

Intelligent Control

Introduction to Artificial Intelligent (1)

by

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(Credit to D.Pebrianti)

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Intelligent by N.M.A Ghani

Chapter Description

At the end of this topic , student should be able to:-

- Understand Intelligent System and its applications.
- Able to compare classical control system and modern intelligent system.



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Contents

1.1 Overview of Artificial Intelligence (AI)

1.2 Artificial Intelligence application

1.3 Comparison with classical controller



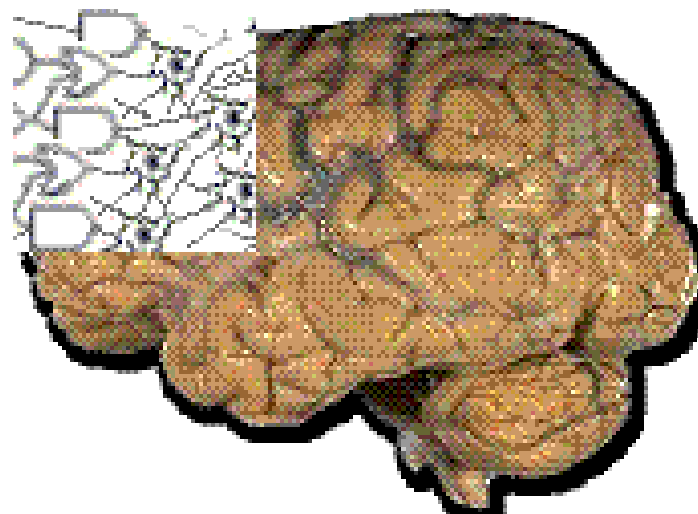
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Overview of Artificial Intelligence (AI)

1.1



ARTIFICIAL INTELLIGENCE: WHAT IS IT ALL ABOUT?



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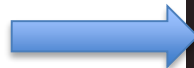
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One way to understand “intelligence” is by looking at our own capabilities, *which means that* humans are able to:

- think
- understand
- recognize
- perceive
- generalize
- adapt
- learn
- make decisions
- solve daily problems



Source: <https://www.flickr.com>



Source: <https://pixabay.com>



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According to the Oxford and English Dictionaries the word “**intelligence**” can be defined as follows:

- ability to understand
- reason
- perceive
- quickness in learning
- mental alertness
- ability to grasp relationships
- clever
- information
- news



Source: <https://en.wikipedia.org>



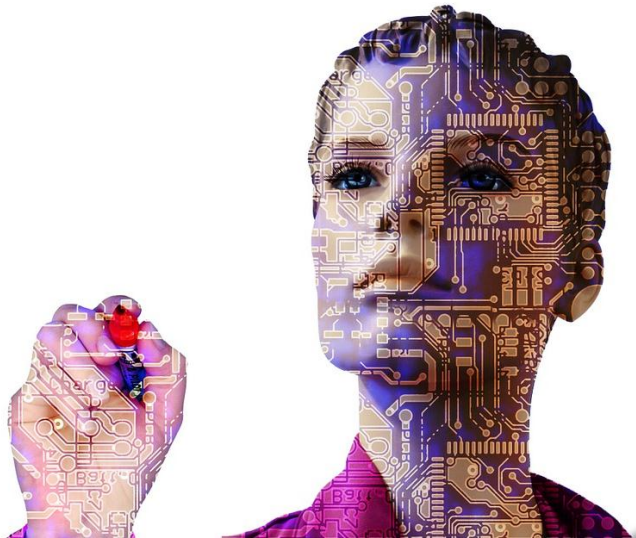
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Artificial Intelligence (AI) ?

AI is a study about inventing machines/computers that capable of mimicking human/animal intelligent behavior.



Source: <https://pixabay.com>



Source: <https://pixabay.com>

The ultimate objective is to develop a system that can think and act rationally like humans.



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How do we design Intelligence?

- Study from biological models (brain, genetic, DNA, life, Molecular biology,) → neural nets, GA, Artificial Life, DNA Computing, Quantum Computing, Robotics, etc.
- Study from human phenomena (common sense, reasoning, predicting, observing, inference, ...) → fuzzy logic, expert systems, search techniques, etc.
- Need to develop mathematical/logical algorithms based on the above biological models or phenomena



