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# Artificial Intelligence Use-Cases in Defense and Military

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# ARTIFICIAL INTELLIGENCE USE-CASES IN DEFENSE AND MILITARY



**COLONEL ASSIST. PROF. DR. IR. ARWIN DATUMAYA WAHYUDI SUMARI**

INDONESIAN AIR FORCE/STATE POLYTECHNIC OF MALANG/INDONESIA DEFENSE  
UNIVERSITY/INDONESIA ARTIFICIAL INTELLIGENCE SOCIETY (IAIS)



# Cognitive Artificial Intelligence Research Group (CAIRG)



## A BIT ABOUT ME

**Colonel Assist. Prof. Dr. Ir. Arwin Datumaya Wahyudi Sumari, S.T., M.T., IPM, ASEAN Eng., F.S.I., F.S.M.E., V.D.B.M., S.A., S.R.Eng.**

- Senior Electrical Engineer Officer at Abdulrachman AFB, 2<sup>nd</sup> Operation Command, Indonesian Air Force**



<https://id.linkedin.com/in/dr-arwin-sumari-s-t-m-t-ipm-fsi-fsme-vdbm-sa-a2378169>



[https://scholar.google.co.id/scholar?hl=en&as\\_sdt=0%2C5&q=arwin+datumaya+wahyudi+sumari&oq=](https://scholar.google.co.id/scholar?hl=en&as_sdt=0%2C5&q=arwin+datumaya+wahyudi+sumari&oq=)  
<https://www.scopus.com/authid/detail.uri?authorId=35175182800>



[https://www.researchgate.net/profile/Arwin\\_Sumari](https://www.researchgate.net/profile/Arwin_Sumari)

## Military (Indonesian Air Force)

- Indonesian Air Force Academy – 1991 (2<sup>nd</sup> Lt.)**
- School of Electronic Officer Branch – 2002 (Captain)**
- School of Unity of Command – 2003 (Captain)**
- School of Command and Staff – 2011 (Lt.Col.)**
- Defense Management Course, NPS, USA – 2014 (Colonel)**
- National Security Leadership, George Washington University, USA – 2014 (Colonel)**



## Academic Career

- S.T. in Electronics Engineering ITB, focus on Artificial Neural Networks (ANN) – 1996**
- M.T. in Computer Engineering ITB, focus on Multi-Agent System (MAS) – 2008**
- Dr./Ph.D in Electrical Engineering and Informatics ITB, focus on Cognitive Artificial Intelligence (CAI) – 2010**
- Team Leader, Cognitive Artificial Intelligence Research Group (CAIRG) since 2019**
- Assistant Professor on Assymetric Warfare, IDU – 2015**
- Adjunct Professor, Perbanas Institute - 2017**
- Adjunct Professor, State Polytechnic of Malang – 2019**
- Steering Committe, Indonesia Artificial Intelligence Society - 2019**



# Achievement in AI Invention and Development

1994 - Join with Intelligent System Research Group (ISRG) ITB, the Embryo of CAIRG

1996 - Intelligent Retrieval System based on ART1 NN (Final Project)

2001 - Intelligent Retrieval System for Military Aircraft Troublesooting (First Winner in Indonesian Armed Forces Competition)

2008 - Maximum Score of the Total Sum of Joint Probabilities (MSJP) - a new method for Multi-Agent System (Master Thesis)

2009 - A3S Method for Knowledge Growing System (KGS)

2010 - Knowledge Growing System as a New Perspective in Artificial Intelligence (Doctor/Ph.D. Dissertation)

2019 and 2020 - Three Patents on KGS (Registered) and One Copyright for A3S for KGS Software



# Current Projects on Cognitive AI and AI

4



Task Force for Artificial Intelligence National Strategy (BPPT) - Research and Industrial Innovation



Task Force for Research and Innovation for Covid-19 (TFRIC-19) BPPT - Developing AI-based Medical Imaging System



Enhancing KGS-based Decision Support System for Multipurpose Use-Cases



Supervising Final Project for Vocational Students on AI themes



Delivering Lectures on Artificial Intelligence



Creating Research Corporations



Spread the Wings of CAIRG



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# Al-'Aliim

## Maha Mengetahui (Memiliki Ilmu) , the All Knowing

“Mereka menjawab: ‘Maha Suci Engkau, tidak ada yang kami ketahui selain dari apa yang telah Engkau ajarkan kepada kami; sesungguhnya Engkaulah Yang Maha Mengetahui lagi Maha Bijaksana”

*“They said, "Exalted are You; we have no knowledge except what You have taught us. Indeed, it is You who is the Knowing, the Wise”*

(QS. Al-Baqarah: 32)



# Outline

- A Brief on Cognitive Artificial Intelligence Research Group (CAIRG)
- A Brief on Artificial Intelligence (AI)
- AI Use-cases in Defense And Military
- AI Research in Military and Defense in Indonesia - State-of-the-Art and Possible Use-Cases
- AI New Technology - Knowledge Growing System - Cognitive AI and Its Applications



# Our Team



***Cognitive Artificial Intelligence Research Group (CAIRG)***

*Established in 2007 by Prof. Dr-ing. Ir. Adang Suwandi Ahmad, DEA,  
IPU (RIP in 2019)*

*A Collaboration of Researchers across Universities and  
Institutions to Advocate Cognitive Artificial Intelligence for  
Humankind*

***Republic of Indonesia***



## Team Member



**Arwin Datumaya Wahyudi Sumari**

**Leader**, Researcher, Initiator  
Intelligent Analysis, Strategic  
Decision Making, Cybersecurity,  
Biomedical Engineering (Malang)



**Catherine Olivia Sereati**

Researcher on Health, Cognitive  
Processor (Jakarta)



**Septafiansyah Dwi Putra**

Researcher on Hardware Security,  
Cryptography (Bandar lampung)



**Karel Octavianus Bachri**

Researcher on Power Equipment  
Health (Jakarta)



## Team Member



**Herman Talompo**

Researcher on Cybersecurity  
(Intrusion Detection System)  
(Jakarta)b



**Muhammad Nurwiseso Wibisono**

Researcher on Climate  
Prediction System (Malang)



**Ika Noer Syamsiana**

Researcher on Electrical Energy  
Monitoring (Malang)



**Rizqi Abdulharis**

Researcher on  
Geospatial Intelligence





## Team Member



**Dimas Rossiawan Hendra Putra**

Researcher & Programmer  
on Face Recognition, Image  
Processing, Computer Vision  
(Malang)



**Edi Triono Nuryatno**

Researcher on Health  
Informatics (Australia)



**Rosa Andrie Asmara**

Researcher on Image  
Understanding and  
Computer Vision (Malang)

