

Applications of AI & its Contributions to Society

How AI is Changing Industries
and Helping Society

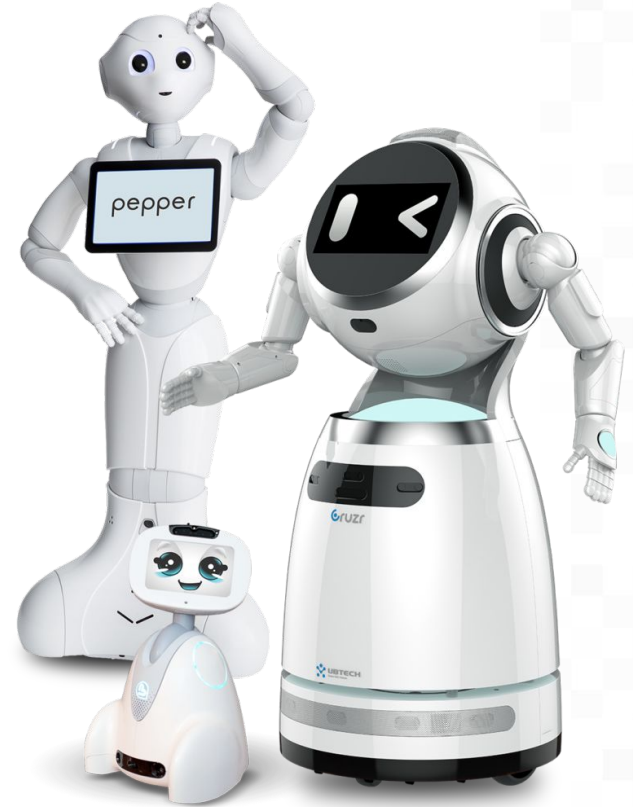


AI in Robotics

Developing Robots with Artificial Intelligence

What are Robots?

- Derived from Czech word “robota”, which loosely translates as a menial labourer
- A primary assumption about robots is that they are in human form with limbs, torso and a head, which can be largely accredited to science fiction
- In reality, robots are not in human form: consider a robot vacuum cleaner which is not equivalent to janitors
- Traditionally, robotics and automation are closely associated
- Artificial intelligence has shifted robotics into “intelligent robotics”, where they no longer perform task in a mindless and repetitive way



Sources: Murphy, R.R. (2000). Introduction to AI Robotics
Intuitive Robots: Humanoid Robots Solution (intuitive-robots.com)

Robots in The New Dawn

- In the modern age, the term “robot” is intrinsically entangled with the word “intelligent”
- Thus, intelligent robots can be defined in terms of inputs and outputs through three robot primitives: SENSE, PLAN, and ACT

ROBOT PRIMITIVES	INPUT	OUTPUT
SENSE	Sensor data	Sensed information
PLAN	Information (sensed and/or cognitive)	Directives
ACT	Sensed information or directives	Actuator commands

Source:
Murphy, R.R. (2000). Introduction to AI Robotics.

How Does AI Affect Robotics?

- Current robotic systems are proficient with repetitive tasks: tasks which does not involve much thinking
- In addition, current robotic systems require explicit programming to make it work
- E.g. robotic arms in a car assembly performs only tasks according to pre-programmed instructions
- AI advances enable robots to act accordingly depending on situations
- With AI, robotic systems can learn though the imitation learning approach
- Consequently, applications of AI in robotic systems are endless