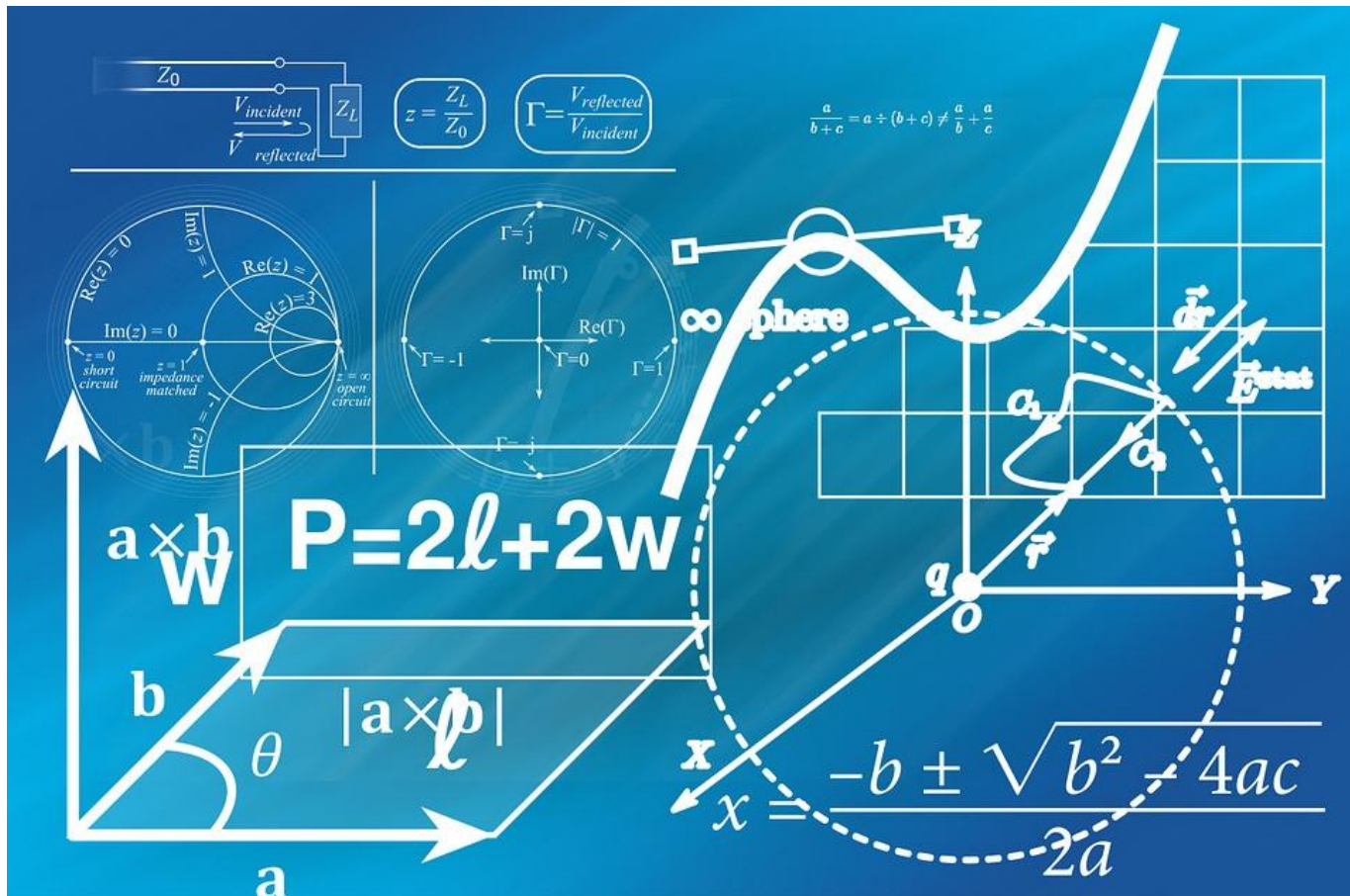
Artificial Intelligence application

1.2



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Where AI can/should be applied?



Source: <https://pixabay.com>



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Where AI can/should be applied?

- Data is overwhelming/abundance
- Too many manual operations/procedures
- Optimization is possible
- Parallel/Distributed procedures/architectures are needed
- Decision making is required
- When current techniques are too complicated to be used/designed



Where AI can/should be applied? .. Cont'd

- Mathematical models are too complex/impossible
- To increase efficiency
- To reduce cost
- To improve performance and reliability



Some Important Facts, you need to know....

- AI is not the only solution.
- AI is only one part of technology.
- AI is just a tool for improvement.
- You must know your domain/target application.



AI : Some of the approaches

- Expert system
- Fuzzy Logic
- Genetic Algorithm
- Swarm Intelligence
- Ant Colony
- etc



Expert System

- **Expert System (ES)** is a branch of Artificial Intelligence that attempt to mimic human experts specifically in decision making process based on prior knowledge.
 - Expert systems can either support decision makers or completely replace them.
 - Expert systems are the most widely applied & commercially successful AI technology.



