CERTIFAI
powered by Skymind

Applications of AI & its Contributions to Society

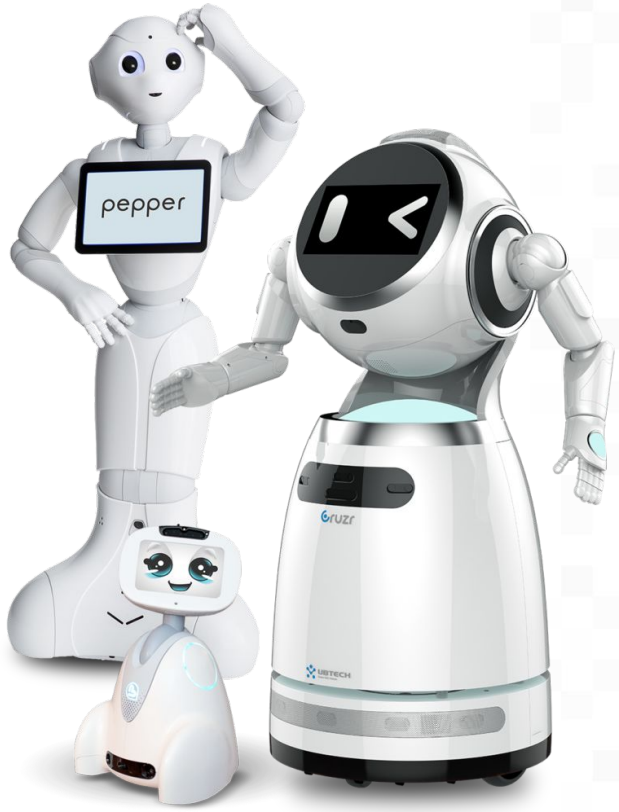
How AI is Changing Industries and Helping Society

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?

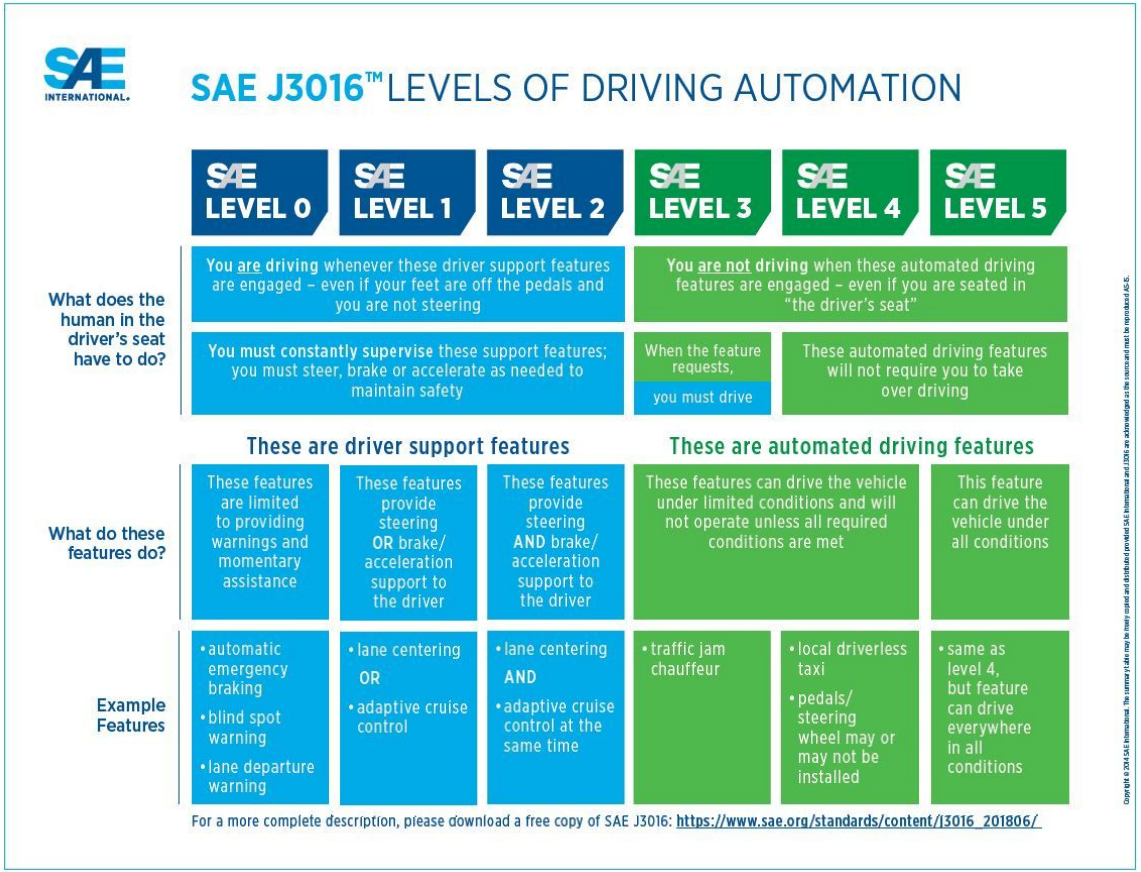
- Current robotic systems are proficient with repetitive tasks: tasks which does not involve much thinking
- In addition, current robotic systems require explicit programming to make it work
- E.g. robotic arms in a car assembly performs only tasks according to pre-programmed instructions
- AI advances 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