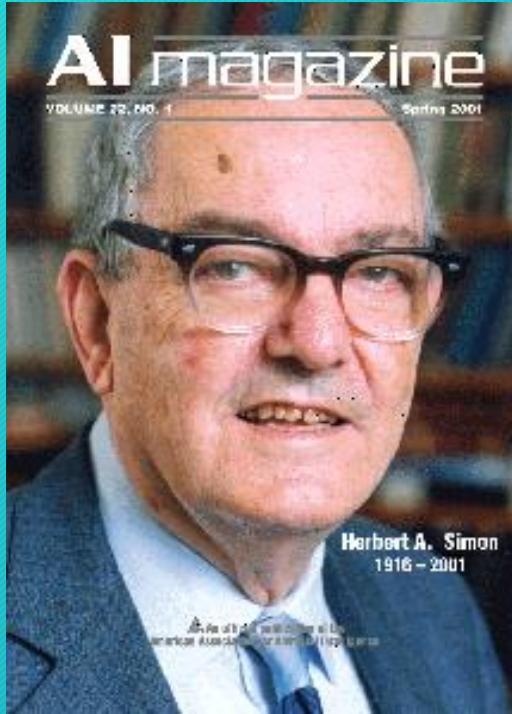




# A BRIEF ON ARTIFICIAL INTELLIGENCE



# The Purposes of AI

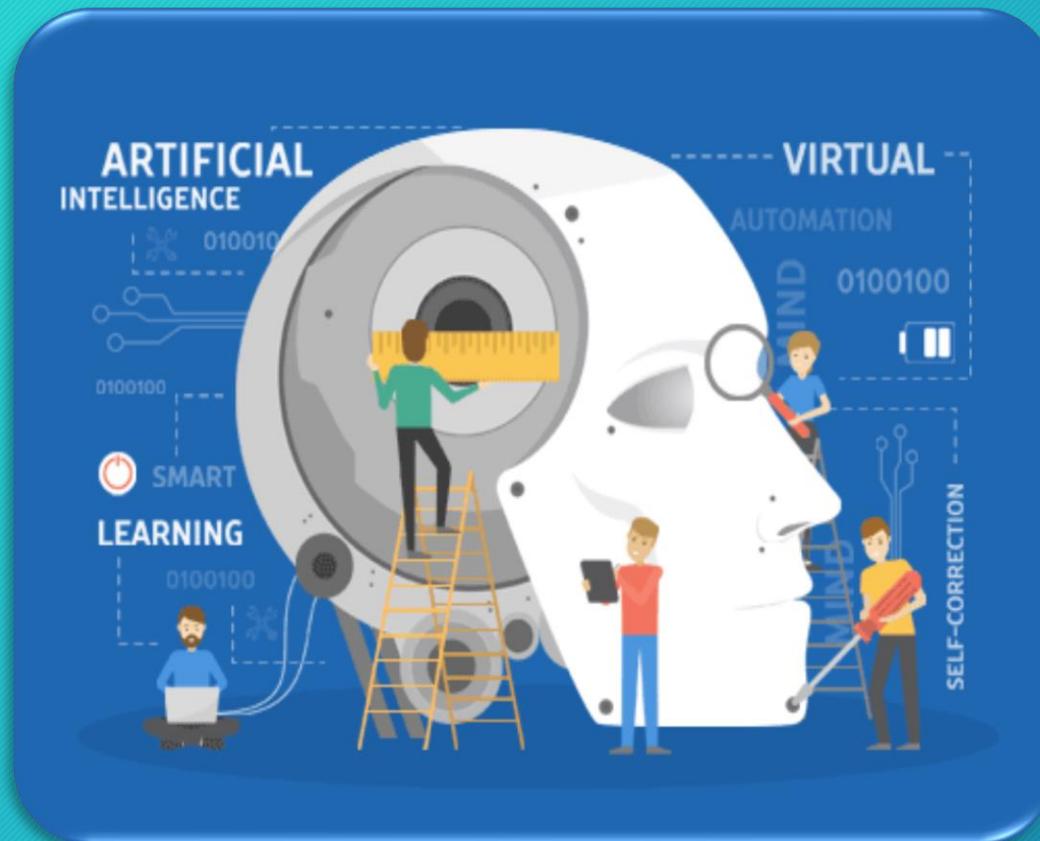


Herbert Simon

AI can have **two purposes**:

- One is to use the power of computers to **augment human thinking**, just as we use motors to augment human or horse power. Robotics and expert systems are major branches of that.
- The other is to use a computer's AI to **understand how humans think**. In a humanoid way, if you test your programs not merely by what they can accomplish, but how they accomplish it, then you're really **doing cognitive science; you're using AI to understand the human mind**.

# Artificial and Intelligence



- **Artificial** = man-made, a copy of a natural phenomenon
- **Intelligence** =
  - the ability to learn or understand or to deal with new or trying situations;
  - the ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria;
  - the act of understanding



# Artificial Intelligence

- A man-made (thing) based on a natural phenomenon which has the ability to learn or understand or to deal or to apply knowledge to manipulate the environment and is measured by objective criteria
- A man-made thing is called “intelligent agent”





# What is AI? - A Simple Understanding

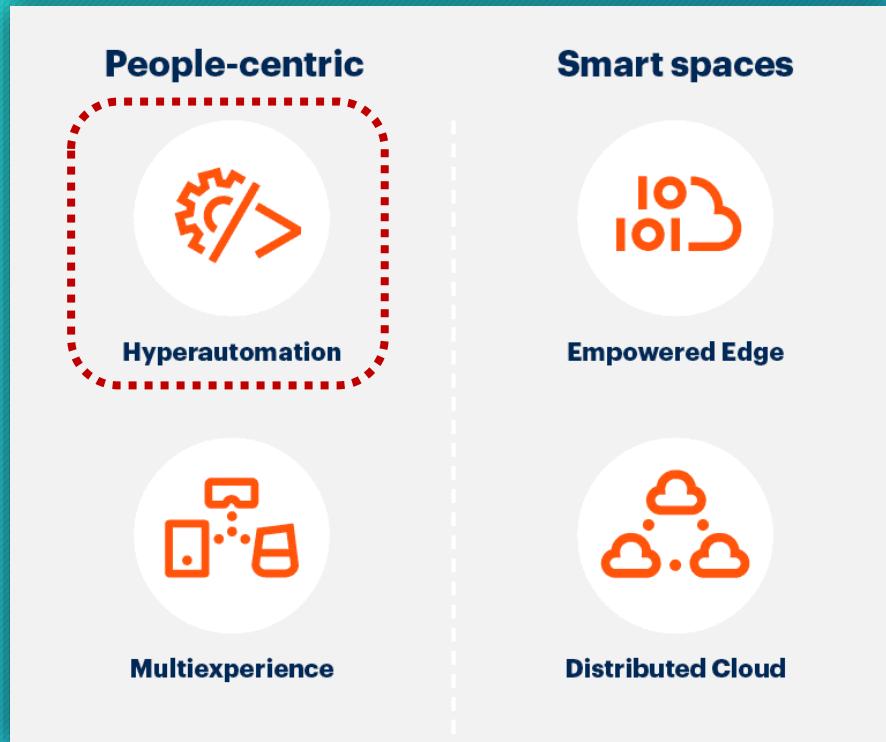
- Human intelligence which is emulated to a computer system by creating mathematical models so as they can be translated into programming language that can be understood by the computer



(Arwin Datumaya Wahyudi Sumari,  
Malang, 11 March 2019)

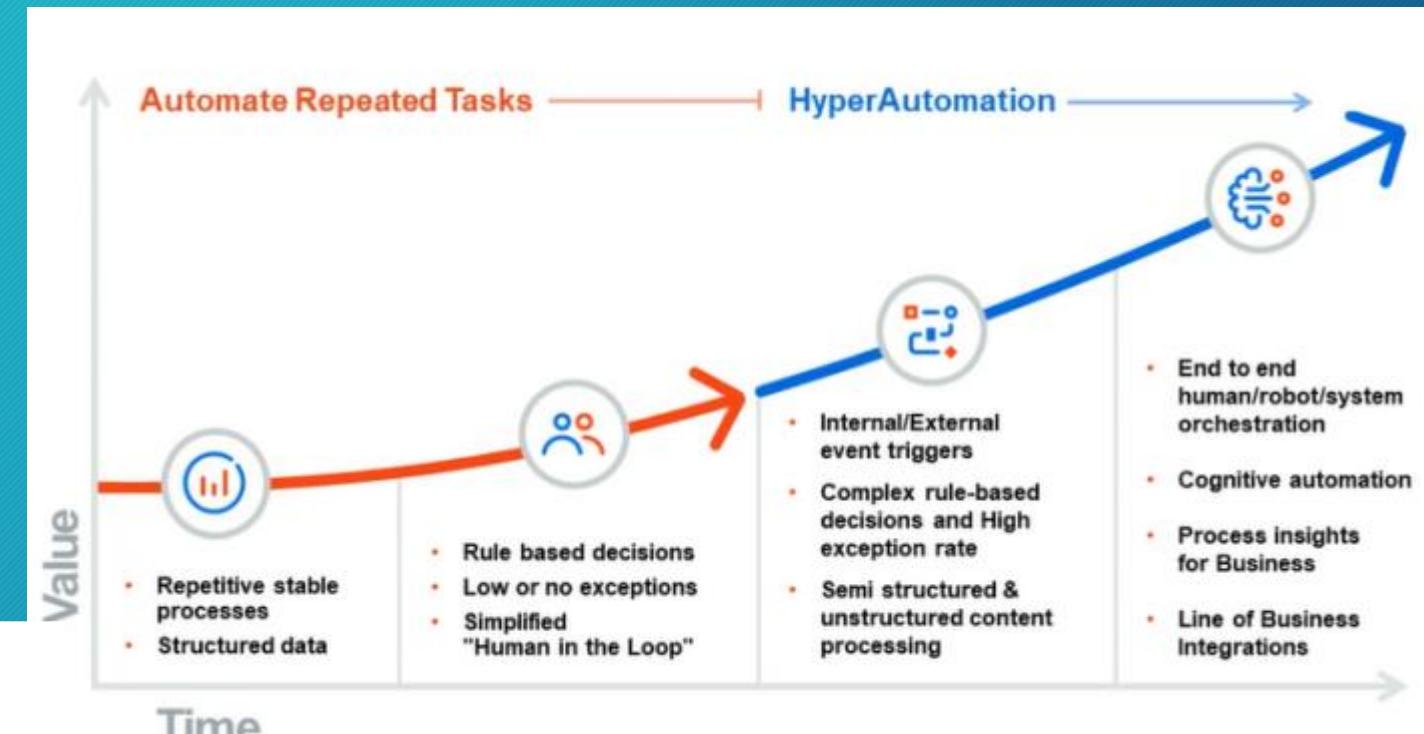
# Strategic Technologies Trend 2020 - Gartner

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# Hyperautomation

- Deals with the application of **advanced technologies** to increasingly automate processes and augment humans, which include:
  - Robotic Process Automation (RPA)**
  - Intelligent Business Management**
  - Artificial Intelligence**
  - Advanced analytics**



