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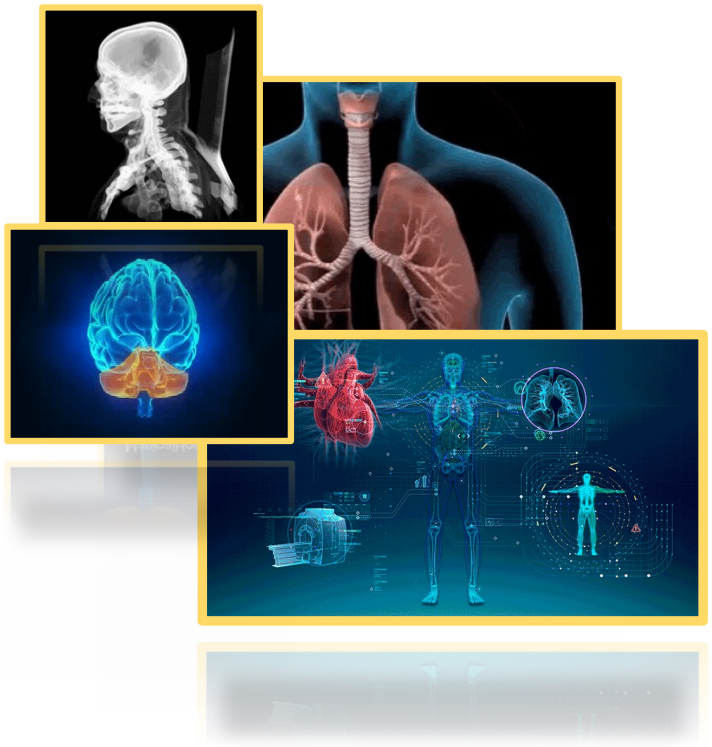

Toward Development of Intelligent System for Radiological Imaging

-HANUNG ADI NUGROHO-

Department of Electrical and Information Engineering
Faculty of Engineering
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Ir. Hanung Adi Nugroho, Ph.D., IPM

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Faculty of Engineering, Universitas Gadjah Mada
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Research areas: Biomedical signal and image processing and analysis; computer vision; medical instrumentation; pattern recognition; data mining; statistical data analysis.

Bachelor of Engineering (S.T.) – Teknik Elektro, Universitas Gadjah Mada, Yogyakarta, Indonesia (2001)

Master of Engineering (M.E.) – School of Information Technology and Electrical Engineering, The University of Queensland, St Lucia, Brisbane, Australia (2005)

Doctor of Philosophy (Ph.D.) – Electrical and Electronics Engineering Department, Universiti Teknologi PETRONAS, Seri Iskandar, Malaysia (2012)

Universitas Gadjah Mada
Department of Electrical and Information Engineering

18 Laboratories:

2 Basic labs
3 Service labs
13 Research labs

10 Research groups:

1. e-Systems Research Group
2. Software Engineering-Technology Enhanced Education-Computer Human Interaction
3. Digital Systems
4. Smart System and Communication Technology
5. Power System
6. Power Electronics
7. Intelligent Systems
8. System of Instrumentation, Control, Automation and Robotics
9. Digital Native and Literacy
10. High Voltage and High Current Engineering

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Universitas Gadjah Mada
Department of Electrical and Information Engineering

BAN-PT Accreditation : A

6 Study programs:

- Bachelor of Electrical Engineering Program
- Bachelor of Information Engineering Program
- Bachelor of Biomedical Engineering Program
- Master of Electrical Engineering Program
- Master of Information Engineering Program
- Doctoral of Electrical Engineering Program

110 staffs

1374 students

Bachelor student : 1066 students
Master student : 245 students
Doctoral student : 63 students

Lecturer (M.Eng) : 25 staff
Lecturer (PhD) : 37 staff
Lecturer (Prof) : 2 staff
Academic staff : 47 staff

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DEVELOPMENT OF INTELLIGENT SYSTEMS FOR SMART ENVIRONMENT

UNIVERSITAS GADJAH MADA

Peoples

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Teguh Bharata Adji, Ph.D
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Dr. Eng. Igi Ardiyanto
igi@ugm.ac.id
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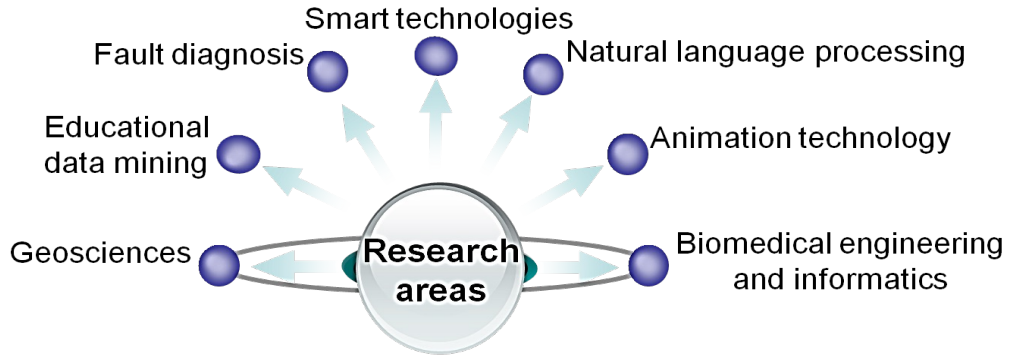

