Topic : Toyota Wants to Put a Robot Friend in Every Home

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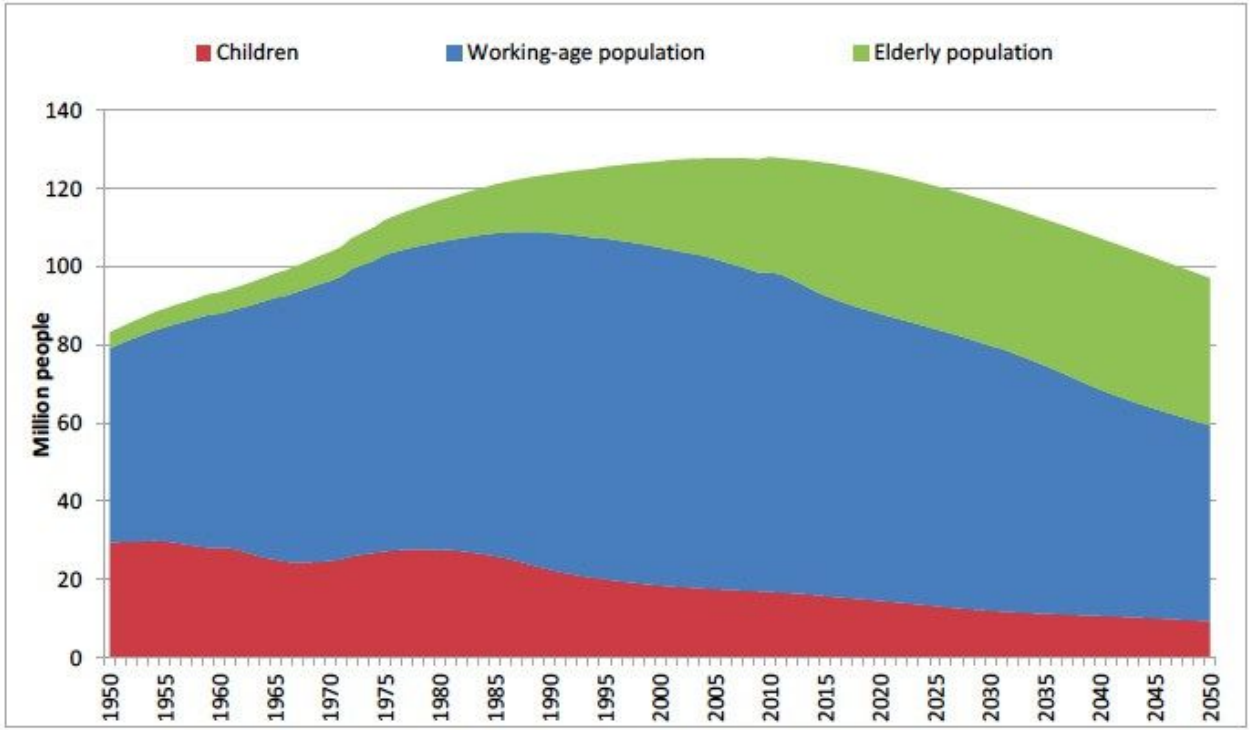
Aging Issue in Japan

- Japan is facing low birth rate challenges
- The population has been aging and shrinking ever since 2010.
- According to statistics, the elderly population is estimated to be 35.57 million, 28.1 % of the total population.
- In the article, Toyota sees robots to be able to transcend the factory, become commonplace in home, and even offering companionship in the future.

Figure 1.1. Japanese population and age structure, 1950-2050



Source: OECD Historical Population Data and Projections (1950-2050).