<https://www.oneglobesystems.com/blog/usecase-hyper-automation-2019>

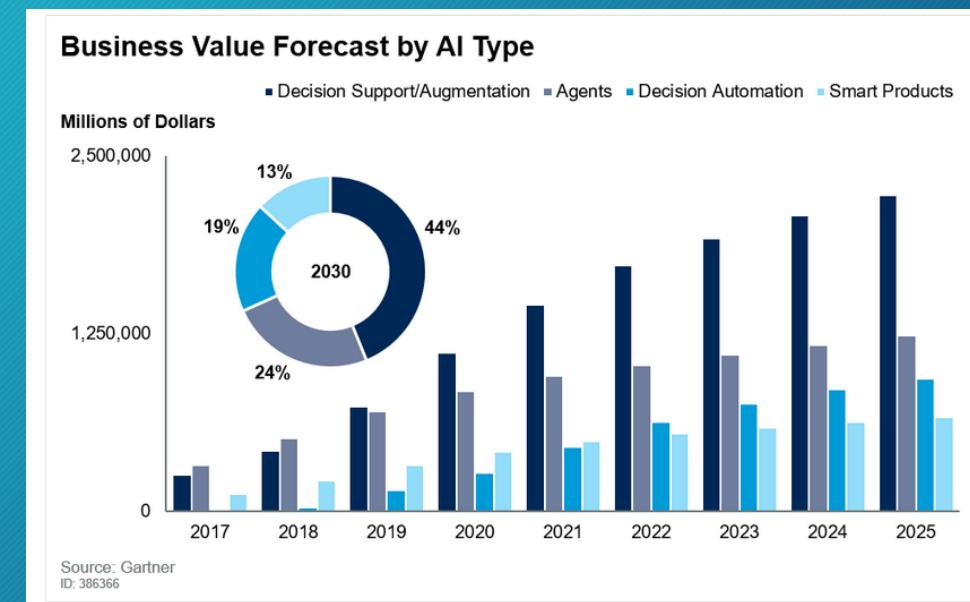
# Human Augmentation

- The use of technology to **enhance** a person's cognitive and physical experiences.
- Technologies that **enhance** human productivity or capability, or that somehow add to the human body



<https://robohub.org/robots-soldiers-and-cyborgs-the-future-of-warfare/>

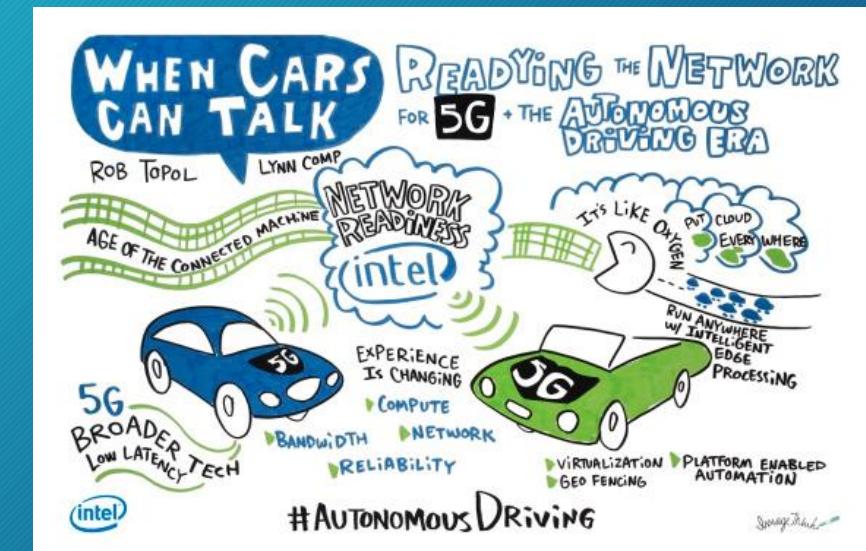
arwin.sumari@tni-au.mil.id - AI in Defense and Military [09072020] @ BISA.ai



<https://www.zdnet.com/article/ai-will-drive-business-value-via-decision-support-human-augmentation/>

# Autonomous Things

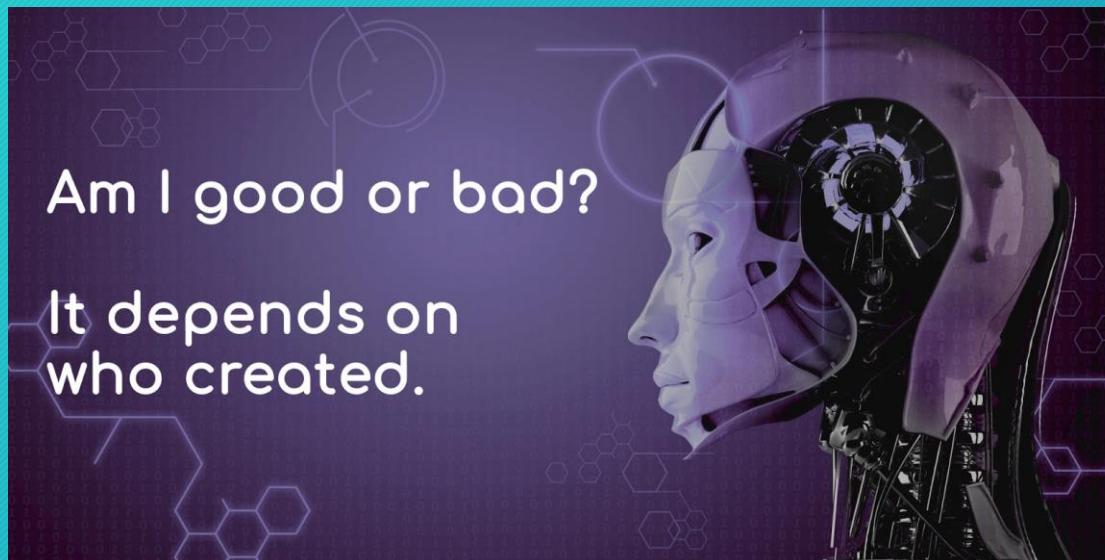
- Autonomous Things (AuT), or the Internet of Autonomous Things (IoAT), are devices that work on specific tasks **autonomously without human interaction** thanks to AI algorithms. These devices include robotics, vehicles, drones, autonomous smart home devices and autonomous software.
- Autonomous things **cannot replace the human brain** and operate most effectively with a narrowly defined, well-scoped purpose





# AI Security

- **Protecting AI-powered systems:** Securing AI training data, training pipelines and ML models.
- **Leveraging AI to enhance security defense:** Using ML to understand patterns, uncover attacks and automate parts of the cybersecurity processes.
- **Anticipating nefarious use of AI by attackers:** Identifying attacks and defending against them.