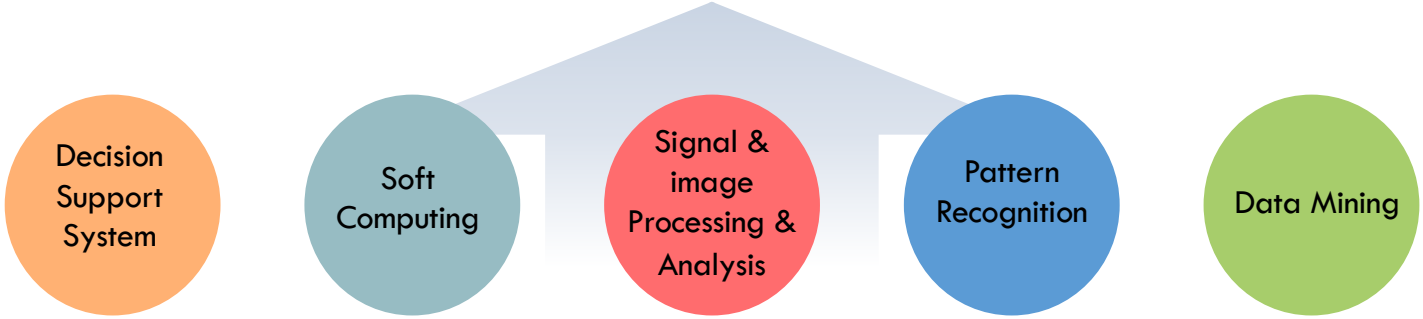

i-Systems Research Group

OUTLINE

UNIVERSITAS GADJAH MADA

1

Artificial Intelligence Application

2

Artificial Intelligence for Thyroid Nodule Classification

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OUTLINE

UNIVERSITAS GADJAH MADA

1

Artificial Intelligence Application

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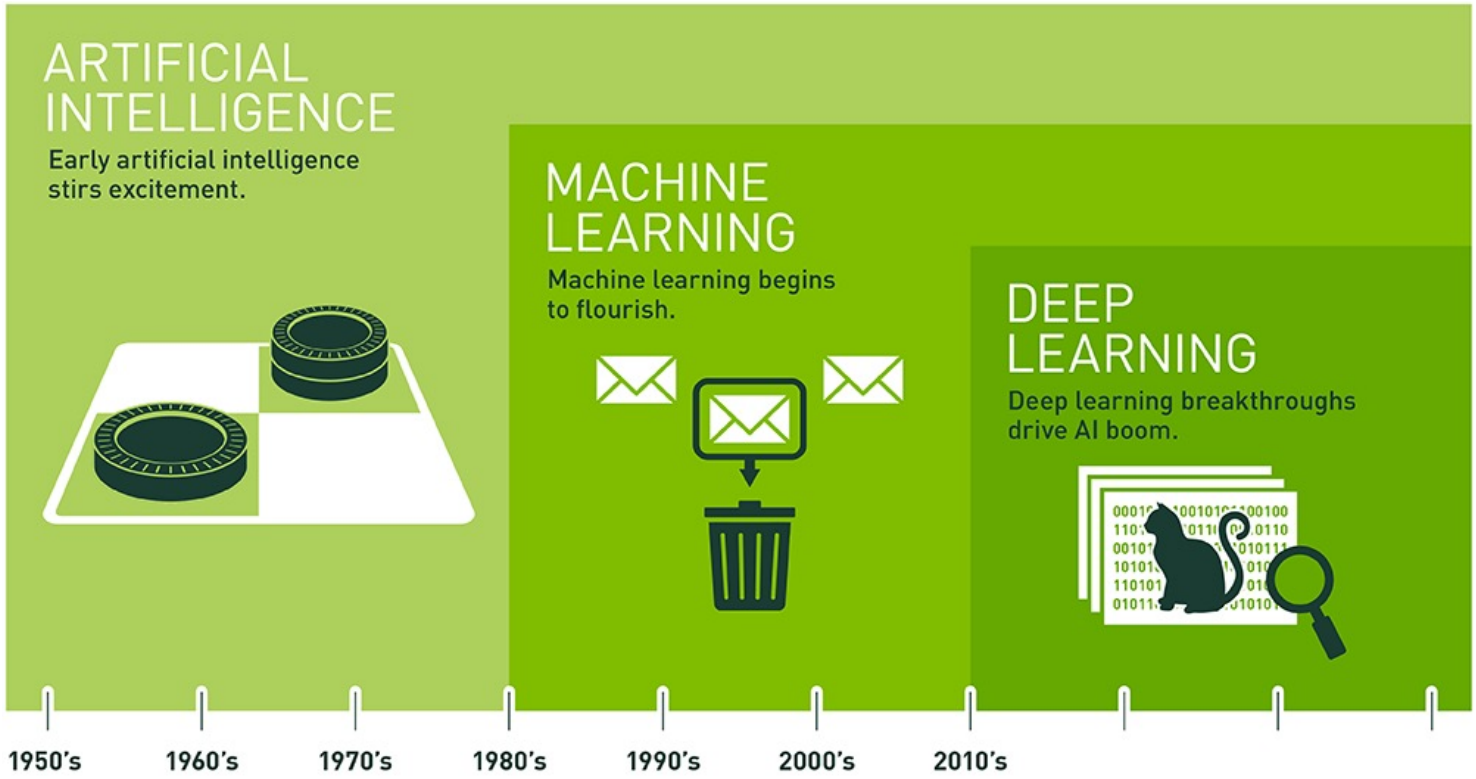

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

ARTIFICIAL INTELLIGENCE

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APPLICATION OF AI

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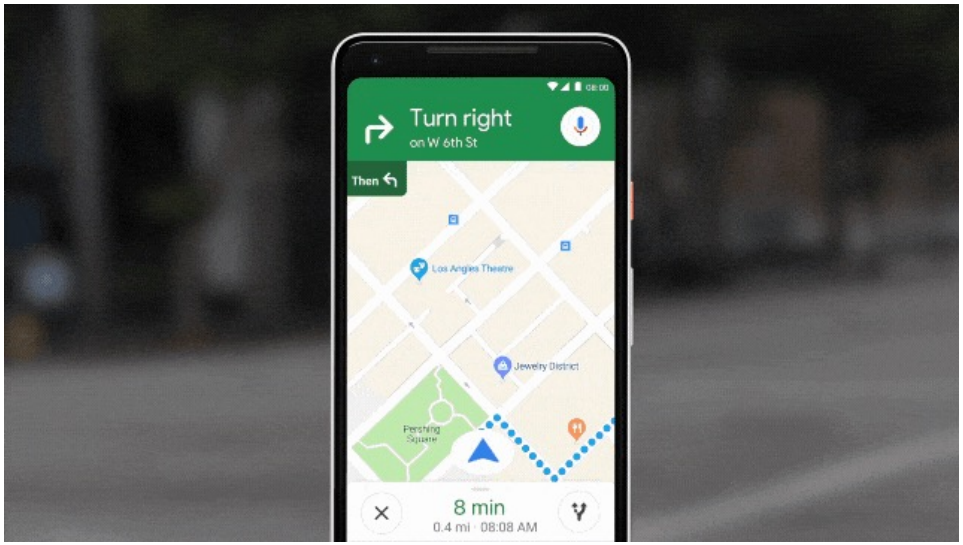