AI in Robotics

Autonomous Self-Driving Cars

Robotics Application 1: Autonomous Self-driving Cars



SAE J3016™ LEVELS OF DRIVING AUTOMATION

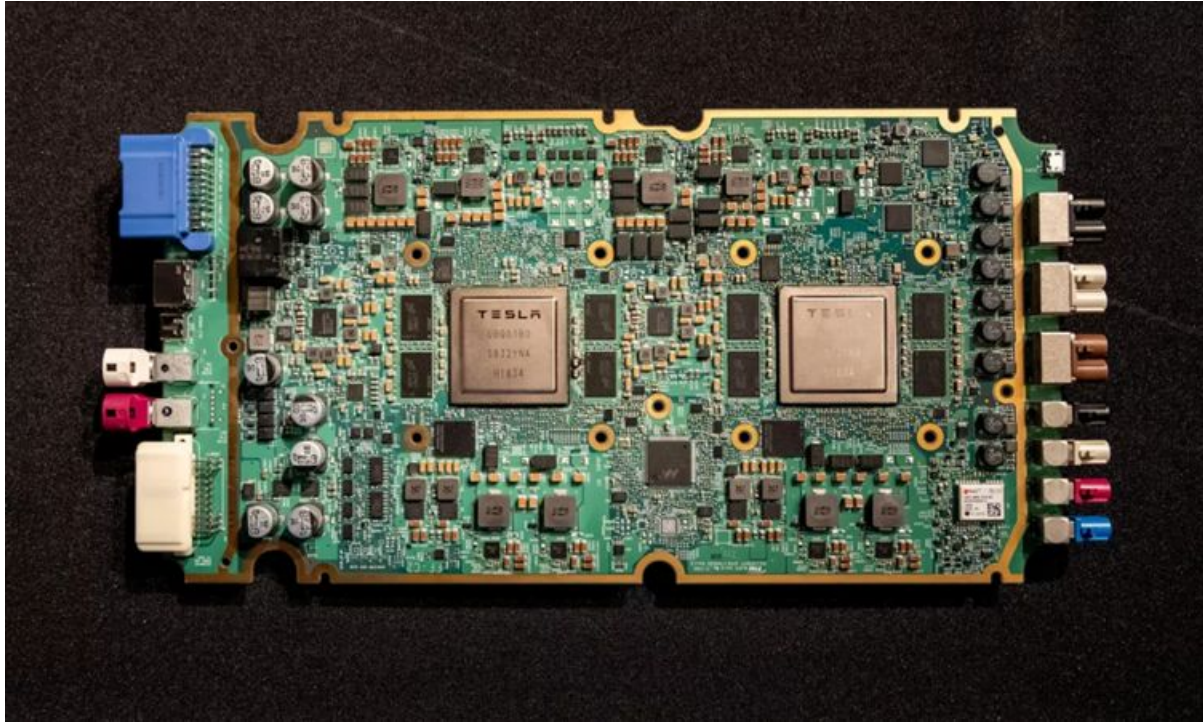
		SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in the driver's seat have to do?		You are driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			You are not driving when these automated driving features are engaged – even if you are seated in “the driver’s seat”		
		You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
What do these features do?		These are driver support features				These are automated driving features	
		These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/acceleration support to the driver	These features provide steering AND brake/acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met	This feature can drive the vehicle under all conditions	
Example Features		<ul style="list-style-type: none">• automatic emergency braking• blind spot warning• lane departure warning	<ul style="list-style-type: none">• lane centering OR• adaptive cruise control	<ul style="list-style-type: none">• lane centering AND• adaptive cruise control at the same time	<ul style="list-style-type: none">• traffic jam chauffeur	<ul style="list-style-type: none">• local driverless taxi• pedals/steering wheel may or may not be installed	<ul style="list-style-type: none">• same as level 4, but feature can drive everywhere in all conditions

For a more complete description, please download a free copy of SAE J3016: https://www.sae.org/standards/content/J3016_201806/

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<https://www.sae.org/news/2019/01/sae-updates-j3016-autonomous-driving-graphic>

TESLA



Tesla's Full Self Driving Computer board

- Pulls images and video in the real world
- Uses the vehicle's radar sensors to determine object depth and distance without use of stereoscopic camera
- Cars uploads data for training to be used by the neural network

Tesla's "Full Self-Driving"





