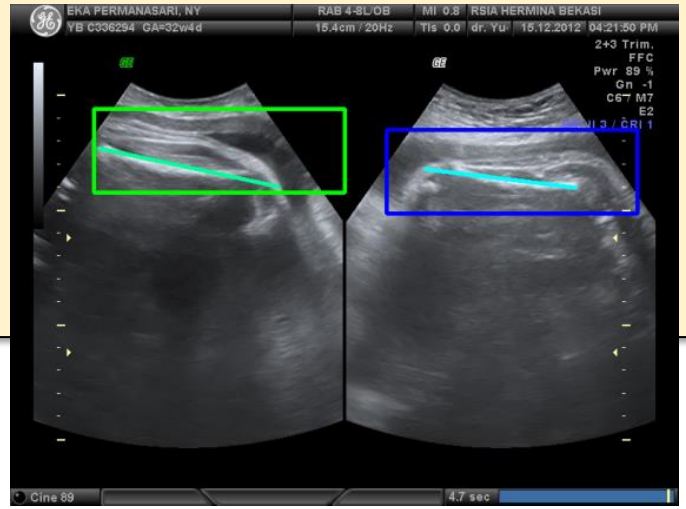
Fetal Biometric Mesurement

Server

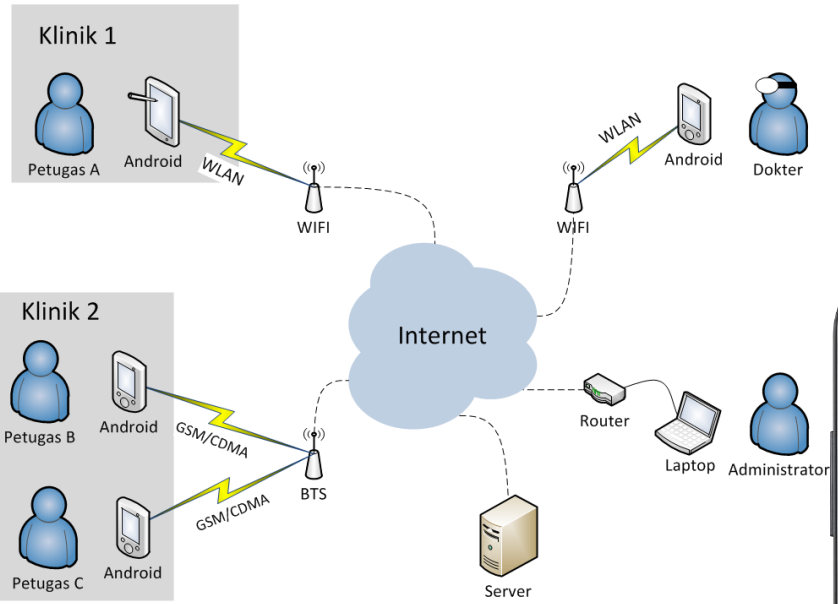
Web Service

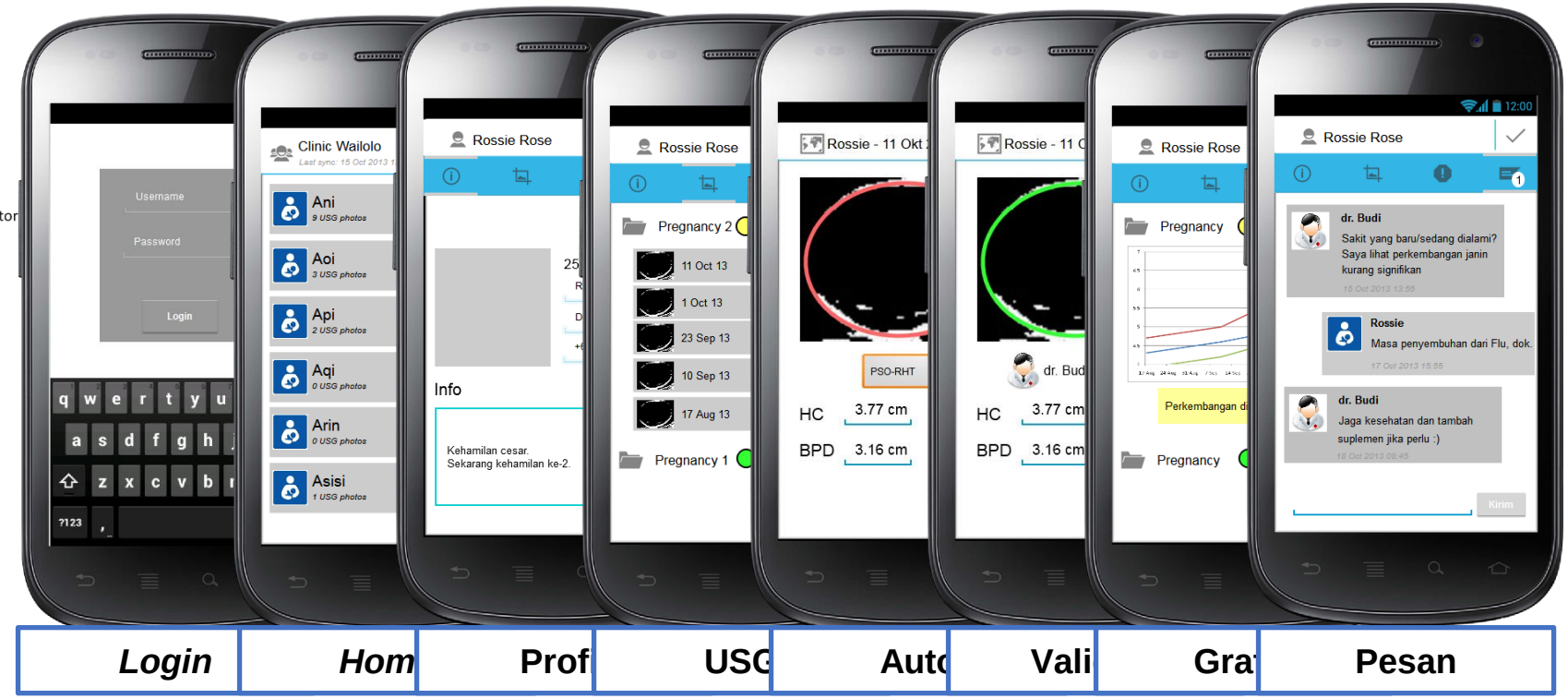
Database





Fetal Detection - System



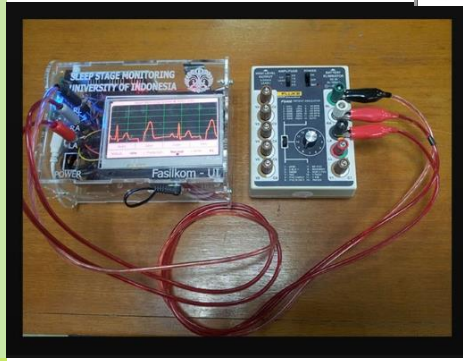