Toyota’s Intention & Successful Research on Humanoid Robot

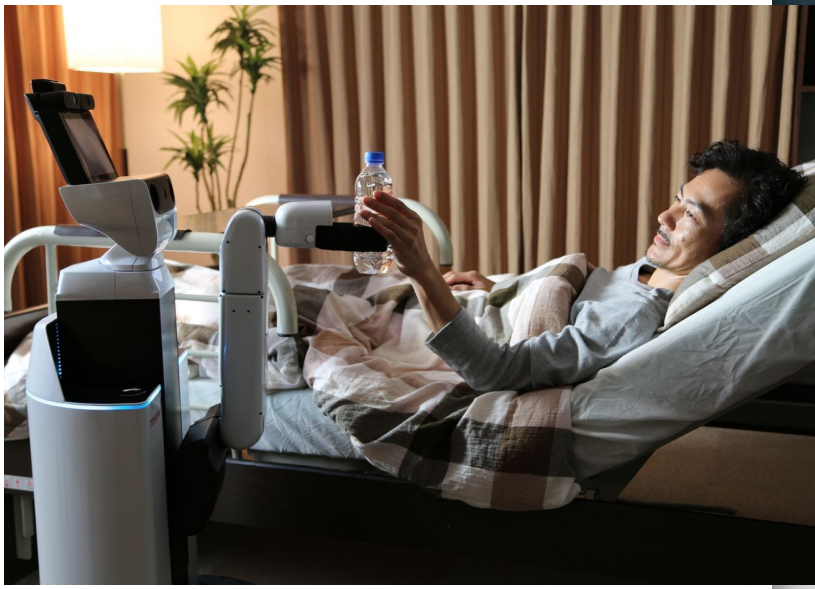
- Toyota intends to invent a robot that is capable to help with the household tasks
  - Loading a washing machine
  - Carry groceries
- In 2004, Toyota created a robot that could play a trumpet during an actual performance with an orchestra.
- The robot is designed with artificial lips, lungs, and fingers.

Toyota’s Other Successful Research on Humanoid Robot

- Toyota newest android, T-HR3
- The robot can be controlled by the users through vision goggles and wearable controls.
- Users are able to see images that are passed through the robot’s eyes.
- Intend to serve as lifesaver when it comes to searching in dangerous disaster area.

Toyota’s Other Successful Research on Humanoid Robot

- Toyota’s Human Support Robot, HSR
- Composed with a retractable arm, a screen on top and two large cameras which are able to recognize the face of a human
- The weight of the robot is estimately about six bowling balls.
- The robot is able to lift and carry objects that are about 1.2 kilogram which is about a medium-sized water bottle.

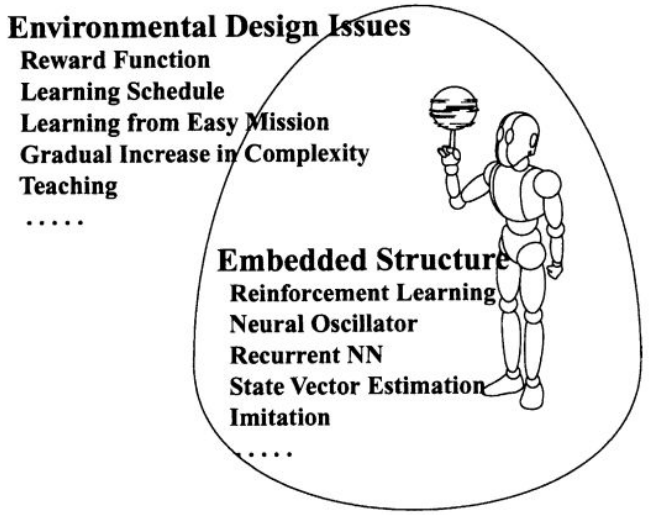


Research on Cognitive Developmental Robotics (CDS)

- Household robots that are available on the market are still different from the ideal robot that are capable to think critically and understand human emotions.
- Example : robotic vacuum, robotic lawnmower
- CDS : understand the cognitive developmental process that a robot would need and and the way to realize the process physically.
- The goal of the research is pointing out how CDS as new approach when it comes to design robots that are capable to think as a human.

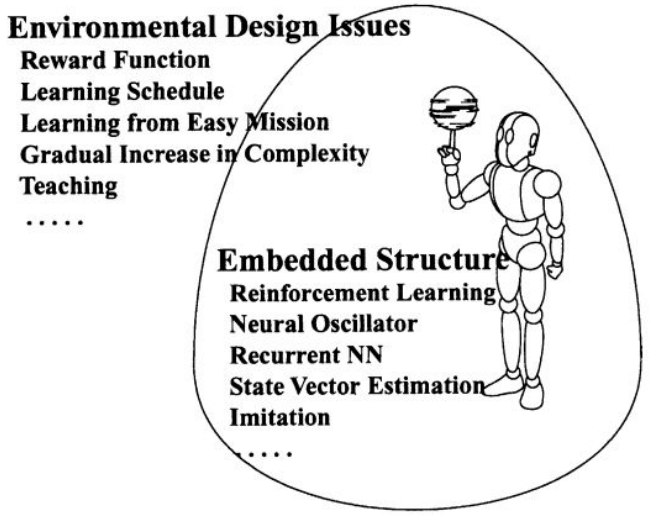
Cognitive Developmental Robotics (CDS)

