Iteration 1

Individual assignment 1

Originally Alan Turing postulated in his 1950 paper, that a machine that could interaction with human without human knowing that it is a machine could be identify as an intelligent machine and can win the imitation game. In 1956, the American computer scientist John McCarthy organized the first Dartmouth Conference, at which the term Artificial Intelligence was first used. Researcher Allen Newell and Herbert Simon were instrumental in promoting AI as a field of computer science that later would revolutionize the world of Technology. [1]

In 1956, the Dartmouth Research Project on AI defined AI as the problem of *making a machine behave in ways that would be called intelligent if a human were so behaving*. [2]

In 1968 in his thesis, Marvin Minsky, a pioneering mathematician, cognitive scientist, and computer engineer, and a father of the field of artificial intelligence considered AI as *the science of making machines do things that would require intelligence if done by men*. [3]

The theory of multiple intelligences differentiates intelligence into specific 'modalities', rather than seeing intelligence as dominated by a single general ability. Howard Gardner proposed this model in his 1983 book Frames of Mind: The Theory of Multiple Intelligences. According to Gardner, an intelligence must fulfil eight criteria: musical-rhythmic, visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinaesthetic, interpersonal, intrapersonal, and naturalistic. He later suggested that existential and moral intelligence may also be worthy of inclusion. [4]

I would define AI as a combination of given three definitions above, as Howard Gardner proposed that an AI should perform in all eight criteria in independently that imply definition of J. McCarthy and Minskys definition that an artificial agent display intelligence that are distinctly human and that beat an imitation game or pass the turing-test for an AI, where a human that cannot distinguish that the intelligent agent is human or a non-human being.

Definition of AI

A machine that can mimic human attribute in completing tasks that are undistinguishable from a human.

This definition characterizes machines abilities to adopt human behaviours which would server purpose in our development. That is there would be no desire to build a machine that cannot adopt human behaviours. An ultimate goal for an AI would be achieve human-level intelligent, which require ultimately that it can express all eight criteria of H. Gardner and aware of its existence and reinforce knowledge.

Amazon is an online retail giant offers both consumer and business-oriented AI products and services and many of its professional AI services are built on consumer products. Amazon Echo brings artificial intelligence into the home through the intelligent voice server, Alexa. For AWS, the company has three primary services: Lex, a business version of Alexa, Polly, which turns text to speech, and Recognition, an image recognition service. [5]

A boys best Friend by Issac Assimov, is a science fiction short story published in 1975. This story is set far in the future when habitation of the Moon has already taken place. Jimmy Anderson is a Moon-born ten-year-old, and he owns a robotic dog named Robutt, whom he comes to love. He can go on the moon freely and securely as he is moon born and has Robutt with him. However, his parents want him to have a real dog, a Scottish Terrier. Since Moon-borns cannot visit Earth, his parents bring the dog to the Moon. But since the relationship between Jimmy and Robutt is so close, Jimmy decides not to have the 'living' dog and keep the 'fake' dog Robutt instead. [6]

The word Robot is not an original English word, it was first coined by a brilliant Czech playwright, novelist and journalist named Karel Čapek (1880-1938) who introduced it in his 1920 hit play, *R.U.R.*, or *Rossum's Universal Robots.* [7] *Robot* is originally from an old Church Slavonic word, *robota*, for "servitude," "forced labor" or "drudgery." The word, which also has cognates in German, Russian, Polish and Czech, was a product of the central European system of serfdom by which a tenant's rent was paid for in forced labor or service.