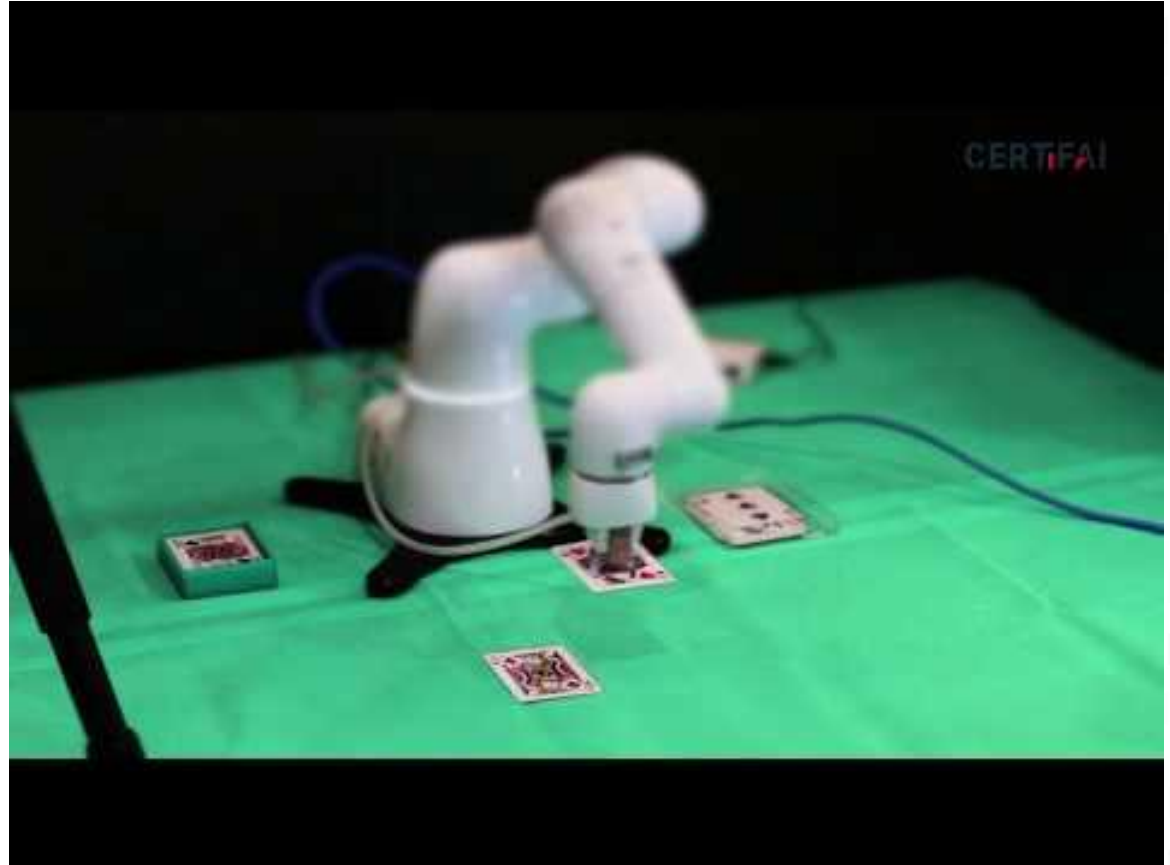


AI in Robotics

Autonomous Card Playing Robot by Skymind

Robotics Application 2: Autonomous Card Playing Robot

Plays card game with
Densowave robotic
arm with intelligence
powered by **DL4J**



Features

- Automatically distribute cards during a game.
- Automatically cleans up after a game.
- Smart mapping of 2D to 3D Coordinates
- Able to make decisions as a normal blackjack player.
- Able to detect and classify all 52 kinds of playing cards.
- Able to detect and classify 6 kinds of poker chips.
- Predicts Card's Orientation



Object Detection

- Deep Learning based Object Detection models:
 - 52 classes Playing Cards Detection
 - 6 classes Poker Chip Detection
- Green labels denotes **predicted object class**.
- e.g. Jc means Jack of Clubs