Types of ES

- *Ruled Based Expert System*
 - Represented as a series of rules
- Frame-Based System
 - Representation of the object-oriented programming approach
- Hybrid System
 - Include several knowledge representation approach
- Model-Based System
 - Structured around the model that stimulates the structure and function of the system under study
- Ready-Made (Off-the-shelf) System
 - Custom-made, similar to application package such as an accounting general ledger or project management in operation mgmt.



Rules as a knowledge representation technique

- The term *rule* in AI, which is the most commonly used type of knowledge representation, can be defined as an *IF-THEN* structure that relates given *information or facts in the IF* part to some *action in the THEN* part. A rule provides some description of how to solve a problem. Rules are relatively easy to create and understand.
- Any rule consists of two parts: the *IF* part, called the *antecedent (premise or condition)* and the *THEN* part called the *consequent (conclusion or action)*.

Rules can represent relations, recommendations, directives, strategies and heuristics:

❑ Relation

IF the 'fuel tank' is empty
THEN the car is dead

❑ Recommendation

IF the sea is very deep
AND the sky is cloudy
AND the forecast is danger
THEN the advice is 'do not go to the sea'

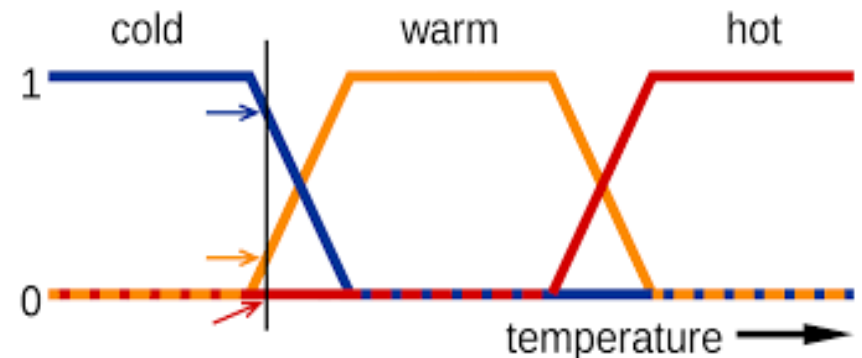
❑ Directive

IF eat too much raya cakes, rendang
AND the stomach is always aching
THEN the action is 'fasting in Syawal'



Fuzzy logic : human reasoning process (approximation)

- Differs from binary set theory(true or false, or 1 or 0)
- Similar to probability but not same in concept.
 - Fuzzy (degree of truth)
 - Probability (likelihood)
- An element might have partial characteristics of others or a subset of something but non-fuzzy is more deterministic.



Source: <https://commons.wikimedia.org>



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Source: <http://archive.defense.gov>

AI IN INDUSTRIES



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Advantages of Adding Intelligence in Products/ Systems

- Better performance
- Longer Life
- Reliability
- Simpler operation
- Cost effective
- Higher efficiency
- Self-organizing / self-optimization
- Simpler design



Is there really a need for AI?

- Manufacturers need to improve on their products
- Need to satisfy customers
- Need to improve products' reliability
- Need to improve products' performance
- Need to improve products' features
- Need to distinguish their products away from their competitors



Future Research in Humanoids

ROBOT

- Speed (Fast)
- Not tired-Can do repetitive job (Fuel Cell)
- Not imaginative/Not creative
- Better speech and pattern recognition
- Some emotion
- Entertainment
- Personal Friend