Sources: https://www.ft.com/content/f80c390c-5293-11e7-bfb8-997009366969
https://www.theverge.com/2020/1/29/21083313/robot-picking-warehouses-logistics-ai-covariant-stealth

AI in Robotics

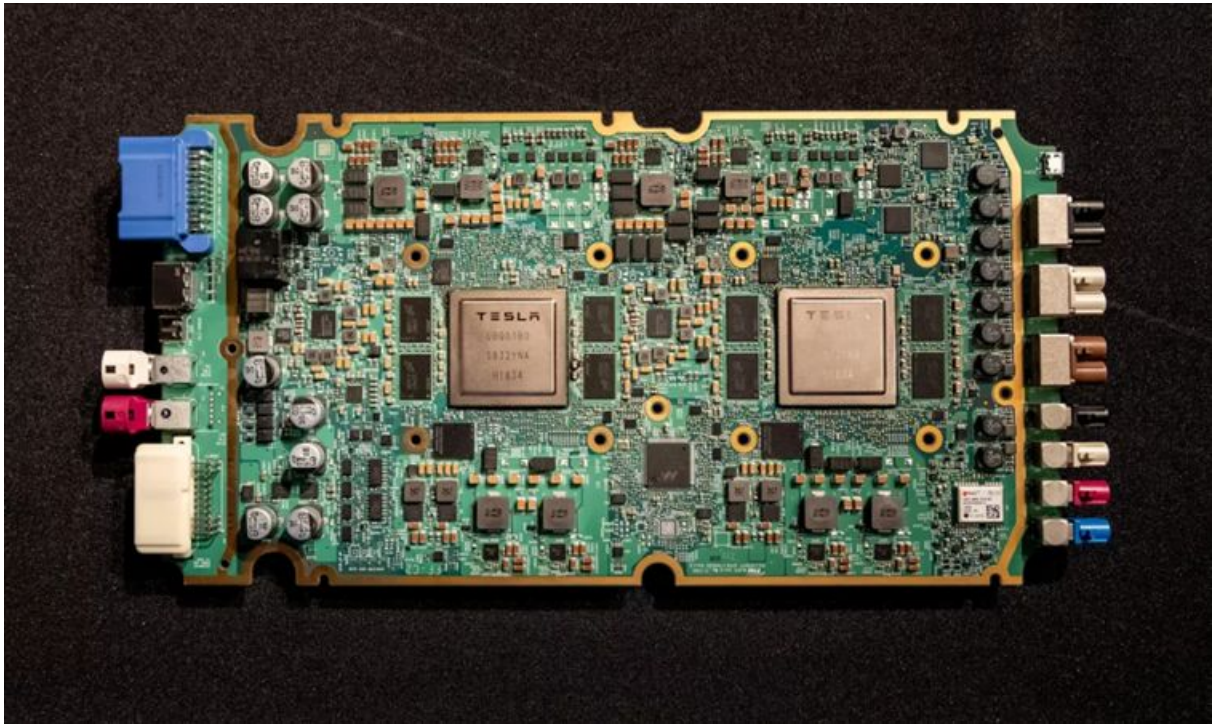
Autonomous Self-Driving Cars

Robotics Application 1: Autonomous Self-driving Cars



https://www.sae.org/news/2019/01/sae-updates-j3016-automated-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”