IT Application

Smart phone application

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AI IN MEDICAL APPLICATION

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AI-enabled population health	Patient virtual health assistant	FHW virtual health assistant	Physician clinical decision support
Platform ingesting, analyzing, and providing recommendations on population health data • Surveillance and prediction • Population risk management • Intervention selection • Intervention targeting	Assisting patients to direct their own care and wellness, e.g., data-driven diagnostics with care recommendations • Self-referral • Personalized outreach • Behavior change • Data-driven diagnosis • AI-facilitated care • Medical records	Augmenting FHW expertise to direct patient care, e.g., triage and symptom-based diagnostics and care recommendations • Self-referral • Personalized outreach • Behavior change • Data-driven diagnosis • AI-facilitated care • Medical records	Providing more specialized expertise to generalist physicians, e.g., enabling a GP to read diagnostic images • Image-based diagnosis • Clinical decision support • Quality assurance and training

Research Scope

Source: Artificial Intelligence in Global Health. USAID (2019)

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OUTLINE

UNIVERSITAS GADJAH MADA

1

Artificial Intelligence Application

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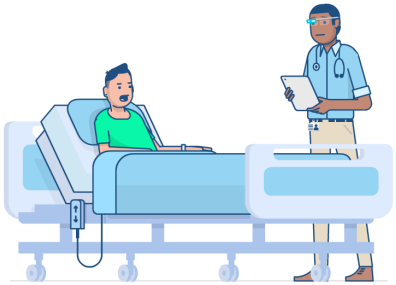
Artificial Intelligence for Thyroid Nodule Classification



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WHAT IS THYROID NODULE

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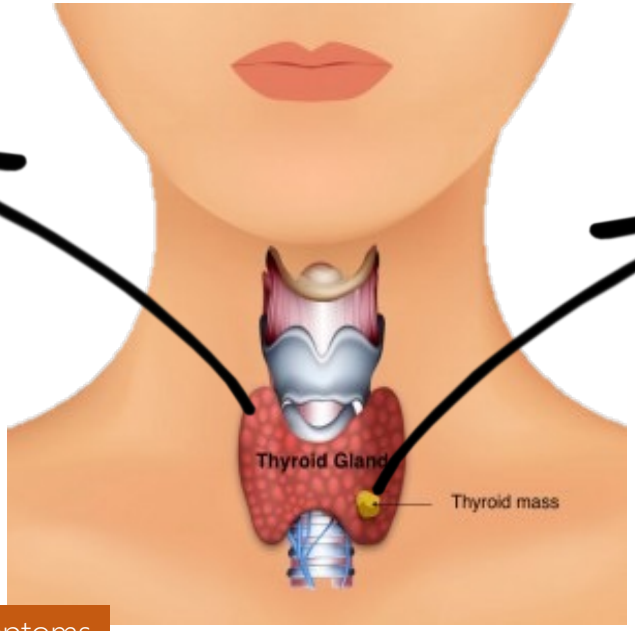
Thyroid Gland

a butterfly-shaped endocrine gland that is normally located in the lower front of the neck

Thyroid Function

It produces hormone keeps the brain, heart, muscles, and other organs working as they should



Thyroid Nodule

Abnormal cells that grow in thyroid gland

Common in people who

- have a history of exposure to high doses of radiation
- have a family history
- older than 40 years old
- is woman
- is patient with iodine deficiency

Symptoms

- Pain in the neck, jaw, or ear
- Difficulty in breathing
- Difficulty in swallowing
- Tickle in the throat
- Hoarseness
- Etc.

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THYROID CANCER FACTS

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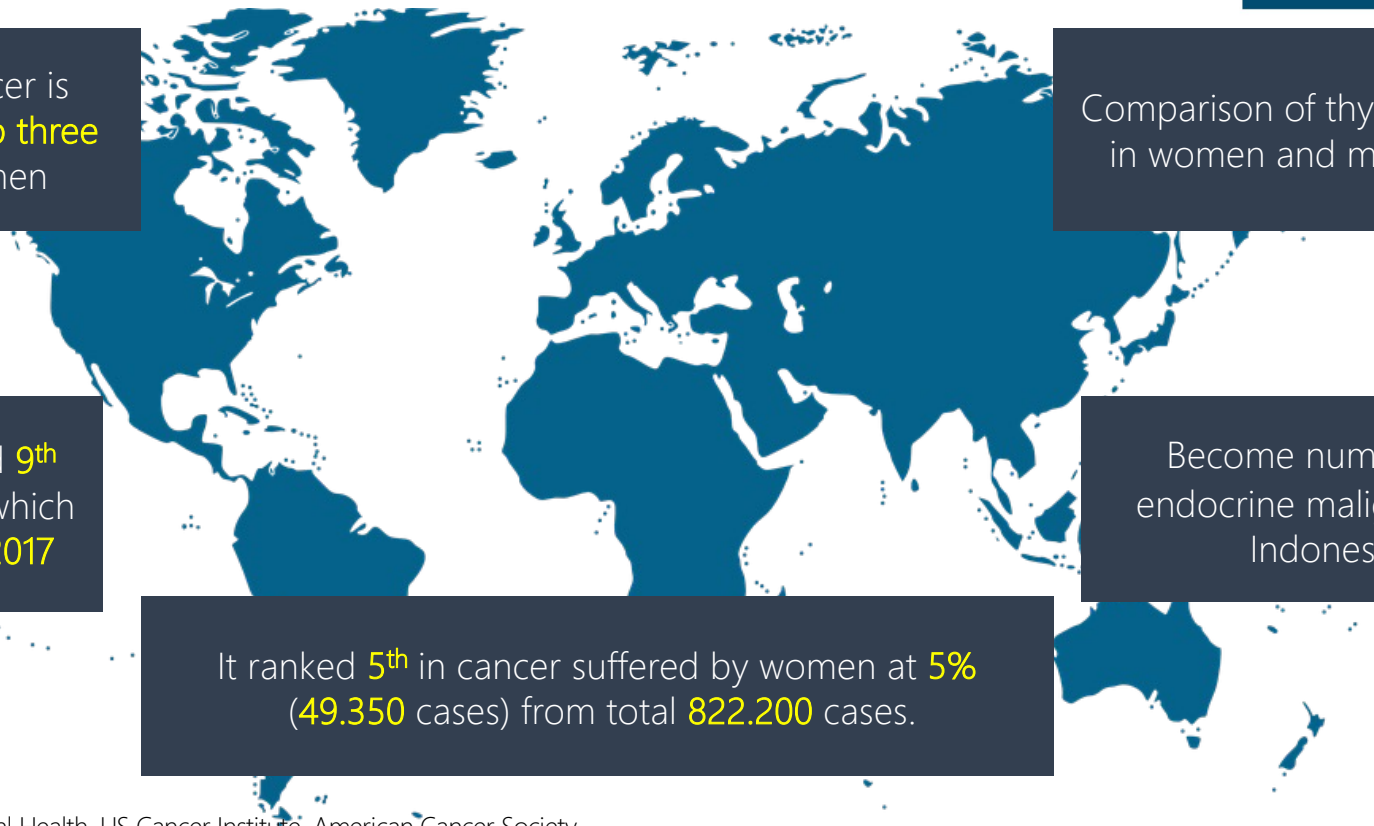
In 2019, thyroid cancer is predicted to reach top three malignancy in women