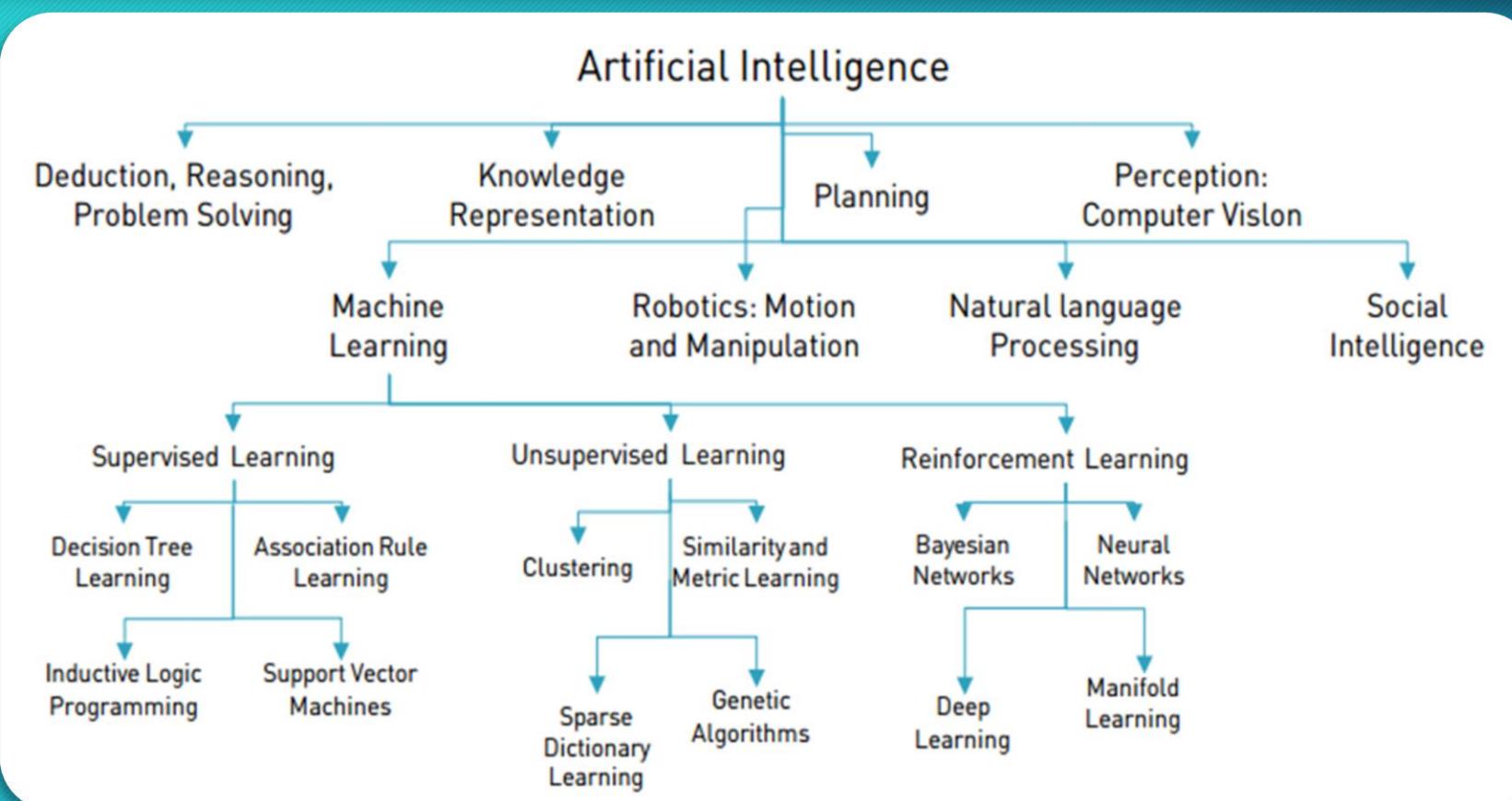


**BAD AI COMES  
FROM BAD DATA**



# Artificial Intelligence Disciplines

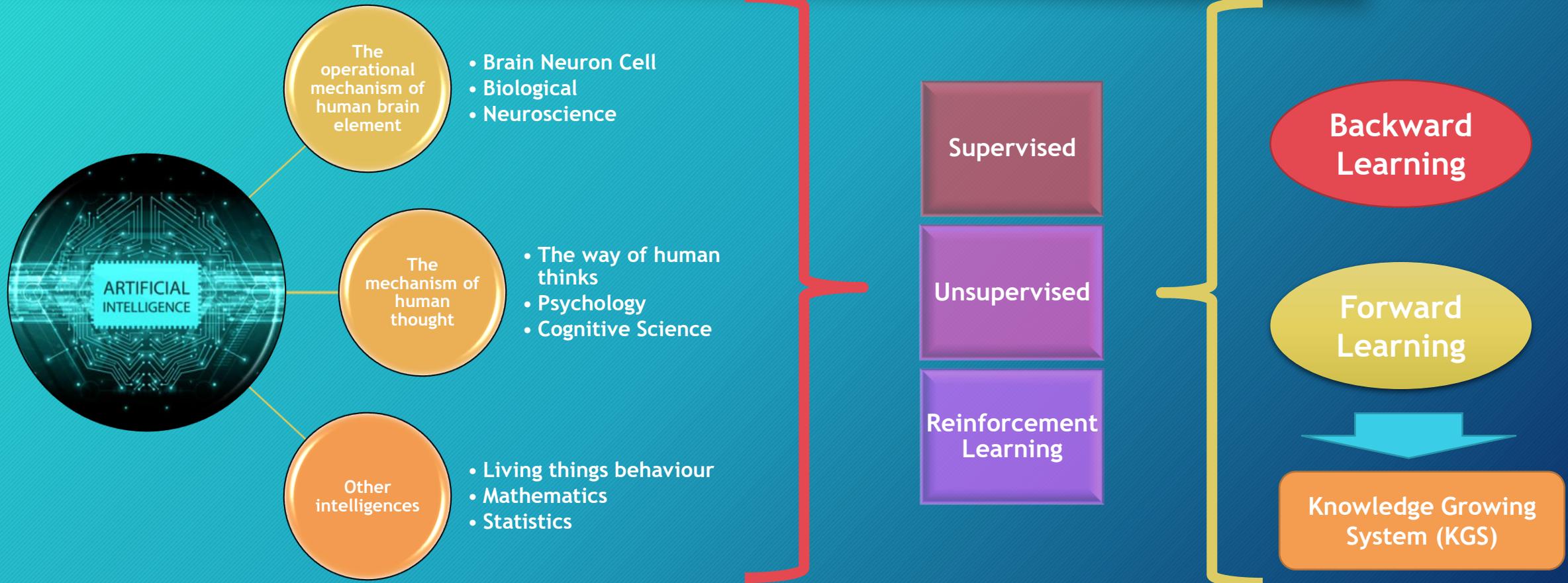
22





# Perspectives of Artificial Intelligence

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# Motivations

	Human Benchmark (H)	Rationality benchmark (R)
<b>Intelligence as Thought Processes (T)</b>	<b>(T-H) Systems that think like humans</b> (e.g. cognitive science)  <i>"The exciting new effort to make computers think ... machines with minds, in the full and literal sense"</i> Haugeland, 1985  <i>"The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..."</i> Bellman, 1978	<b>(T-R) Systems that think rationally</b> (logic/laws of thought)  <i>"The study of mental faculties through the use of computational models"</i> Charniak and McDermott, 1985  <i>"The study of the computations that make it possible to perceive, reason, and act"</i> Winston, 1992
<b>Intelligence as goal-oriented behavior (B)</b>	<b>(B-H) Systems that act like humans</b> (Cf. Turing test; Winograd Schema Challenge <sup>39</sup> )  <i>"The art of creating machines that perform functions that require intelligence when performed by people"</i> Kurzweil, 1990  <i>"The study of how to make computers do things at which, at the moment, people are better"</i> Rich and Knight, 1991	<b>(B-R) Systems that act rationally</b> (rational agents)  <i>"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes"</i> Schalkoff, 1990  <i>"The branch of computer science that is concerned with the automation of intelligent behavior"</i> Luger & Stubblefield, 1993

## Intelligent Agent

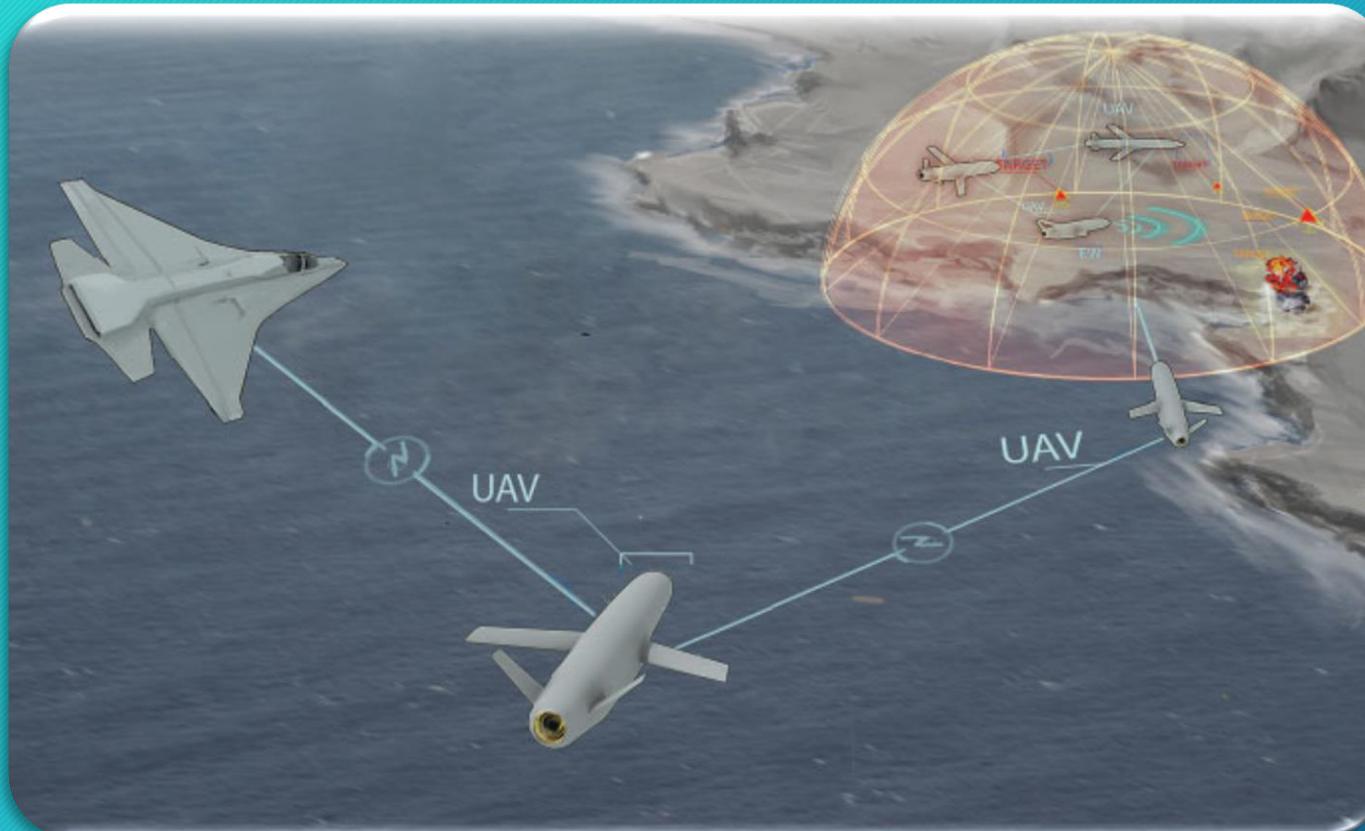


Agent that is able to  
act/think humanly/rationally  
**NOT**  
Free will



# AI Use-Cases in Defense and Military

# Supervised Combat Robots



- **Combat robots where collaborative autonomy, or the capability of groups of unmanned aircraft systems (UAS) to work together under one person's supervisory control**