https://www.tesla.com/autopilot

https://www.tesla.com/autopilot

AI in Robotics

Autonomous Card Playing Robot by Skymind

Robotics Application 2: Autonomous Card Playing Robot

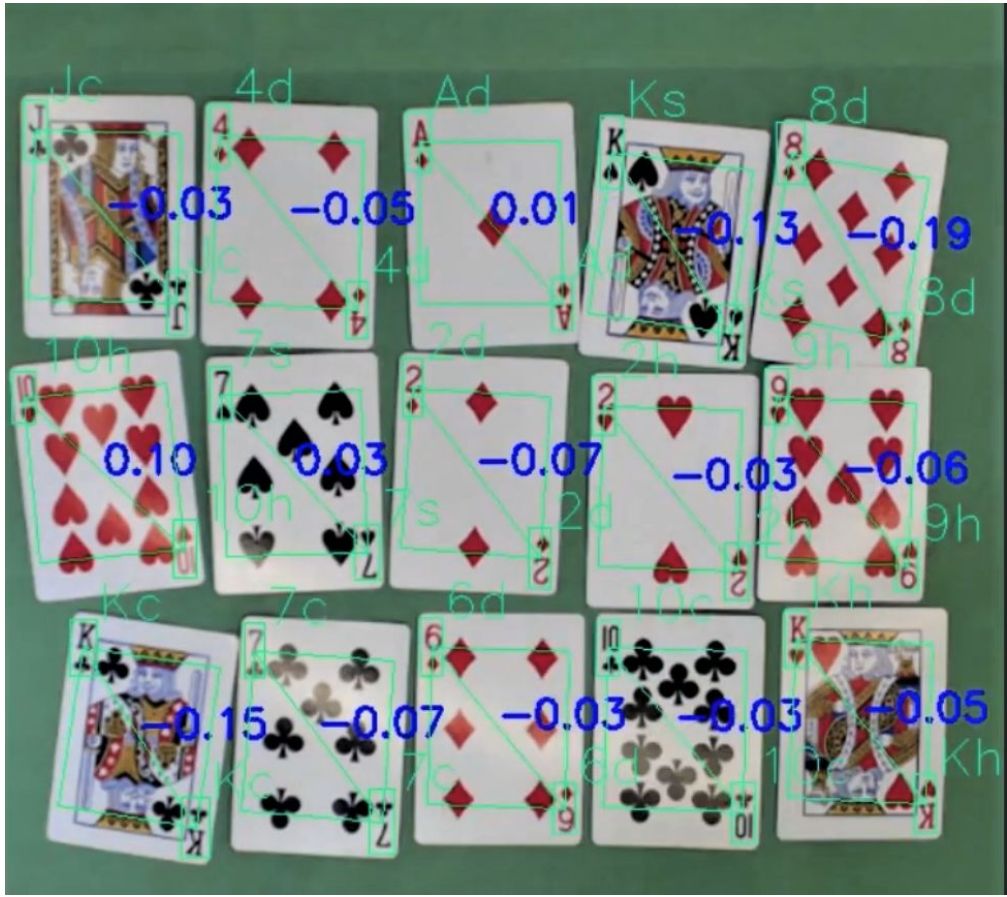
Plays card game with Densowave robotic arm with intelligence powered by **DL4J**