Comparison of thyroid cancer in women and men is 3 : 1



In Indonesia, it ranked 9th from all cancer illness which is 347.792 cases per 2017

Become number 1 in endocrine malignancy in Indonesia.

It ranked 5th in cancer suffered by women at 5% (49.350 cases) from total 822.200 cases.

Source: Ministry of Health of RI, Global Health, US Cancer Institute, American Cancer Society

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THYROID EXAMINATION

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MRI

- More Detail
- Expensive
- Limited availability

CT Scan

USG

- Cheaper, No radiation
- Short acquisition time
- High availability
- Non traumatic, Non invasive
- High subjectivity interpretation
- Doctors' experience

Fine Needle Aspiration Biopsy (FNAB)

- Minor surgical procedure
- Secondary examination
- Invasive procedure

TIRADS describes the important characteristic of thyroid nodule based on USG images

TIRADS: Thyroid Imaging Reporting and Data System

Thus, the computer aided diagnosis (CAD) based on ultrasound images is needed

The system aims to reduce miss-interpretation and as second opinion / objective opinion in diagnosis

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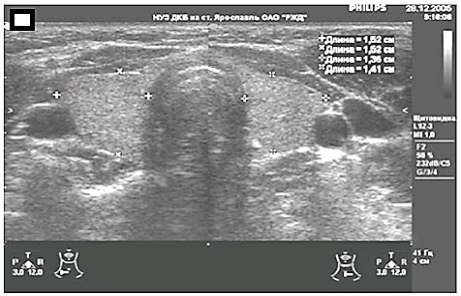
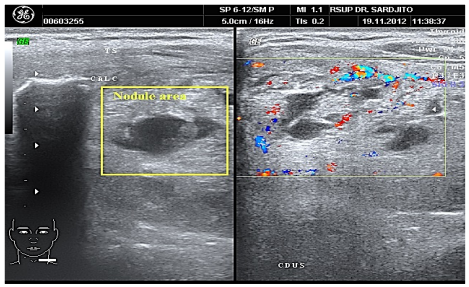
THYROID EXAMINATION

NORMAL



ABNORMAL



TIRADS

No.	Characteristic	Class
1.	Composition	Solid
		Cystic
		Complex
2.	Echogenicity	Anechoic
		Isoechoic
		Hyperechoic
		Hypoechoic
		Markedly Hypoechoic
3.	Margin	Smooth
		Irregular
4.	Shape	Round to Oval
		Irregular
5.	Orientation	Parallel
		Nonparallel

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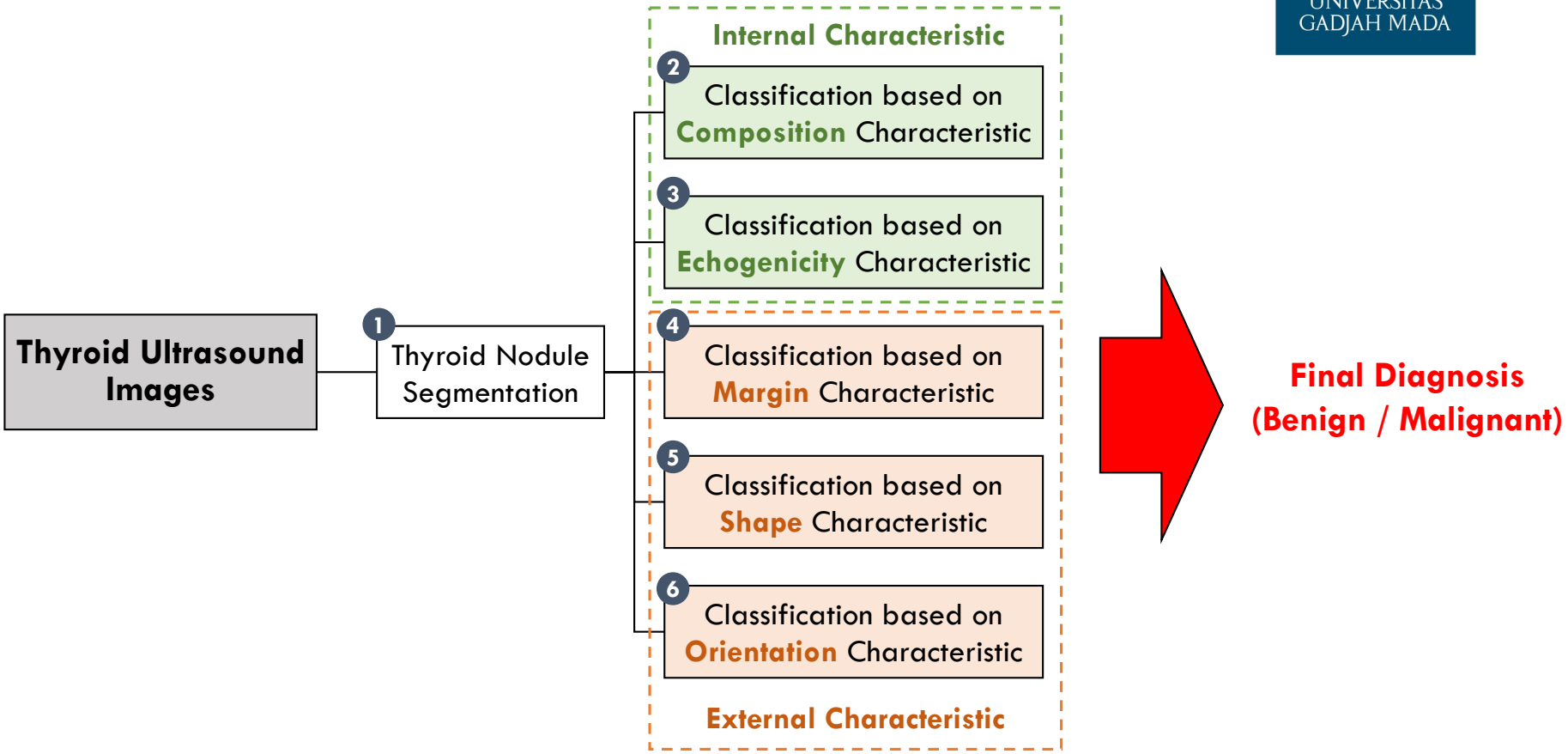
RESEARCH SCHEME