# Combat Robots in Formation Flight

27



- XQ58-A Valkyrie **drone wingman** might someday **accompany** the F-35 and a new version of the F-15 fighter jet
- A low-cost platform that **would be controlled** by a parent aircraft to **accomplish a variety of tasks**
- A part of a larger **Artificial Intelligence (AI) program**, which would be designed to help pilots as a sort of **on-board assistant**

# Unmanned Warfare Ship

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- **Sea Hunter - the Anti-submarine Warfare Continuous Trail Unmanned Vessel (ACTUV)**
- **Fully autonomous, no crew onboard or humans controlling it remotely - Intelligent Vessel**



ACTUV Computer System

# Unmanned Tank



- **Uran-9 (Russia) Unmanned Ground Combat Vehicle (UCGV)**
- **Remotely controlled by an individual from a mobile vehicle that must remain within 1.8 miles**

**Russia's Uran-9 armed robot tank**

Russia has unveiled a new remote-controlled tank alongside other advanced weaponry at its Victory Day parade in Moscow. The Uran-9 has already seen action in Syria's civil war, according to Russian claims

**URAN-9 UNMANNED GROUND COMBAT VEHICLE**

**Remotely operated turret**  
Mounts different weapons based on mission requirements

**Four 9M120-1 Ataka anti-tank guided missiles, two per side.**  
Range: 0.4km-6km

**Six 93mm-calibre Shmel-M reactive flamethrowers.** Maximum range: 1km

**7.62mm coaxial machine gun**

**One stabilised 30mm Shipunov 2A72 automatic cannon – for defence against ground and low-flying aerial targets**

**Protection**  
Vehicle has ability to resist firing of small arms ammunition and shell splinters

**Weapon options:** Include four Igla surface-to-air missiles or six 9M133M Kornet-M anti-tank missiles

**Uran-9 specifications**

Weight 10 tonnes	Length 5.12m	Max speed 35km/h
---------------------	-----------------	---------------------

**Armata main battle tank to scale**

**Sensors:** Robot can detect and track targets by itself, at distance of 6km during day and 3km at night

**Decision to fire taken by operator in armoured truck up to 3km away.** Vehicle can also be controlled by means of portable control panel

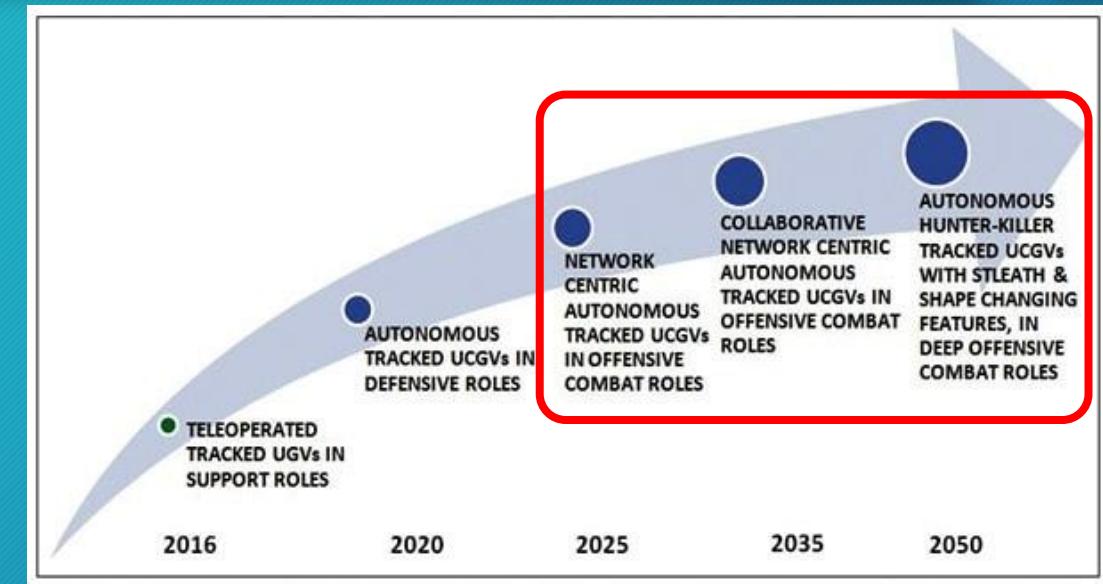
Sources: Army Technology, BBC

Picture: Facebook © GRAPHIC NEWS





# Unmanned Tank



- Mission UNmanned TRacked (MUNTRA, Russia) Unmanned Ground Vehicle (UGV)
- Teleoperated/autonomous UGV platforms and to implement payloads for unmanned missions of surveillance, NBC reconnaissance and mine detection/marketing missions
- Designed to be network-centric enabled and autonOmous using Artificial Intelligence (AI)



# AI Research in Military and Defense in Indonesia - State-of-the-Art and Possible Use-Cases



# State-of-the-Art

- Research and development of AI technology **has not been started yet** either in government units or in universities as **organization**.
- **Partial works**, factually, have been carried out by some research groups such as **CAIRG**.
- CAIRG have been doing **AI research and development for defense and security since 2007**.



## CAIRG AI R&D Achievements

2010 - Knowledge Growing System (KGS) as a new perspective in AI - stated

2008 - The invention of Maximum Score of the Total Sum of Joint Probabilities (MSJP) as new learning method for intelligent agent also MAS

2018 - Cognitive Processor based on KSG

2019 - KGS CAI patents

2020 - KGS for Covid-19 Detection System with BPPT

- 2009 - Knowledge Growing System (KGS) for Biomedical Engineering (genes behavior)
- 2015 - Intelligent Information Fusion for Bakamla
- 2017 - Cognitive C4ISR
- 2018 - CAI for Humankind
- 2019 - Dissolve Gas Analysis
- 2019 - Cognitive Countermeasure for Cyber Defense
- Ongoing - Intrusion Detection System (IDS)



# CAIRG AI R&D FUTURE PROGRAMS

- Image Understanding
- Face Recognition
- Cognitive C4ISR
- Cognitive Command Decision Making
- Cognitive Processor
- Cognitive Countermeasure
- Cyberattack Predictive System
- Energy Predictive System
- Health Predictive System





# Possible Use-Cases

- Autonomous deep learning machine systems to see the patterns of hybrid warfare
- Human machine collaboration
- Assisted human operations.
- Advanced human-machine combat teaming.
- Network-enabled semi-autonomous weapons.