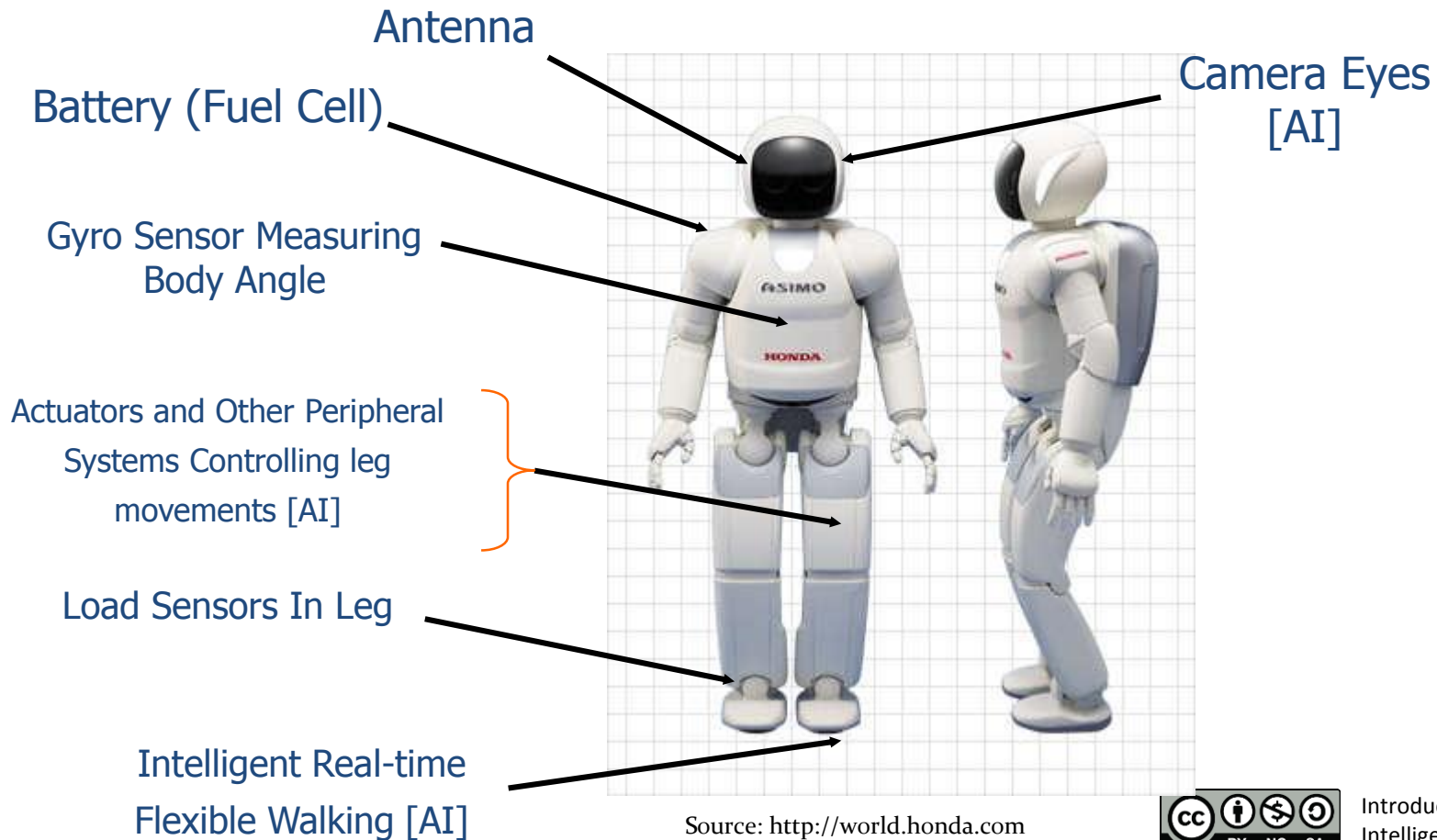
HUMAN

- Slow
- Intelligent
- Easily tired
- Imaginative/Creative
- Emotional
- Desire
- Etc.



ASIMO

Advanced Step in Innovative MObility



Source: <http://world.honda.com>



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Issues to be considered...

- **Do not apply AI when**
 - Lack of Data
 - Simpler techniques are available / sufficient
 - Further optimization is not possible
- **The AI Machine faulty**
- **Are Robots More Intelligent than Humans?**
- **Can Robots Replace Humans?**
- **Human vs Machine**



Comparison with classical controller

1.3



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Intelligent Control \leftrightarrow Classical Control

| | Classical Control | Intelligent Control |
|---------------------|---|---|
| Basic Concept | Mathematical Modeling - Designer designed the system which includes system dynamics | Abstract Modeling - Designer input the behavior to the system and then system attempt to abstractly define the system |
| Characteristics | Need to know prior information about the system dynamics | Does not need to know all about the system dynamics and conditions |
| | Suitable for system that can be easily model | Appropriate for complex system |
| Examples of Methods | Open loop system | Fuzzy logic |
| | Closed loop system | Artificial Neural Network |
| | System Modeling | Genetic Algorithm |
| | Bode plot | Support vector machine |
| | PID Controller | Swarm Intelligence |
| | Nyquist plot | Particle Intelligence |



Intelligent Control \leftrightarrow Classical Control

Classical Control

Software

Designer

Intelligent Control

Designer

Software

INTELLIGENCE



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AI Application

- Group Activity (1 hour) – 4-5 person
- Freshen up your industrial attachments...
 - List down industries application which use the classical control in their company.
 - Identify any of the application in the industries that has applied AI in their system.
 - Propose any one of the AI method for any suitable/appropriate system in industries and explain why did you choose the proposed technique.





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