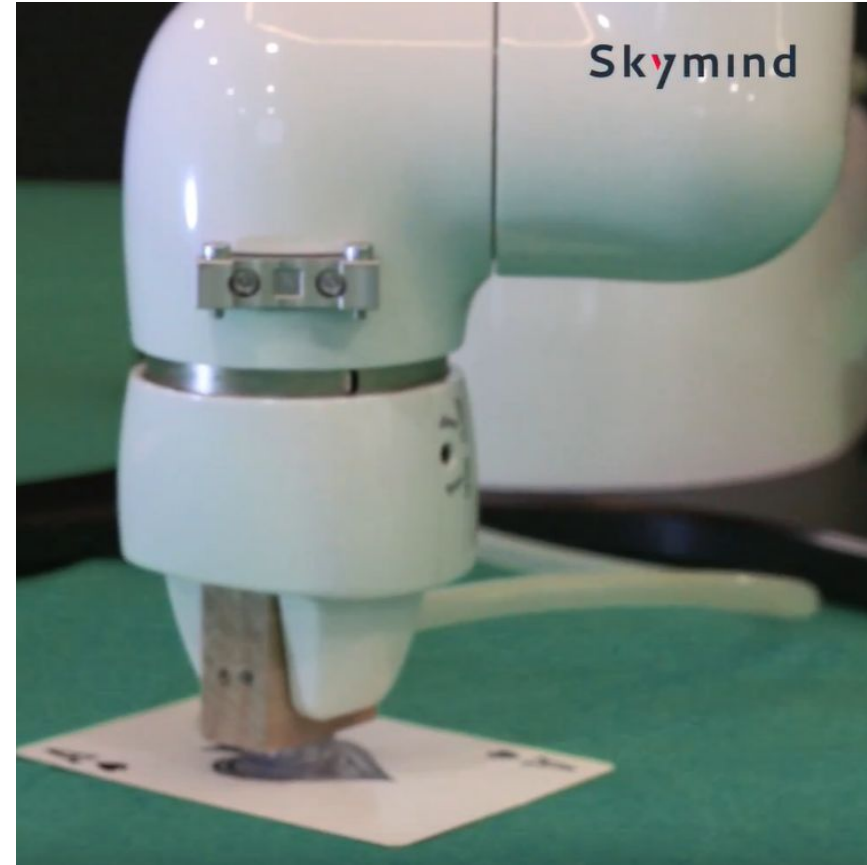
Object Detection

- Deep Learning based Object Detection models:
 - 52 classes Poker Cards Detection
 - 6 classes Poker Chip Detection
- Blue labels denotes **predicted object class**.
- e.g. chip100 means 100 value-poker chip