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EXISTING RESULT

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EXISTING RESULT

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- Thyroid Nodule Segmentation
- Classification based on Composition Characteristic
- Classification based on Echogenicity Characteristic
- Classification based on Margin Characteristic
- Classification based on Shape Characteristic

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EXISTING RESULT

UNIVERSITAS GADJAH MADA

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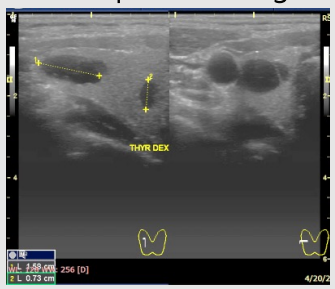

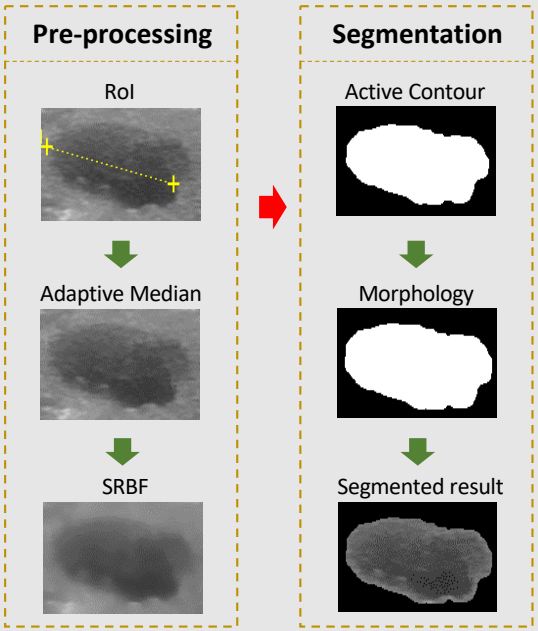

Results

Component	Value
MSE	53.19
SNR	19.92
PNSR	30.87
AD	0.0221
SI	1.32e-5

Success in reducing speckle noises using bilateral filtering as it supports active contour segmentation effectively

H. A. Nugroho, A. Nugroho, and L. Choridah, "Thyroid Nodule Segmentation Using Active Contour Bilateral Filtering on Ultrasound Images," Int. Conf. io Qual. Res., pp. 43–46, 2015.

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EXISTING RESULT

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- Thyroid Nodule Segmentation
- **Classification based on Composition Characteristic**
- Classification based on Echogenicity Characteristic
- Classification based on Margin Characteristic
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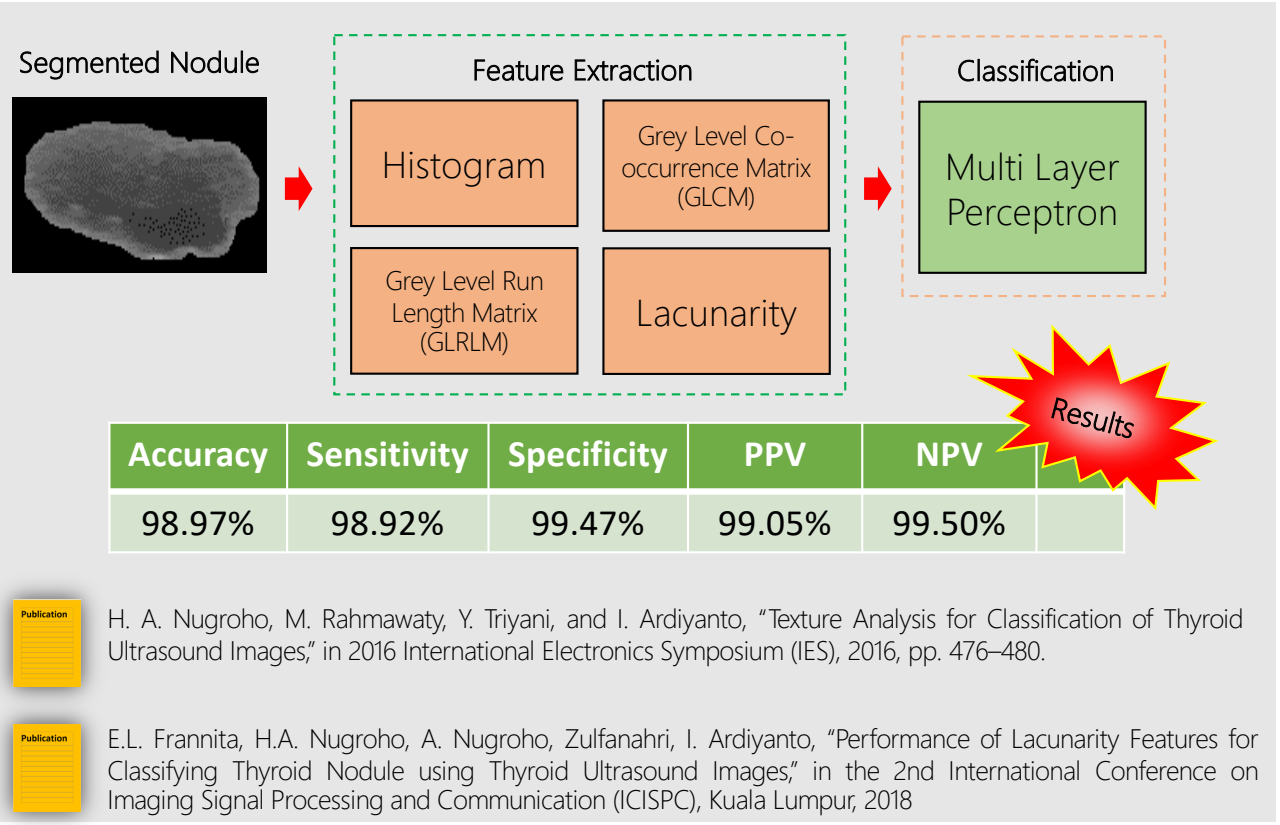