- First main design component
  - Define the proper way to implement the robot's brain that allow for self-learning process
  - Reinforcement Learning
    - Rewarding for the correct behavior
    - Increase the probability of the positive actions in the future
  - To increase the speed of the learning process
    - Robot shaping
      - Introduce simple tasks first



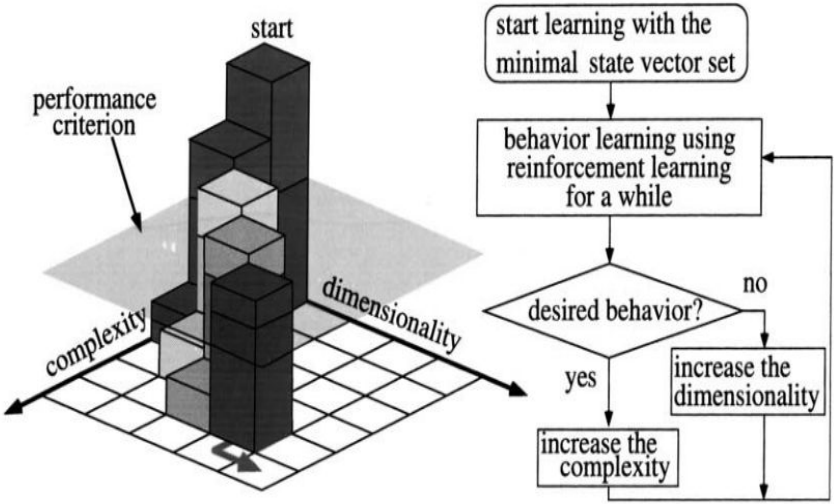
Cognitive Developmental Robotics (CDS)

- Second main design component
  - Design the proper learning environment that encourages the robot's brain to develop cognitively
  - Two different learning environments
    - Stationary environments
      - Sensing input devices
    - Environments that involve passive agents.
      - Moving or still
      - Example, interact with a ball



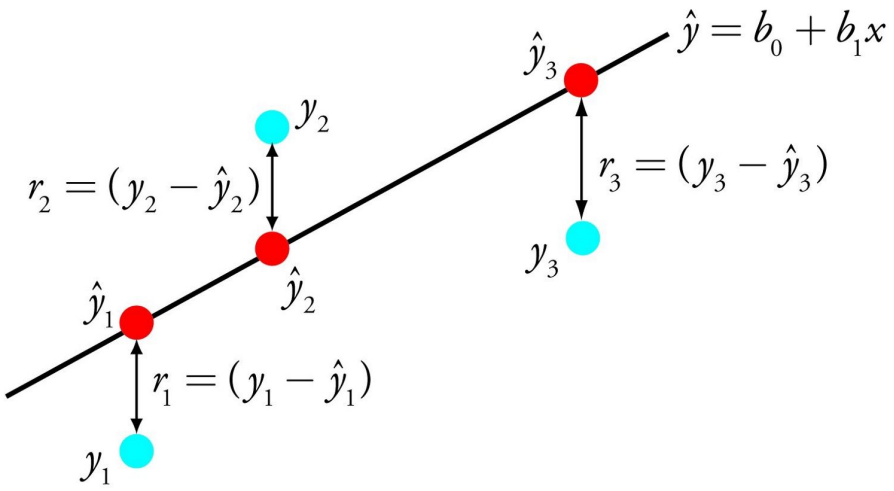
Relation between Robot's Brain & Learning Environment

- Researchers from Osaka University points out an algorithm that relate both of the factors
- Layout of the algorithm
  - Allow the robot to learn with small set of input
  - If outputs are desired behavior, then increase the level of complexity.
  - If outputs are not desired, the level of dimensionality will be increased instead.