R.U.R. takes inspiration from other known literary accounts of scientifically created like Mary Shelley's classic Frankenstein and the Yiddish-Czech legend The Golem. *R.U.R*., or *Rossum's Universal Robots* about a company using latest technologies in biology, chemistry and physiology to mass produce workers who are non-human being as Karel described in the book entities "lack nothing but a soul". [7]

In the play the robots able to perform all the works that humans generally not preferred as a result the fictional robot-company is inundated with orders. In early drafts of his play, Čapek named these creatures *labori*, after the Latinat root for *labor*, but later suggested by his brother, Josef, Čapek he changed it *roboti*, or in English, *robots*. [7]

In the play's final act, the robots revolt against their human creators. After killing most of the humans living on the planet, the robots realize they need humans because none of them had the knowledge of manufacture more robots, a secret that they didn't possessed and died with the last human being. In the end, there is a *deus ex machina* moment, when two robots somehow acquire the human traits of love and compassion and go off into the sunset to make the world anew. [7]

A robot can be defined as a programmable, self-controlled device consisting of electronic, electrical, or mechanical units. More generally, it is a machine that functions in place of a living agent. [8]

In this definition a robot defined as a mechanical component that can operate in place of human agents and thus carry out functionalities that usually required human presents and eventually replace human workers.

Even though, definition do not specifies a given robot physical appearances or described with human's physical attributes but characterized as performed at same level as humans with higher mechanical endurance in similar functional manner perhaps with different physical attributes. At the same time follows a given set of instructions without any form of external supervision and guidance.

A robot is an autonomous machine capable of sensing its environment, carrying out computations to make decisions, and performing actions in the real world. [9]

Above definition describes more of an autonomous unit more interactive with its environments. Like as it describes by the author, think of the Roomba robotic vacuum. It uses sensors to autonomously drive around a room, going around furniture and avoiding stairs.

it carries out computations to make sure it covers the entire room and deciding based on predefined logical-instruction sets if a spot needs a more thorough cleaning; and it performs an action by "sucking dirt," as roboticist Rodney Brooks, one of the Roomba creators, explains. [9]

Definition of Robot

A robot is a mechanically designed component to perform one or more tasks based on predefined instructions and perform repetitively without human supervision and guidance.

This definition suggests a Robot can perform given set of instruction and continuously perform assigned tasks without any human or other external supervision or guidance. A typical example of this would be industrial robot, generally heavy rigid devices limited to manufacturing. That has a routines and instructions given to it that focuses on one specific task involving such as assemble a car-door in a car manufacturing company or assembling any component of a vehicle, and its only goal is manufacture as much as possible.

Another advance semi-autonomic example that is going to imply involving cars is self-driving car in near future, likes of Tesla. That can read and adjust its driving patterns on the road and calculate its rout without any human interventions or supervision. Like Tesla vehicles today have this type self-driving routines but the requirements are human-driver should have its hands on the cars steering wheels at all time, but in next two or three as Tesla plans that would be obsolete.