Accuracy	Sensitivity	Specificity	PPV	NPV
98.97%	98.92%	99.47%	99.05%	99.50%

Publication

H. A. Nugroho, M. Rahmawaty, Y. Triyani, and I. Ardiyanto, "Texture Analysis for Classification of Thyroid Ultrasound Images," in 2016 International Electronics Symposium (IES), 2016, pp. 476–480.

Publication

E.L. Frannita, H.A. Nugroho, A. Nugroho, Zulfanahri, I. Ardiyanto, "Performance of Lacunarity Features for Classifying Thyroid Nodule using Thyroid Ultrasound Images," in the 2nd International Conference on Imaging Signal Processing and Communication (ICISPC), Kuala Lumpur, 2018

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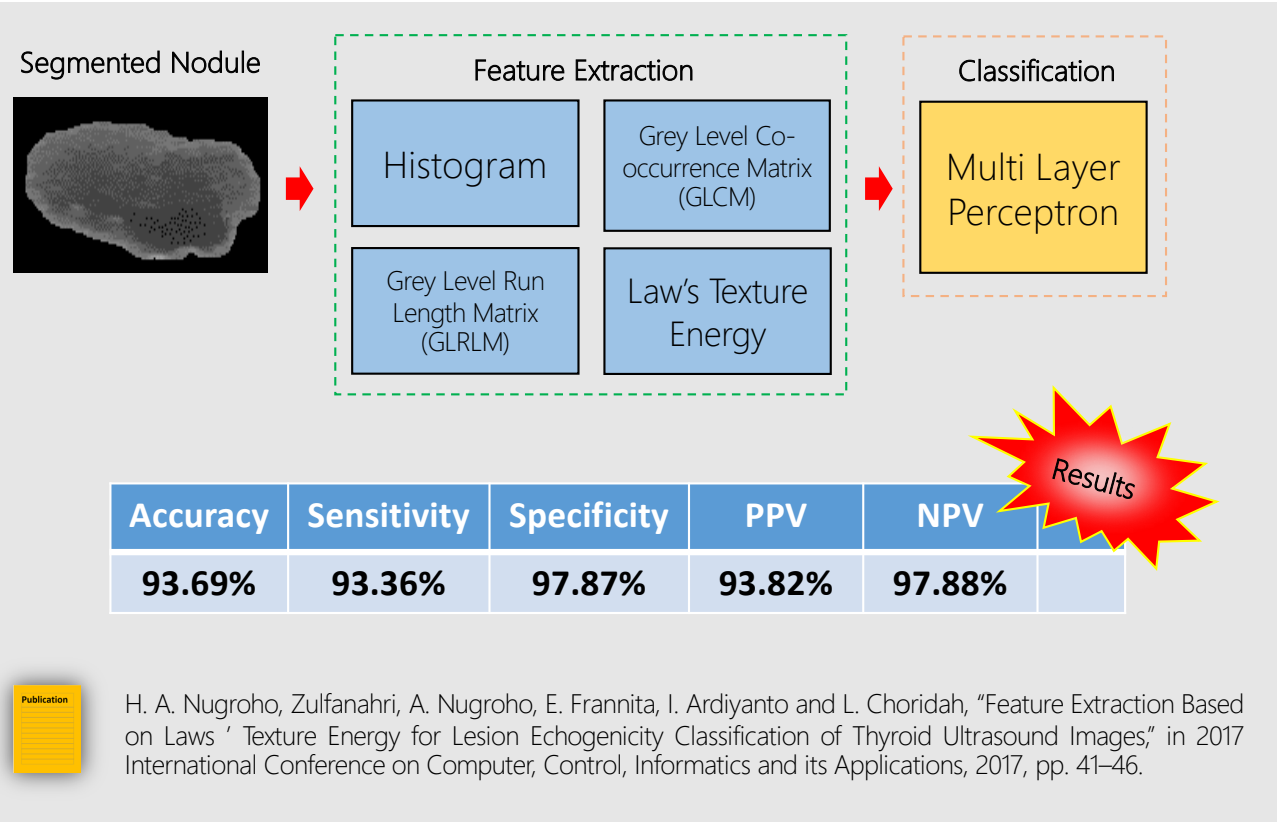
EXISTING RESULT

UNIVERSITAS GADJAH MADA

- Thyroid Nodule Segmentation
- Classification based on Composition Characteristic
- **Classification based on Echogenicity Characteristic**
- Classification based on Margin Characteristic
- Classification based on Shape Characteristic



Accuracy	Sensitivity	Specificity	PPV	NPV
93.69%	93.36%	97.87%	93.82%	97.88%

Publication

H. A. Nugroho, Zulfanahri, A. Nugroho, E. Frannita, I. Ardiyanto and L. Choridah, "Feature Extraction Based on Laws ' Texture Energy for Lesion Echogenicity Classification of Thyroid Ultrasound Images," in 2017 International Conference on Computer, Control, Informatics and its Applications, 2017, pp. 41–46.

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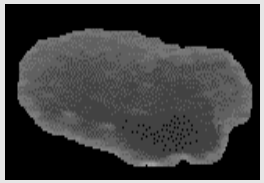
EXISTING RESULT

UNIVERSITAS GADJAH MADA

- Thyroid Nodule Segmentation
- Classification based on Composition Characteristic
- Classification based on Echogenicity Characteristic
- Classification based on Margin Characteristic
- Classification based on Shape Characteristic



Results

Accuracy	Sensitivity	Specificity	PPV	NPV	
92.30%	91.88%	92.73%	92.80%	91.80%	

Publication

H. A. Nugroho, E. L. Frannita, A. Nugroho, Zulfanahri, I. Ardiyanto, and L. Choridah, "Classification of Thyroid Nodules Based on Analysis of Margin Characteristic," in 2017 International Conference on Computer, Control, Informatics and its Applications, 2017, pp. 47–51.