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

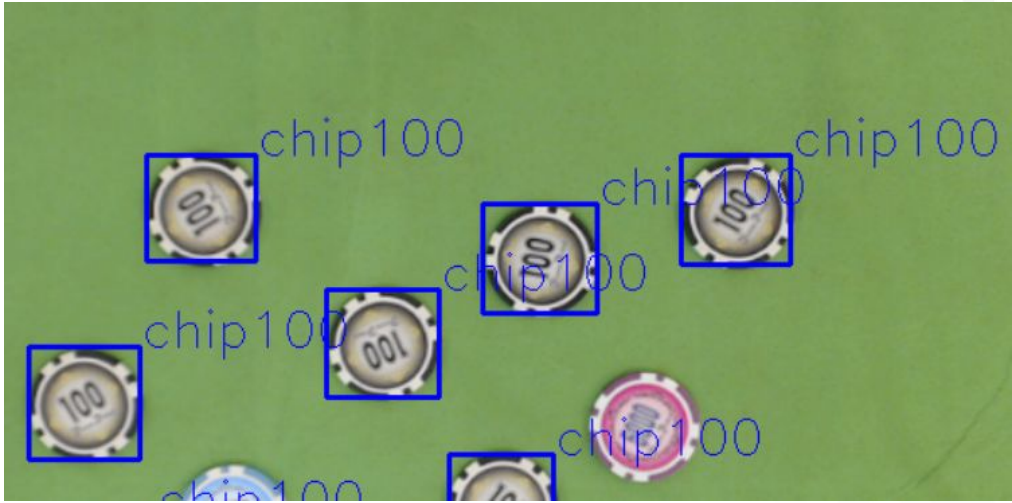
Object Detection

- 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

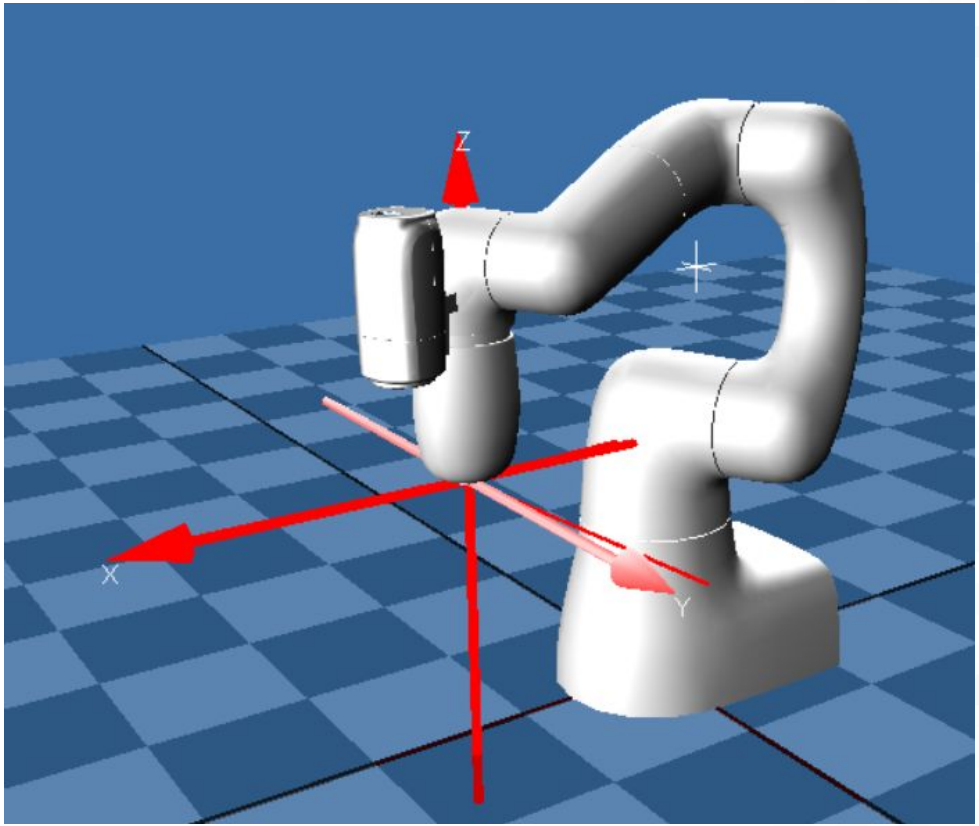


Orientation Calculation

- 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

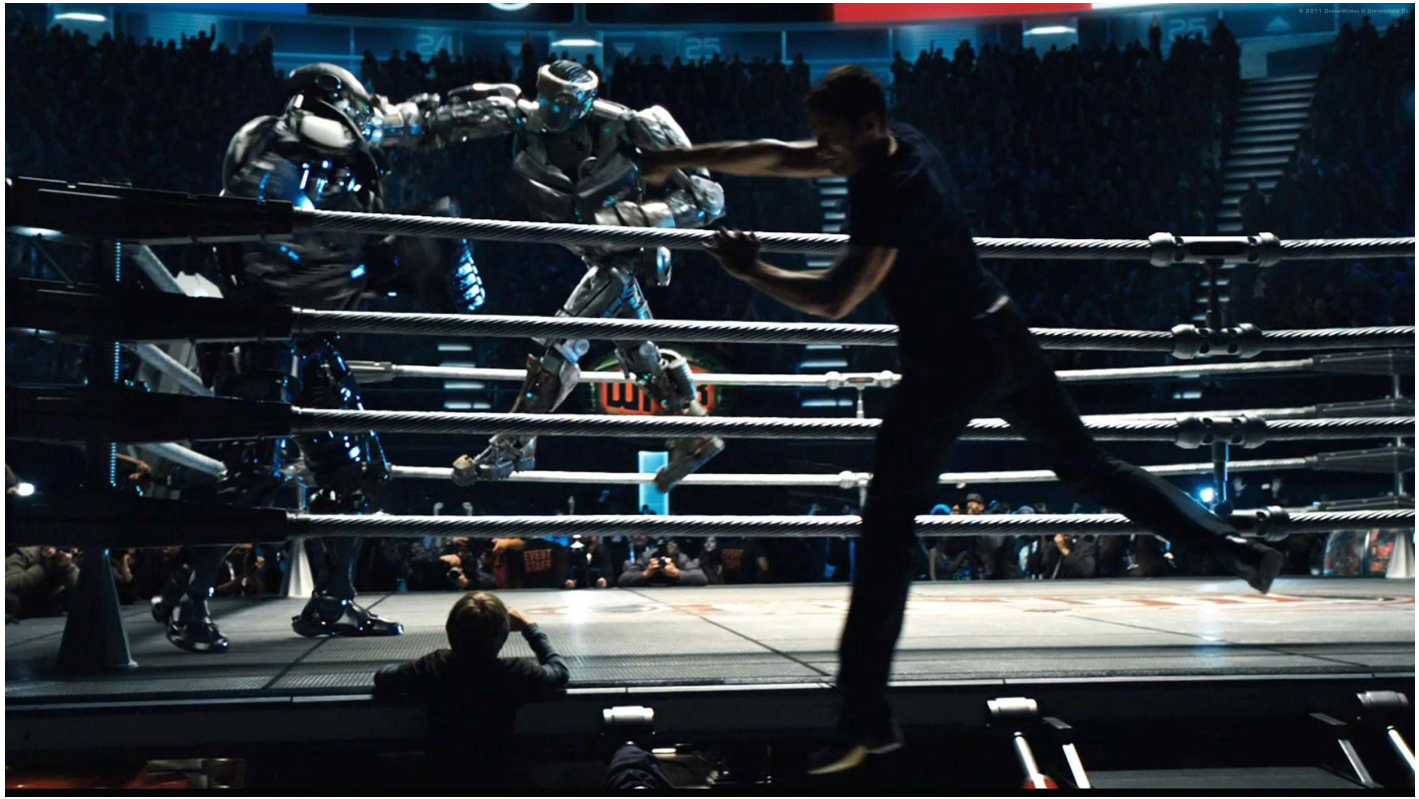