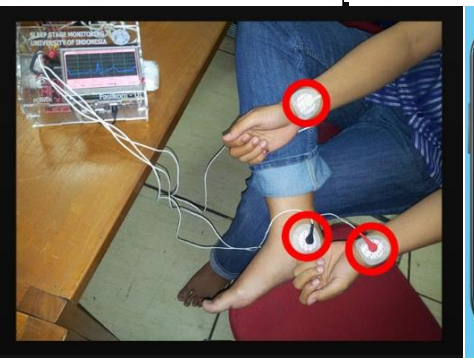
Telehealth Consortium

TKT 9
TKT 8
TKT 7
TKT 6
TKT 5
TKT 4
TKT 3
TKT 2
TKT 1

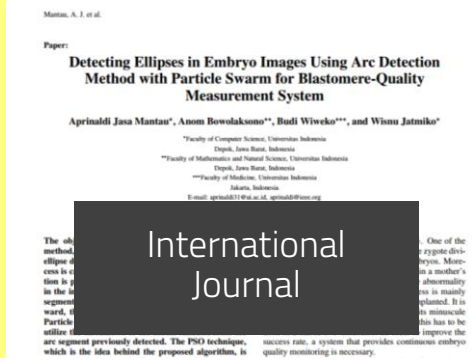
Product

Prototype & Copyright





Science Article



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END OF PRESENTATION