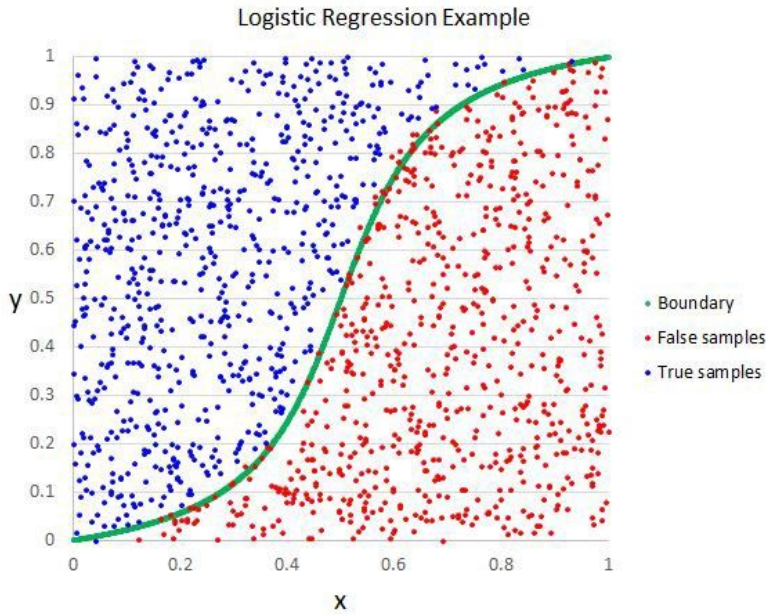
Common Algorithms for Machine Learning

- Linear regression
  - Finding the equation that mostly fit the relation between variable x (input) and variable y (output).
  - For example, Y = B0 + B1 * x
  - The goal is to find the values for both of the coefficients.



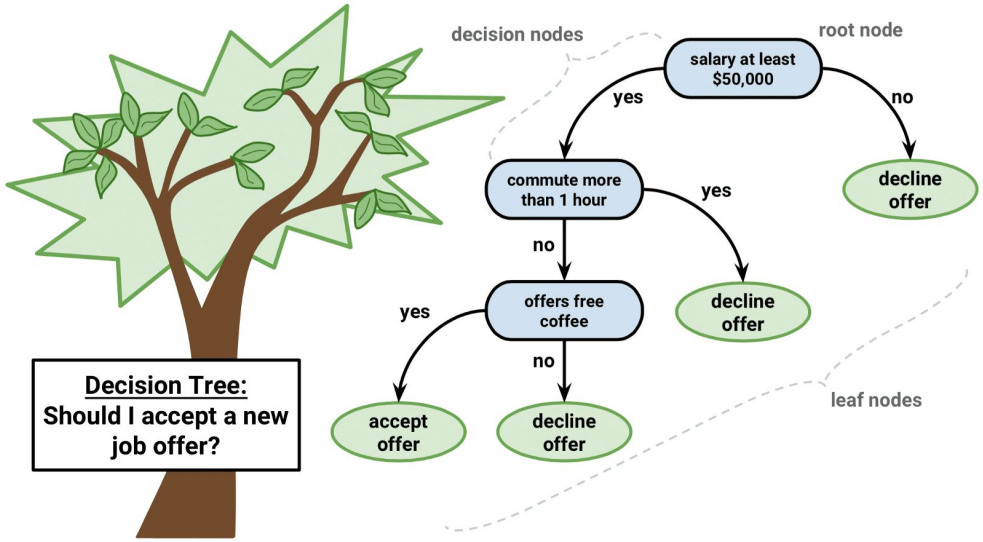
Common Algorithms for Machine Learning

- Logistic regression
  - Binary classification problem(two class values)
  - Goal is to find values for coefficients that correspond to the weight of each input variable.
  - Transform any value into the range 0 to 1.
  - Useful because it is a fast model.



Common Algorithms for Machine Learning

- Classification and Regression Trees
  - Binary tree
  - Each node refers to a single input variable (x)
  - A split point locate on each variable
  - An output variable (y) that store the predictions outcome
  - Fast to make predictions since not require preparation for the data.