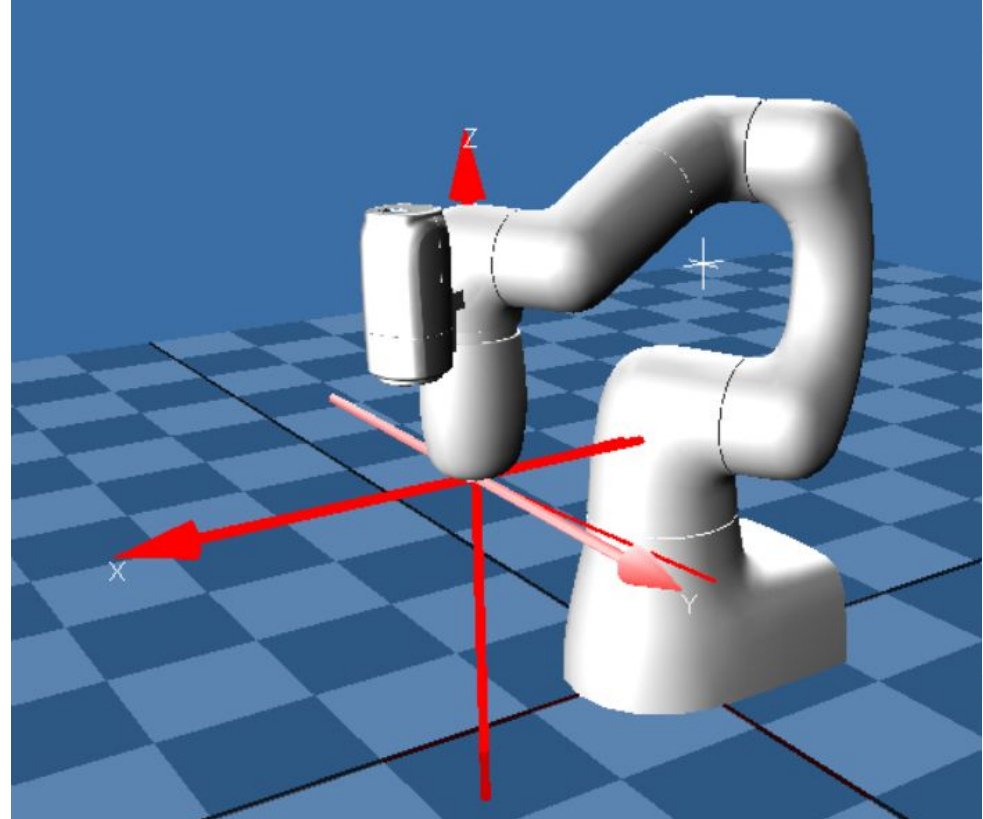
Orientation Calculation

- Able to calculate the card's **orientation** value.
- Able to do **orientation correction**.
- Able to adjust robotic arm's R_z axis to match the card's orientation.
- During the clean up process, the robotic arm is able to pick up the card at **any orientation** and stack them up in a **fixed and tidy manner**.



Smart Mapping

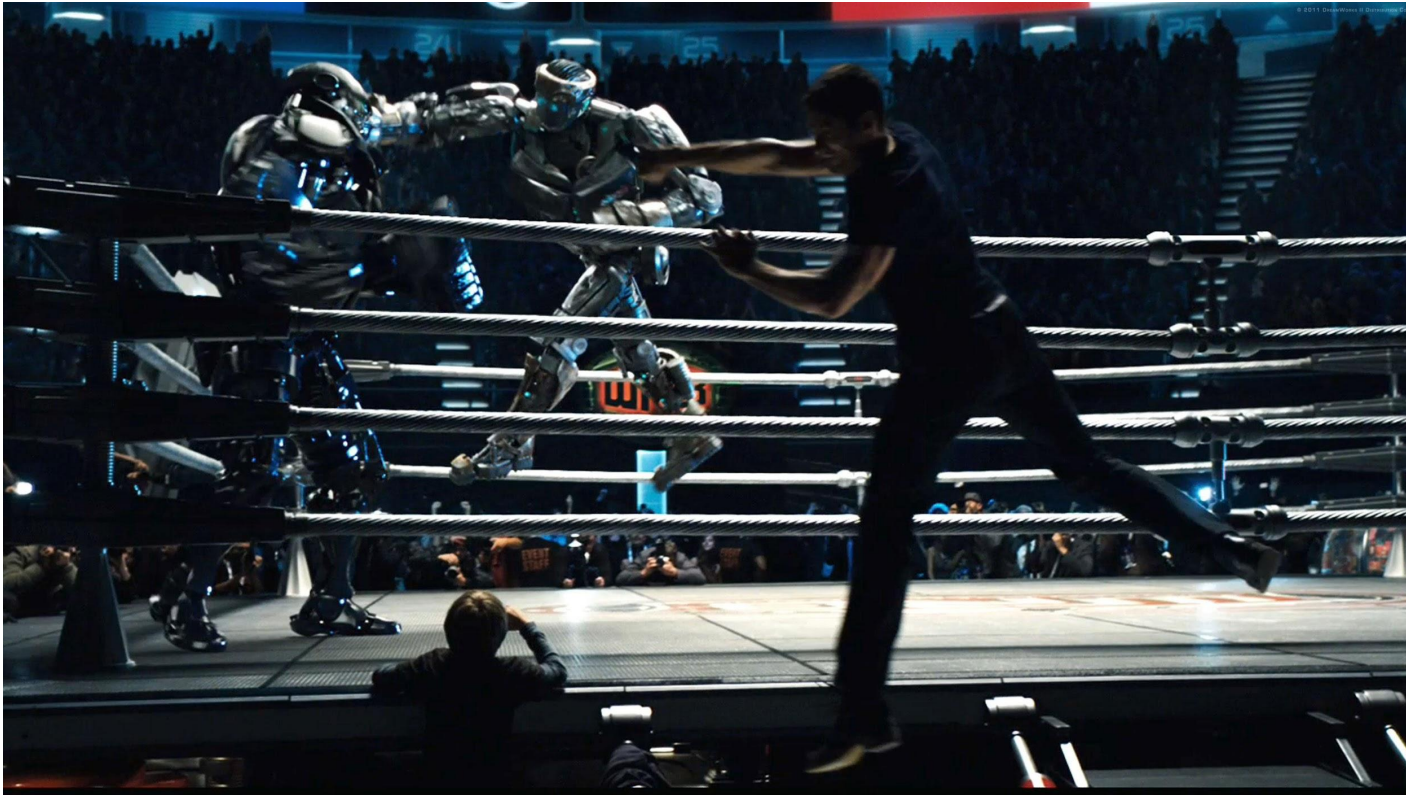
- Maps the **camera's 2D coordinates** space to the **robotic arm's 3D coordinates space**.