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EXISTING RESULT

UNIVERSITAS GADJAH MADA

- Thyroid Nodule Segmentation
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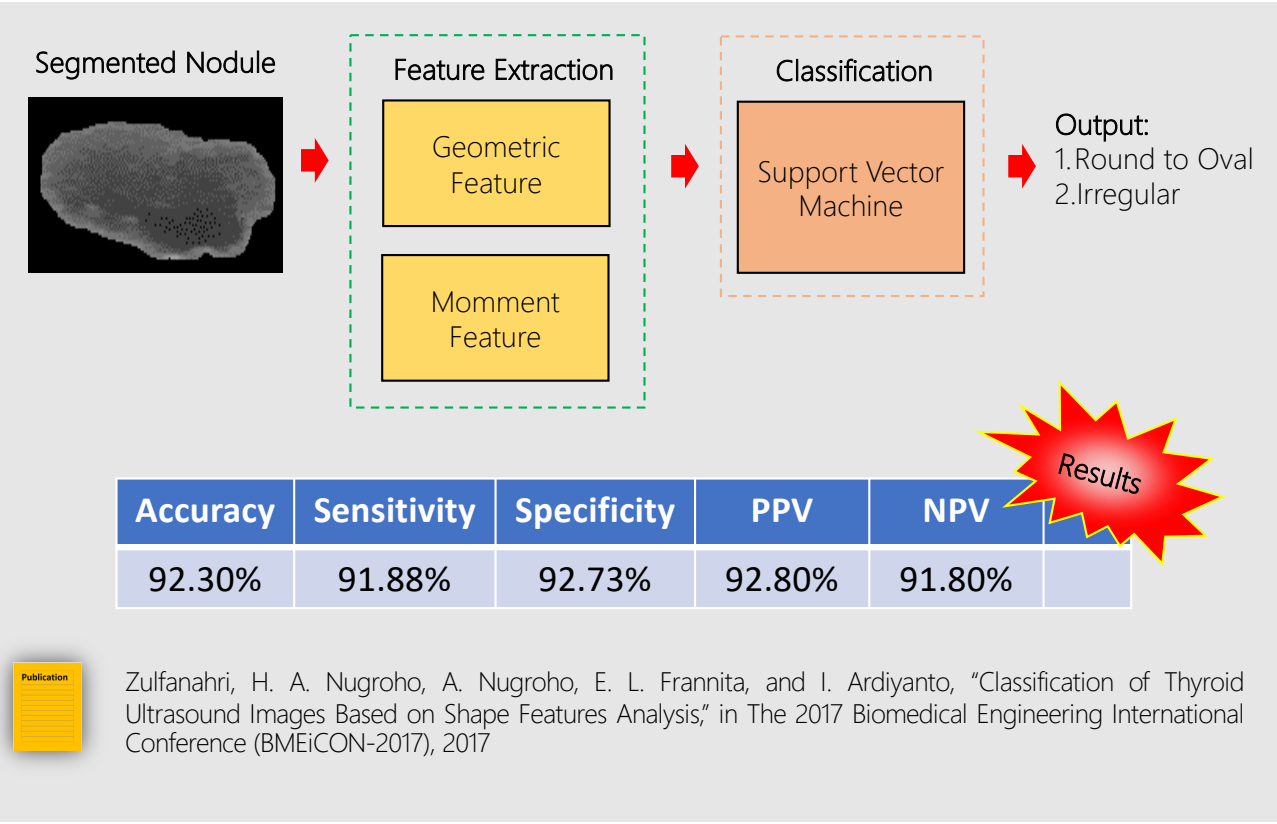

Accuracy	Sensitivity	Specificity	PPV	NPV
92.30%	91.88%	92.73%	92.80%	91.80%

Publication

Zulfanahri, H. A. Nugroho, A. Nugroho, E. L. Frannita, and I. Ardiyanto, "Classification of Thyroid Ultrasound Images Based on Shape Features Analysis," in The 2017 Biomedical Engineering International Conference (BMEiCON-2017), 2017

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FINAL RESULT OF THYROID CLASSIFICATION

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RESULT (FINAL CLASSIFICATION)

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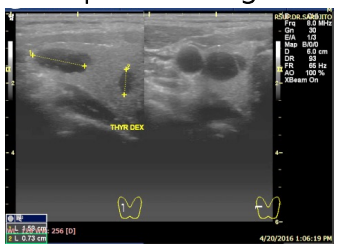
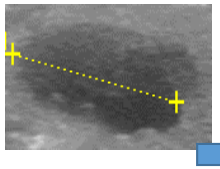
Input USG Image

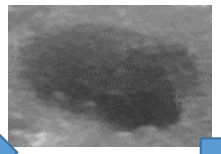


Pre-processing

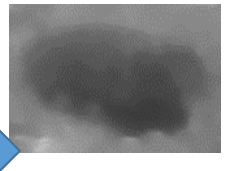
RoI



Adaptive Median



SRBF

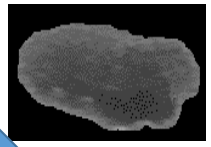


Segmentation

Active Contour

Morphology Operation

Segmented



Feature Extraction

Geometric Feature

Texture Feature

Classification

TIRADS BASED CLASSIFICATION	
External Characteristic	Margin
	Orientation
Internal Characteristic	Composition
	Echogenicity
	Shape

Diagnosis
Benign/Malignant

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DIAGNOSIS RULE (FINAL CLASSIFICATION)

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External Characteristics

Margin	Shape	Orientation	Rule Diagnosis
Smooth	Round to Oval	Parallel	Malignant
	Round to Oval	Non-Parallel	**Benign**
Irregular	Round to Oval	Parallel	Malignant
	Round to Oval	Non-Parallel	Malignant
	Irregular	Parallel	Malignant
	Irregular	Non-Parallel	Malignant

Internal Characteristics

Composition	Echogenicity	Rule Diagnosis
Cystic	Anechoic	Benign
Solid	Markedly Hypo	Malignant
	Hypoechoic	Malignant
	Isoechoic	Benign
Complex	Markedly Hypo	Malignant
	Hypoechoic	Malignant
	Isoechoic	Benign