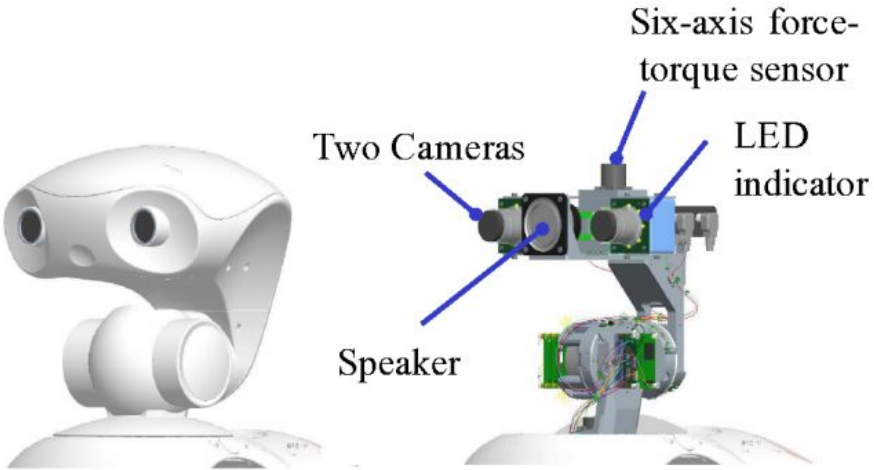


Human Support Robot TWENDY-ONE

- Invented at the Sugano Laboratory at Waseda University back in 2007
- Intended to provide support for elderly and disabled people
- Functions
  - Providing assistance when the user need help for their motion
  - Providing support in the kitchen
    - Carry a tray with food on it
    - Assist of making breakfast with the use of kitchen tools.

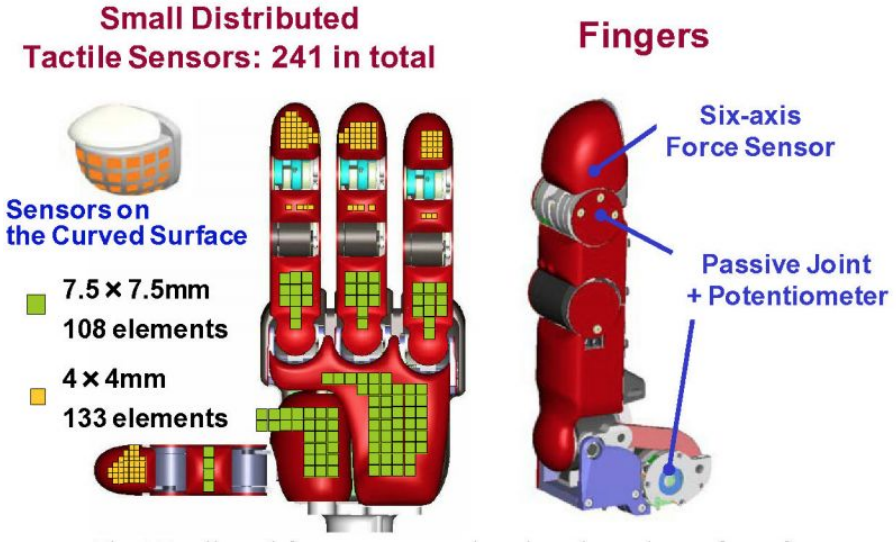
Structure of TWENDY-ONE

- Head Part
  - Three degrees of freedom
    - Roll and tilt
  - Two cameras that are surrounded by LED lights
  - Six-axis force sensor installed on the head part