# Cognitive Artificial Intelligence Research Group (CAIRG)

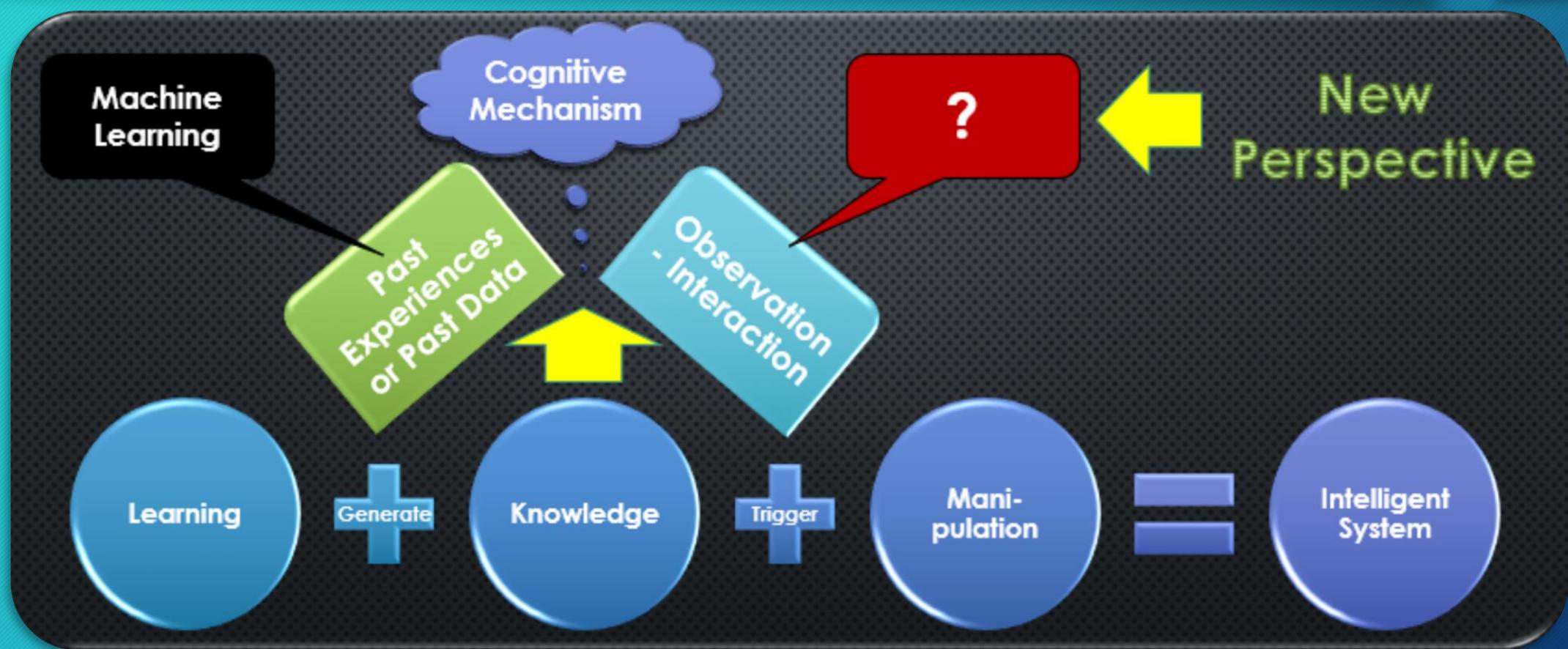
	Public Service (Public Administration, Healthcare, Education & Transportation)	Agriculture	Maritime	Energy & Utility	Supply Chain	Infrastructure	Defence & Security
Lead Generation & Tracking							
Predictive Maintenance							
Behaviour Analysis							
Demand & Inventory Management							
Anomaly Detection							
Sentiment Analysis							
Automation							
Forecasting							
Risk Management							
Strategy Recommendation							
Visual & Audio Recognition							
Audience Targeting							
Decision Support							
Personalized Services							

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# AI New Technology - Knowledge Growing System - Cognitive AI and Its Applications to Defense and Military

# Keys to Artificial Intelligence



# Knowledge Growing System (KGS)

39

A system that is capable of growing its own knowledge as the accretion of information it receives as the time passes



(Arwin Datumaya Wahyudi Sumari & Adang Suwandi Ahmad, 2009)

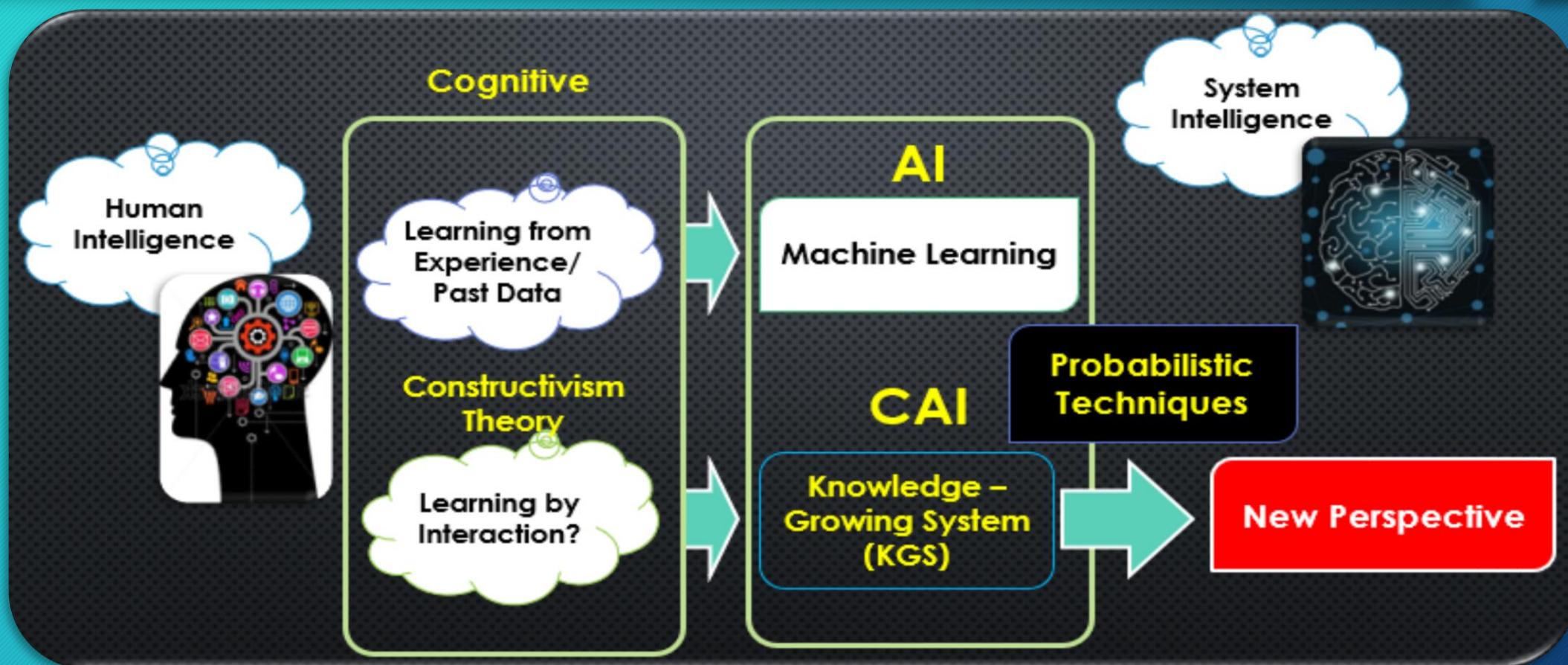
Growing knowledge

Intelligent Activity

Cognitive

Invented in 2008, Patented in 2019, <http://lpik.itb.ac.id/hki/detail/patent/308>

# KGS Foundation of Cognitive AI



# Cognitive AI vs. AI

41

Cognitive AI	AI
<b>Emulating</b> how human thinks in finding problem solution	Used to <b>augment</b> human in finding problem solution and ease the works. Machine Learning (ML) is a part of AI
<b>Acquiring knowledge directly when interacting</b> with the environment and <b>no training is needed</b>	<b>Need past experience or data</b> from the environment to be studied or trained to have knowledge
<b>No need many data</b> and the knowledge is acquired just-in-time	<b>Need many data of past experience</b> so require a significant time to acquire knowledge

## 5 INOVASI DITENGAH PANDEMI

**detikcom**

**1 RDT (Rapid Detection Test) Kit**

- Ada 2 jenis: antibodi IgG/IgM dan antigen micro-chip
- Manfaat: deteksi antibodi IgM dan IgG, OTG, ODP, PDP, Post Infeksi, dan Herd Immunity

**2 PCR Test Kit**

- Gen deteksi Sarscov-2 sekuens virus Indonesia
- Sensitivitas 100% terhadap Sarscov-2

**3 Mobile Lab Bio Safety Lab level 2**

- Ruang utama bertekanan negatif
- Dilengkapi alat pemusnah limbah
- Pencatatan sampel dan pelaporan hasil terintegrasi
- Dilengkapi Aplikasi Pantau Covid-1
- Total biaya produksi: Rp 5,5 miliar