AI in Robotics

Humanoid Robots

Robotics Application 3: Humanoid Robots



Source:
<https://vistapointe.net/clipart/getsecond>

Robotics Application 3: Humanoid Robots



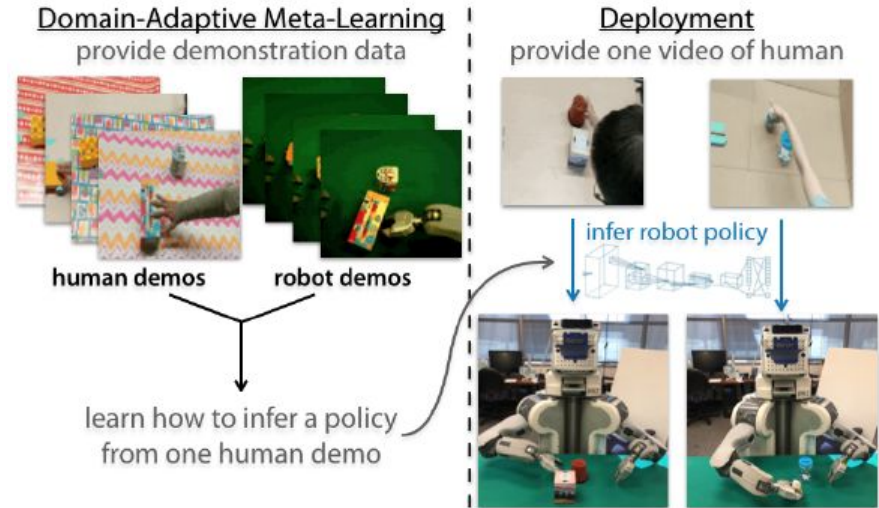
Source: <https://www.youtube.com/watch?v=s9aluPSvXX8>

What is Imitation Learning?

- Humans are able to perform tasks simply by observing, or *imitate*
- Highly desirable for machines to learn just by observing
- This subfield is also known as Behavioral Cloning

Recent Advances

- A recent method used is Domain-adaptive Meta-learning (DAML)
- Researchers record demo videos of an action and the motion protocols are learned using CNN
- Parameters from motion protocols will be used to control the robot, giving its motion



Yu, Tianhe & Finn, Chelsea & Dasari, Sudeep & Xie, Annie & Zhang, Tianhao & Abbeel, Pieter & Levine, Sergey. (2018). One-Shot Imitation from Observing Humans via Domain-Adaptive Meta-Learning. 10.15607/RSS.2018.XIV.002.