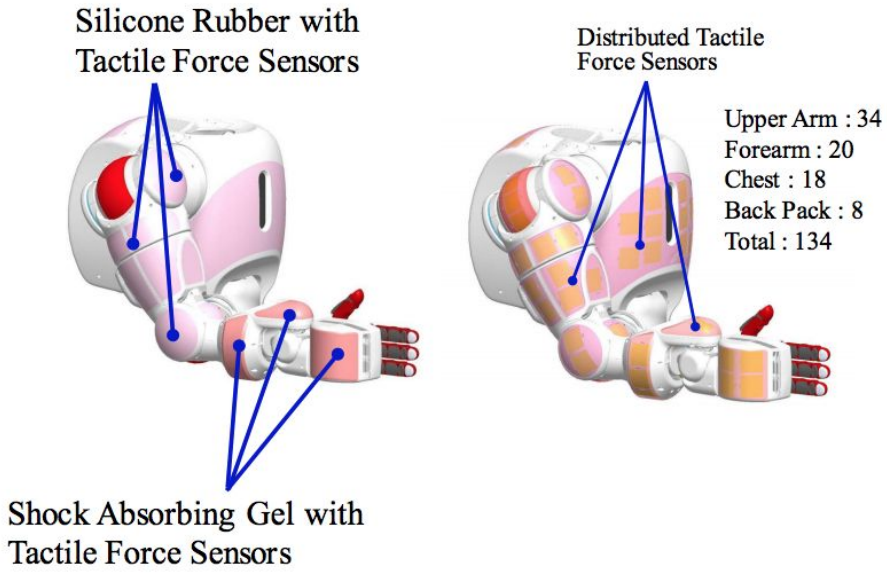
Structure of TWENDY-ONE

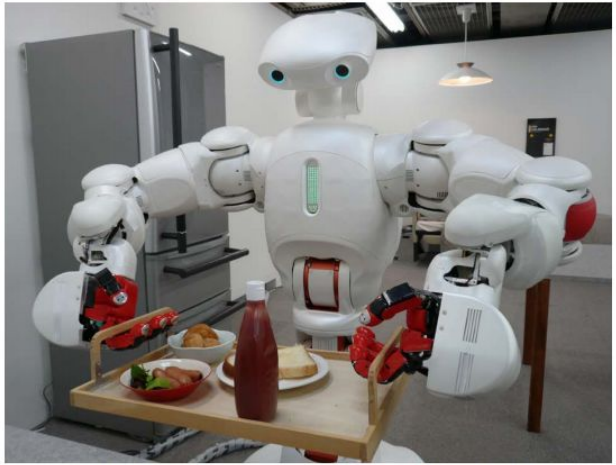
- Hands
  - Four fingers and same degrees of freedom as human fingers
  - Six axis force sensor, distributed force sensors are installed
    - Able to grab and handle objects that have complicated shapes.



Structure of TWENDY-ONE

- Arms
  - Shoulder and elbow have 4 degrees of freedom
  - Covered with silicon materials that allow for shock absorbing during the interactions with the user or environments.





Toyota’s Setbacks on Humanoid Robot

- In 2011, Toyota has invented a machine that could lift patients in and out of bed.
- The machine is intended to help lifting elderly or patients out from bed during check-ups at hospital.
- The engineers only test on healthy volunteers.
- Therefore, the machine need to be on hold since patients require a more delicate touch during treatment.

Issues with Robots

- Physical problem and challenges
  - The more capabilities of the robot can handle, it also increase the weight of the robots as well.
  - Becomes more dangerous.
  - Applying robots into the medical field still require a longer testing period in order to avoid accidents or error.
  - For example, allow a surgeon to supervise a set of robots to perform surgeries on patients.

Issues with Robots

- Ethical Side of Discussion
  - Human no longer takes responsibility for failures
  - Robots take up jobs which then cause unemployment and deskilling of the workforce
  - Using AI in unethical ways
  - AI gradually reduce human freedom

Personal Thoughts

- Keep updating ourselves up with the high-level concept, such as fundamental concepts and algorithms
- The difference between humans and robots : creativity.
  - The most unique and important part in human species
  - Keep improving creativity to make us stand out
- Broaden our view of intelligence and focus on the skills that make us different from machines, such as communication, health care, justice, etc.

Sources

- https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5152702
- https://towardsdatascience.com/a-tour-of-the-top-10-algorithms-for-machine-learning-newbies-dde4edffae11
- https://www.bloomberg.com/news/articles/2018-12-26/toyota-wants-to-put-a-robot-in-every-home-and-make-it-your-pal
- https://www.sciencedirect.com/science/article/pii/S0921889001001579
- https://www.forbes.com/sites/japan/2018/11/12/why-japans-aging-population-is-an-investment-opportunity/#5a5037e2288d
- https://www.vox.com/2016/4/13/11421162/japan-oecd-chart
- https://commons.wikimedia.org/wiki/File:Toyota_Robot_at_Toyota_Kaikan_f.jpg