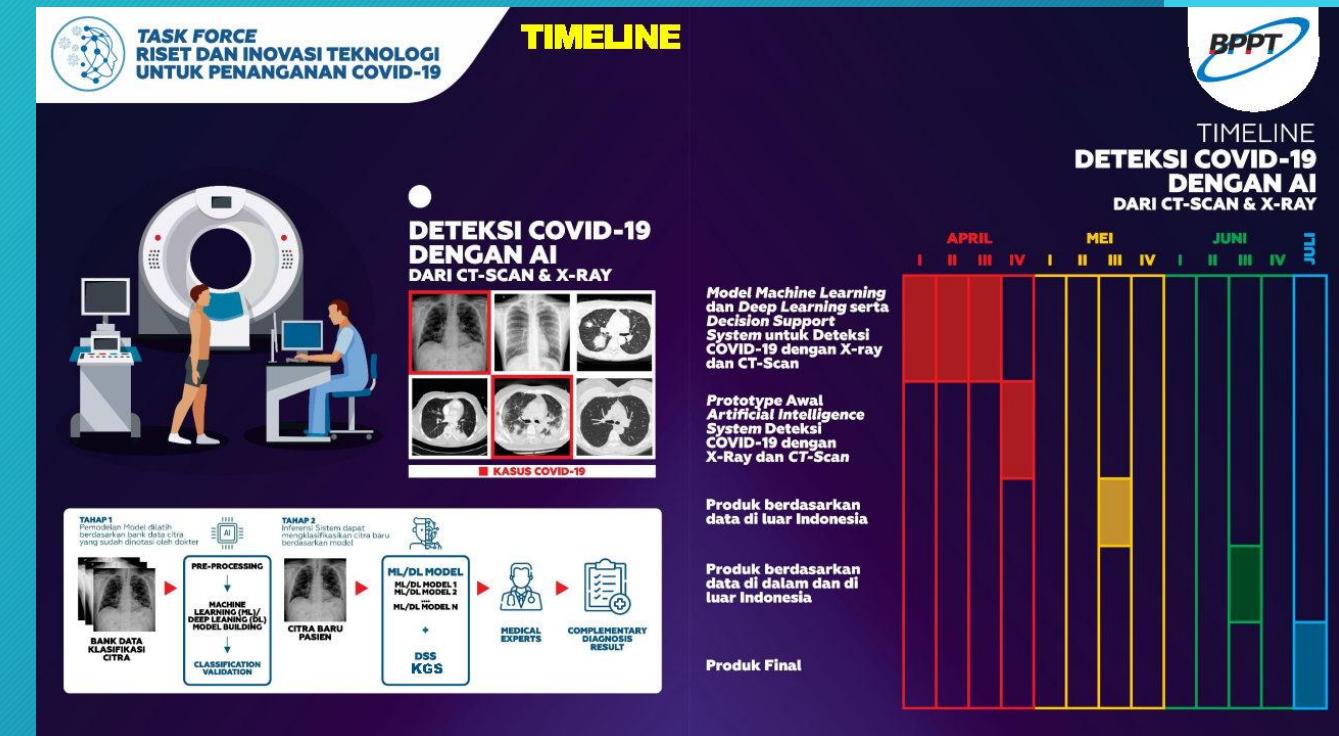
**4 Artificial Intelligences untuk deteksi COVID-19**

- Pencitraan Medis CT Scan dan X-Ray untuk diagnosis Covid-19
- Sistem Pendukung Keputusan berbasis Knowledge Growing System
- Membantu radiolog & dokter mempercepat proses diagnosis Covid-19

**5 Emergency Ventilator**

- Produsen: PT LEN, PT Polya Jaya, PT Dharma
- Power resuscitator berbasis Ambu Bag Mode Arm dan Penumatik

NASKAH: DEDEN GUNAWAN | SUMBER: HUMAS BPPT DAN WAWANCARA KEPALA BPPT | INFOGRAFIS: MINDRA PURNOMO



**Task Force Riset dan Inovasi Teknologi untuk penanganan COVID-19 (TFRIC-19) BPPT**

<https://tfric-19.id/>



# A Comprehensive View on Cognitive AI

43

*Open access peer-reviewed chapter*

## Cognitive Artificial Intelligence: Concept and Applications for Humankind

By Arwin Datumaya Wahyudi Sumari and Adang Suwandi Ahmad

Submitted: July 15th 2017 Reviewed: November 28th 2017 Published: August 29th 2018

DOI: [10.5772/intechopen.72764](https://doi.org/10.5772/intechopen.72764)

<https://www.intechopen.com/books/intelligent-system/cognitive-artificial-intelligence-concept-and-applications-for-humankind>

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# Cognitive AI for Strategic Decision Making

2011 International Conference on Electrical Engineering and Informatics  
17-19 July 2011, Bandung, Indonesia

## Strategic Decision Making based on A3S Information-Inferencing Fusion Method

Arwin Datumaya Wahyudi Sumari<sup>#1</sup>, Adang Suwandi Ahmad\*

Aciek Ida Wuryandari\*, Jaka Sembiring\*

\*Student Officer, Indonesian Air Force School of Command and Staff  
Sekolah Staf dan Komando Angkatan Udara, Jl. Raya Seskoau, Lembang, INDONESIA  
\*School of Electrical Engineering and Informatics, Institut Teknologi Bandung  
Achmad Bakrie Building 2<sup>nd</sup> Floor, Jl. Ganeca 10, Bandung, INDONESIA  
<sup>1</sup>arwin.sumari@yahoo.com, arwin91@aaui.ac.id

A3S = Arwin-Adang-Aciek-Sembiring

<https://ieeexplore.ieee.org/abstract/document/6021518>

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TABLE I  
ASPECTS OF AIRCRAFT "X" AS THE COMPARISON

No.	Aspect	Parameter
1.	Operational Age	First flight on 26 March 1971
	a. Operational Scheme	All Weather
	b. Military Interest	Maritime Patrol, Humanity Mission, Reconnaissance
	c. Technical Specification	
	- STOL	280 m (920 ft)
	- MTOW	8,000 kg
	- Range	675 NM (1,260 km)
	- Ceiling	7,620 m (25,000 feet)
	- Pressurized	No
	- Engine Performance	2 x turboprop, 776 shp
2.	Maintenance	
	- Logistics Support	
	a. Spare Part	Discontinued soon
	b. Service Bulletin	Stopped
	b. Service Manual	Not Supported
	- Maintenance System	
	a. BITE	Not Available
	b. Maintenance Facility	Available
3.	Avionics System	
	a. Technological Advanced	1980s
	b. Additional Facility	Not Available

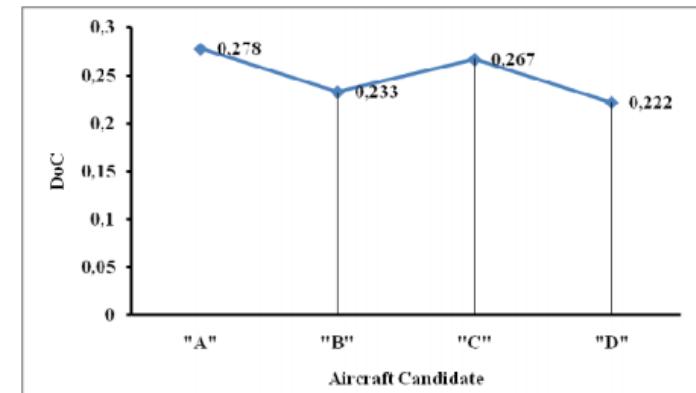


Fig. 1 Graphical representation of DoC of the most representative candidate aircraft and probability distribution of decision making process in the selection of aircraft candidates to replace the old one, aircraft "X".



# Cognitive AI for Power-Source Management

45

The 4th International Conference on Electrical Engineering and Informatics (ICEEI 2013)

## Knowledge Growing System Application in Hybrid Power Plant Energy Management in Nemberala Village Rote Island

A. Mitayani\*, E. R. Priandana, R. Maret

ITB, Jalan Ganeca 10, Bandung, Indonesia

### Abstract

A system employing artificial intelligent (AI) is currently popular to be developed to help people solving their problems, especially for problems that need skill of reasoning. Furthermore, knowledge growing system (KGS) is a new approach in AI environment which the system has a growing knowledge that can be learnt from the past. In this paper, a KGS-based system is applied to control electric source utilization in Nemberala Hybrid Power Plant. Electric source that will be used is controlled by inference information input from sensors which are processed in KGS. The result is Degree of Certainty (DoC) of probability electric source used, such as renewable energy, fossil energy, and Hybrid energy. From DoC, the source that should be used can be decided properly by the system.

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Selection and peer-review under responsibility of the Faculty of Information Science & Technology, Universiti Kebangsaan Malaysia.

**Keywords:** knowledge growing; hybrid power; energy management

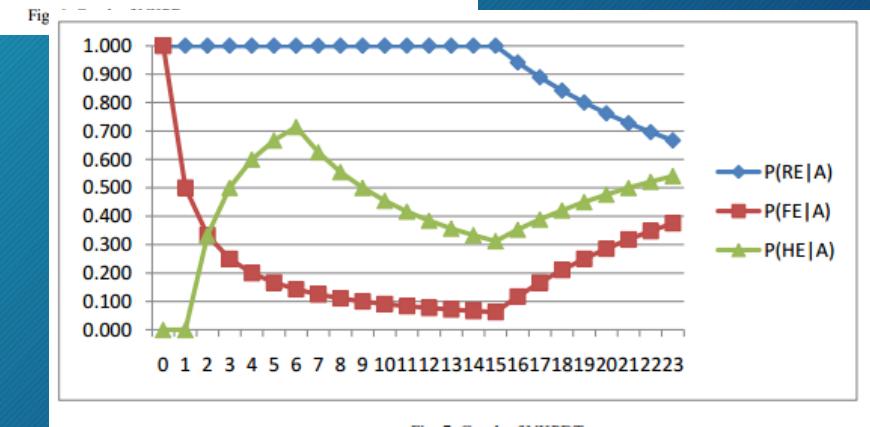
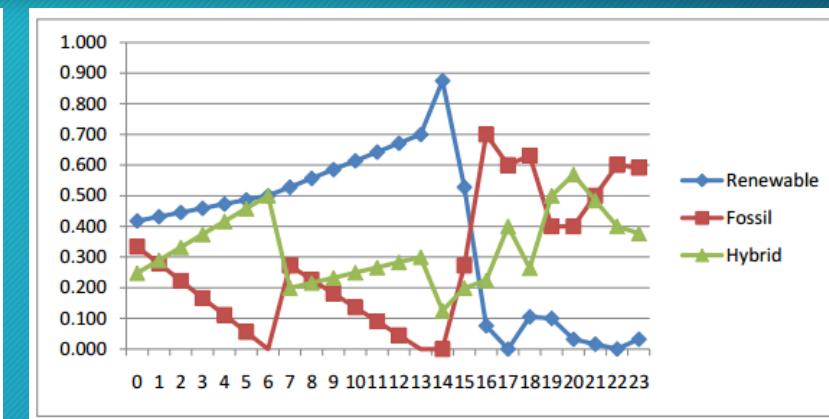