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PERFORMANCE RESULT (FINAL CLASSIFICATION)

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Internal Characteristics

Testing Data

Benign	11
Malignant	43
Total	54

Composition
Echogenicity

Confusion Matrix

True Class	Predicted Class: Malignant	Predicted Class: Benign
Malignant	41	2
Benign	1	10

No.	Output	Result
1.	Accuracy	**94.44%**
2.	Sensitivity	**95.35%**
3.	Specificity	**90.91%**
4.	Positive Predictive Value	**97.62%**
5.	Negative Predictive Value	**83.33%**

External Characteristics

Testing Data

Benign	18
Malignant	27
Total	45

Margin
Shape
Orientation

Confusion Matrix

True Class	Predicted Class: Malignant	Predicted Class: Benign
Malignant	23	4
Benign	1	17

No.	Output	Result
1.	Accuracy	**88.89%**
2.	Sensitivity	**85.19%**
3.	Specificity	**94.44%**
4.	Positive Predictive Value	**95.83%**
5.	Negative Predictive Value	**80.95%**

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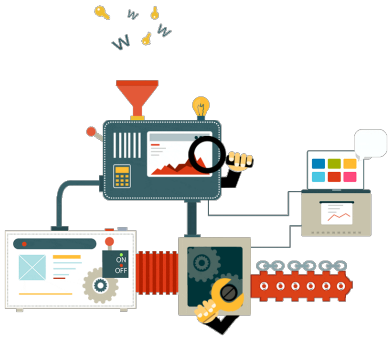
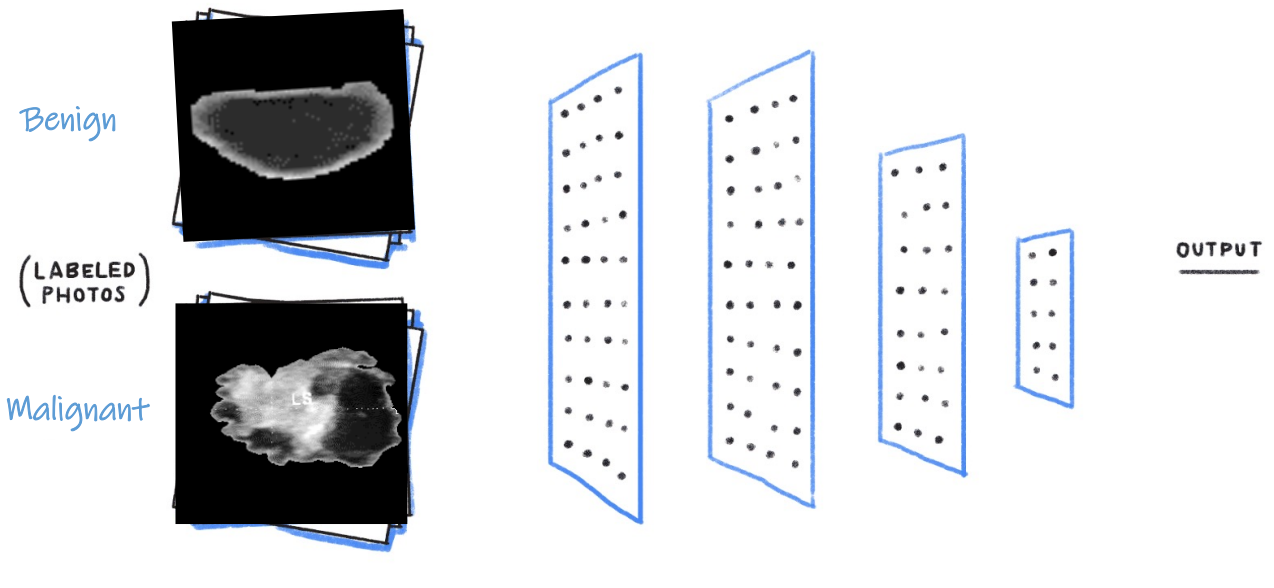
FUTURE WORK



Detecting Plasmodium parasite using Deep Learning approach



Deep Learning is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms

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Ratna Lestari Budiani Buana, Widhia Oktoeberza KZ

Sardjito Hospital, Yogyakarta, Indonesia
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Dr. dr. Lina Choridah, dr. Reni Indrastuti, dr. Elly, dr. Endang

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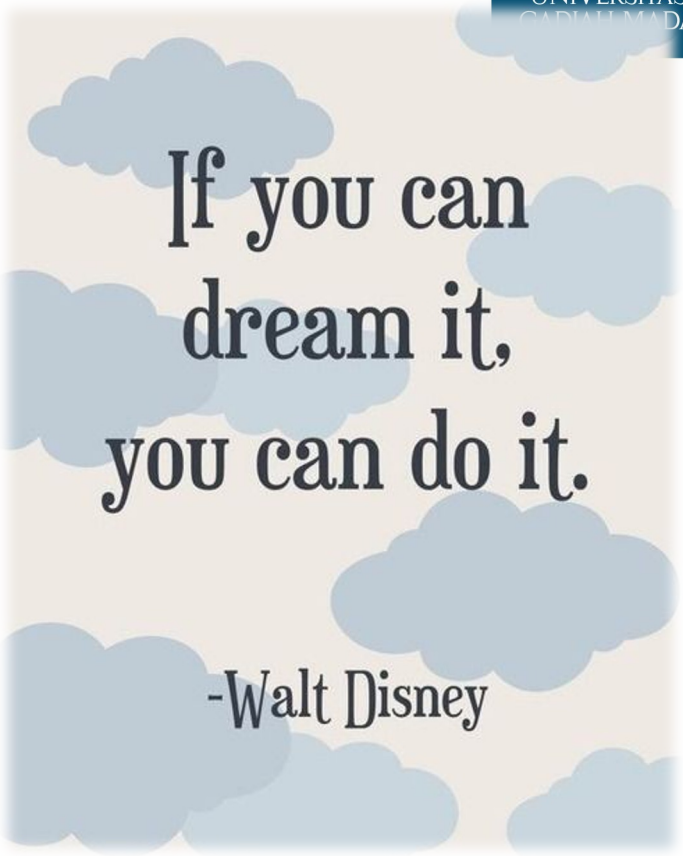
If you can dream it, you can do it.
-Walt Disney

THANK YOU

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Mengakar Kuat
Menjulang
Tinggi

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