- Maps the camera's 2D coordinates space to the robotic arm's 3D coordinates space.



AI in Robotics

Humanoid Robots

Robotics Application 3: Humanoid Robots



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

Robotics Application 3: Humanoid Robots

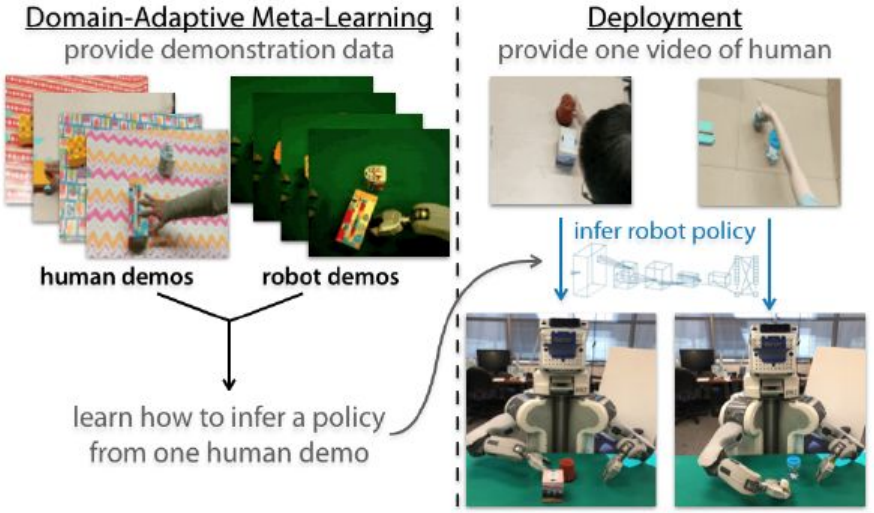
Source: https://www.youtube.com/watch?v=s9aIuPSvXX8

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.