Fig. 7. Graph of NK PDT

<https://www.sciencedirect.com/science/article/pii/S2212017313003940>

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# Cognitive ai for reasoning in biomedical

46

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IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.11, November 2009

## The Application of Knowledge-Growing System to Multiagent Collaborative Computation for Inferring the Behavior of Genes Interaction

Arwin Datumaya Wahyudi Sumari<sup>1</sup>  
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<http://citeseerx.ist.psu.edu/viewdoc/citations;jsessionid=588DA5D4F33957E88A672B0E6C574557?doi=10.1.1.532.9651>

arwin.sumari@tni-au.mil.id - AI in Defense and Military [09072020] @ BISA.ai

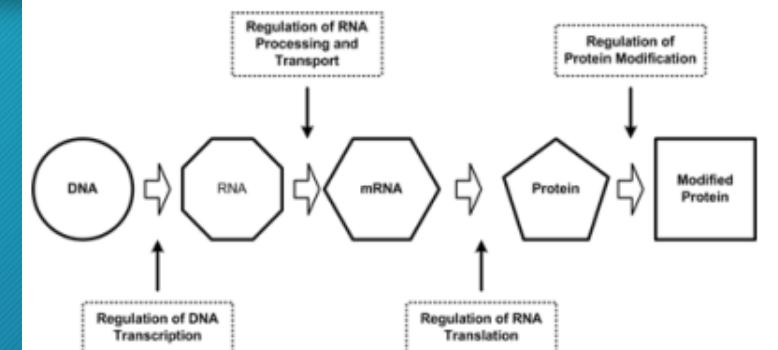


Fig. 1. Regulation of gene expression at different stages of protein synthesis [8] adapted from [14].

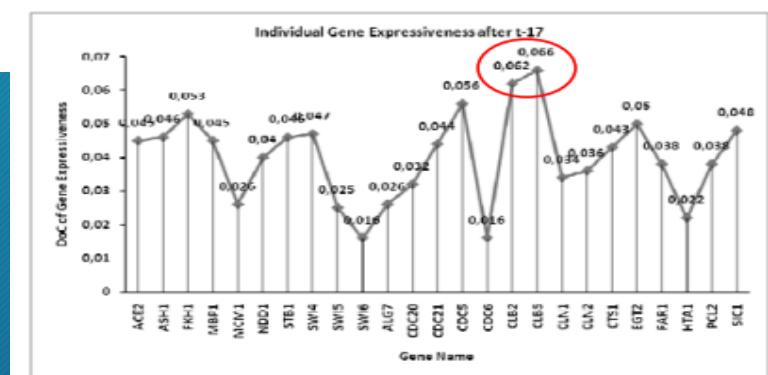


Fig. 19. The knowledge acquired by KGS regarding the MCC behavior after 17t of interaction time.



# Cognitive AI for Equipment Health Prediction

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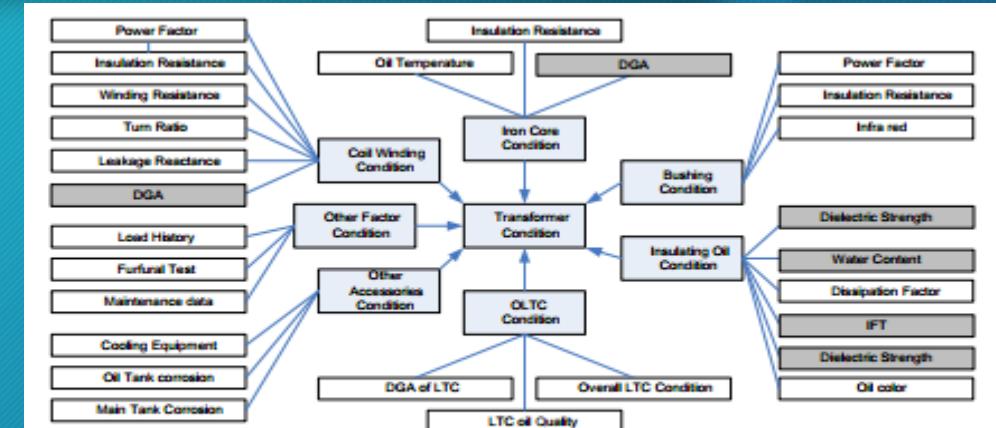
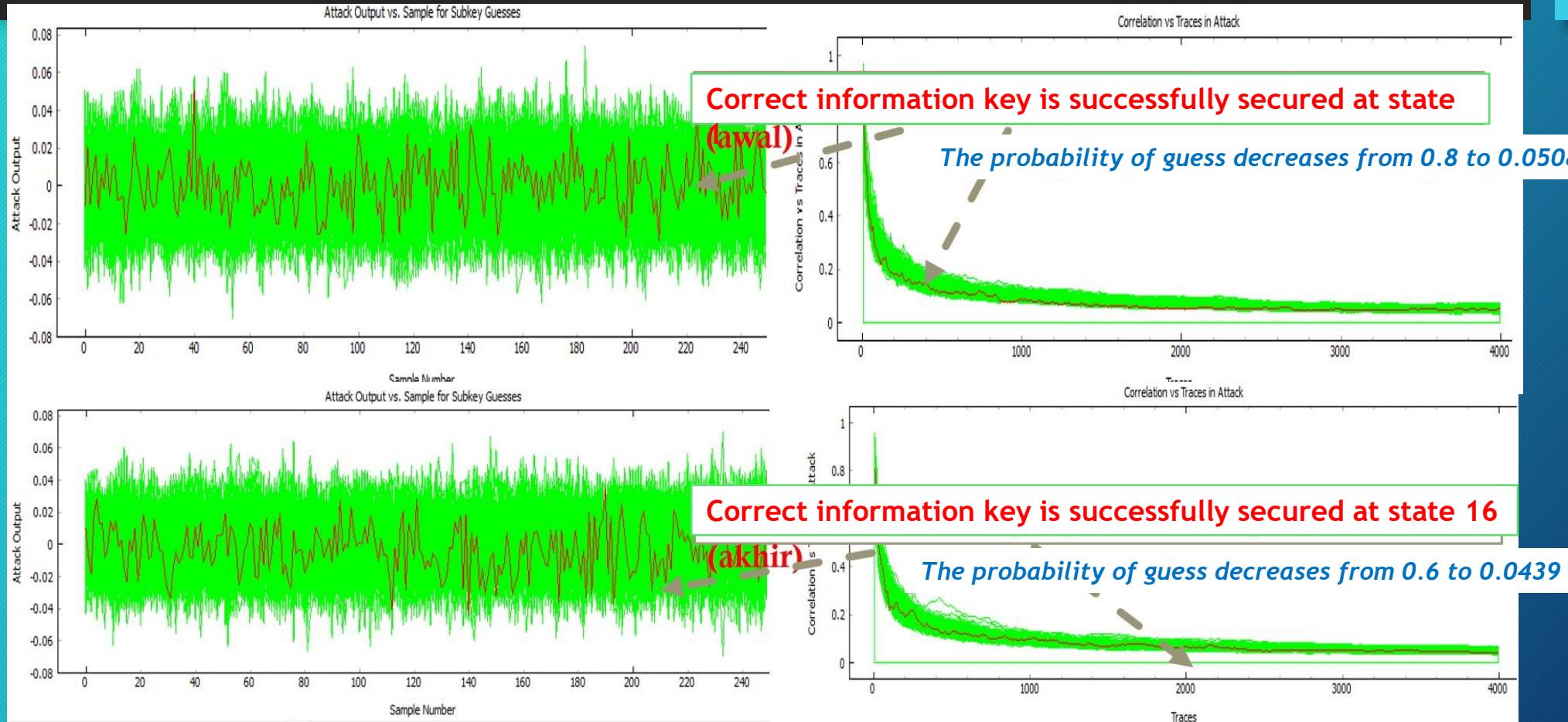


Figure 1 Transformer Condition Factors [2]

- KGS has successfully interpreted DGA data to identified fault based on the classified dataset.
  - It has successfully identified not only the main fault, which has the most significant DoC.
  - It has successfully identified the fault(s) occurred along with the main fault, which has less significant of DoC.
  - This feature acts as the early warning system

# Cognitive AI for Hardware Security





# Thank You