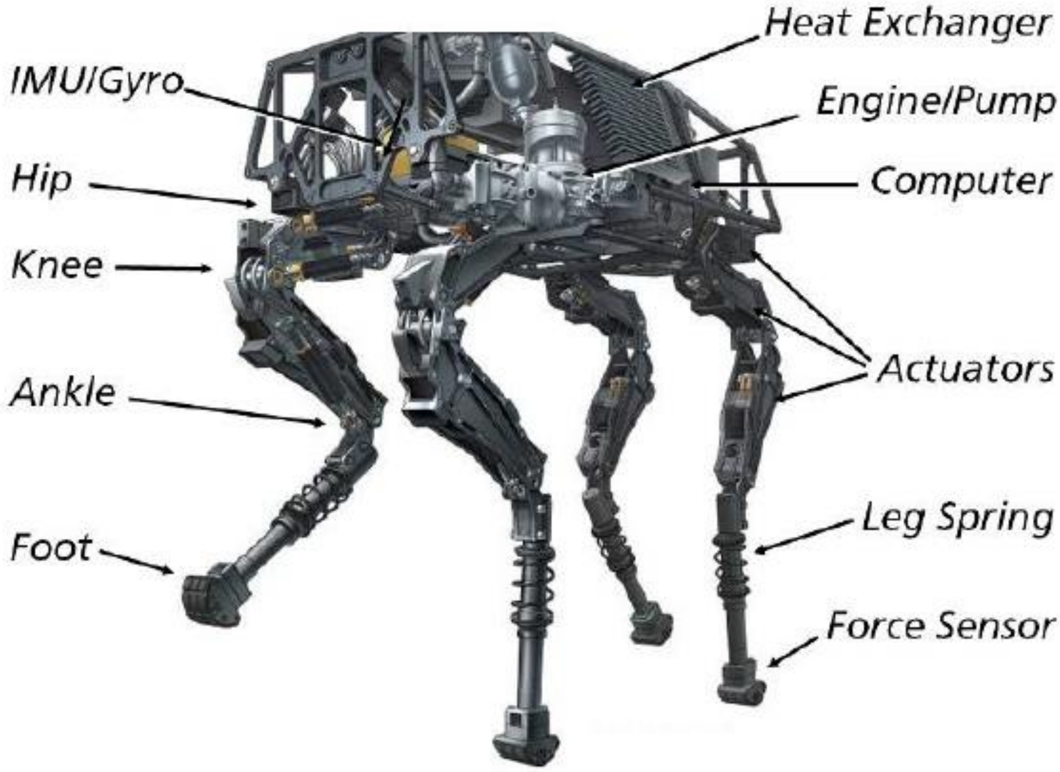
Relation and difference between AI and a Robot, as discussed above section an AI and Robot in general specified in different characterizations, like an AI expected to be self-learned and operate based on experiences, i.e. showcases human learning mechanisms that is believed to be a natural phenomenon. As H. Gardner's eight human attributes and all them leads to the term we human define ourselves dearly is "Creativity", that we human are uniquely creative and separate our self thus from rest of the animal kingdom.

The requirement for an AI to show this peculiarity is signs of intelligence, ergo mimicking human quality. This unique requirement does not automatically apply to any robots because we do not have similar expectation from an industrial robot as we do to an AI. We expect an industrial robot to perform a routine or a set of routines to do continuously perform over longer period of time. Then again we expect a self-driving car to have more human type of common-senses and travel from point a to b. So we can mount an AI on a robot and ask for to be more independent but technical distinctions between AI and Robot are lots.

This section was retrived from Bigdog article from Boston dynamic [10]

Boston Dynamics developed a new breed of rough-terrain robots that capture the mobility, autonomy and speed of living creatures. Such robots will travel in outdoor terrain that is too steep, rutted, rocky, wet, muddy, and snowy for conventional vehicles. They will travel in cities and homes, doing chores and providing care, where steps, stairways and household clutter limit the utility of wheeled vehicles. Robots meeting these goals will have terrain sensors, sophisticated computing and power systems, advanced actuators and dynamic controls.

BigDog is a legged robot is still under development at Boston Dynamics, with funding from DARPA. BigDog has onboard systems that provide power, actuation, sensing, controls and communications. The power supply is a water-cooled two-stroke internal combustion engine that delivers about 15 hp. The engine drives a hydraulic pump which delivers high-pressure hydraulic oil through a system of filters, manifolds, accumulators and other plumbing to the robot's leg actuators. The actuators are low-friction hydraulic cylinders regulated by two-stage aerospace-quality servovalves. Each actuator has sensors for joint position and force. Each leg has 4 hydraulic actuators that power the joints, as well as a 5th passive degree of freedom. A heat-exchanger mounted on BigDog's body cools the hydraulic oil and a radiator cools the engine for sustained operation. See Figure 1 for details



Figur-1 from Boston dynamics [10]

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BigDog has about 50 sensors. Inertial sensors measure the attitude and acceleration of the body, while joint sensors measure motion and force of the actuators working at the joints The onboard computer performs both low-level and highlevel control functions. BigDog has a variety of locomotion behaviors. It can stand up, squat down, walk with a crawling gait that lifts just one leg at a time, walk with a trotting gait that lifts diagonal legs in pairs. Travel speed for the crawl is about 0.2 m/s, for the trot is about 1.6 m/s (3.5 mph), for the running trot is about 2 m/s (4.4 mph) and BigDog briefly exceeded 3.1 m/s (7 mph) while bounding in the laboratory. BigDog weighs about 109 kg (240 lbs), is about 1 meter tall, 1.1 meters long, and 0.3 m wide.

BigDog is usually driven by a human operator who works through an operator control unit (OCU) that communicates with the robot via IP radios. The operator uses the OCU to provide high-level steering and speed input to guide the robot along its path and to control the speed of travel. The operator can also tell the robot to start or stop its engine, stand up, squat down, walk, trot, or jog. A visual display provides the

operator operational and engineering data. The operator only provides high-level input, leaving BigDog's onboard control system to operate the legs, provide stability on rough terrain, and reflex responses to external disturbances.

Universal Design (UD) is an approach to design that increases the potential for developing a better quality of life for a wide range of individuals. It is a design process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation. [11]

It creates products, systems, and environments to be as usable as possible by as many people as possible regardless of age, ability or situation. Other terms for Universal Design used around the world include Design for All, Inclusive Design, and Barrier-Free Design. [11]

Defining inclusive with respect to UD, Inclusive design doesn’t mean you’re designing one thing for all people. You’re designing a diversity of ways to participate so that everyone has a sense of belonging (Susan Goltsman [12]). Inclusive design should always start with a solid understanding of accessibility fundamentals. Accessibility criteria are the foundation of integrity for any inclusive solution.

Facial expressions can give us insight into a person's emotions, an AI that can understand people in the same way that humans do, based on an understanding of not only facial expressions, but the other channels people use to express emotions, including face, voice, and gestures. Only 7 percent of how people communicate their emotions is via words—the rest is non-verbal.

Human Perception AI will enable cars to optimize the ride based on who is in the vehicle, their mood, and how they are interacting with others in the vehicle. Tesla working on HCI system that based on human car interaction done through facial recognition. This would primarily guide the car to follow its human driver its facial and body-reactions. Tesla creating it background of drivers sleeping behind steering wheel while driving the car or instances of drunk driving, where vehicles self-driving mode automatically initialises takes over whenever car detects this pattern of behaviour through facial recognition.

Excluding pattern in AI based on faulty data, like an AI can take make a decision based on a person's ethnicity. In a fictive situation where a person with darker skin tone is a student at a school that uses facial recognition software. The school uses it to access the building and online homework assignments. In this hypothetical situation let's say creator of this software only used people with light-skinned tester to test the software and train its algorithm and initial-stage of software deployment only data this software had are based on light-skinned people. If your skin is darker, and the software has trouble recognizing you. Which automatically cause faulty in the data, such as sometimes you're late to class, or can't get your assignments on time. Your grades suffer. The result is discrimination based solely on skin colour. [13]

Iteration 2

Characteristics of AI-infused systems

Main characteristics of AI-infused systems

- Learning
- Improving
- BlackBox
- Fueled by large data sets

General machine learning (Classical Learning overview)

Learning and improvement process in an AI learning process mainly involved in general machine learning approach that is a system make an action base on learned background that based on large dataset.

Machine learning is a subfield of study in artificial intelligence that enable machines to learn autonomously without explicitly programmed.

In 1959, Arthur Samuel defined ML as [1],

"Field of study that gives computers the capability to learn without being explicitly programmed."

ML, provides machines the ability to learn based on experiences, observations and analysing patterns in the given data. Its goal is to understand and follow the instructions based on the algorithms to perform the task automatically without any human interventions. The basic premise in ML is to build algorithms that can receive input data using statistical analysis to output more accurate, in predicting outcomes.

A typical example of ML Black-Box

A well-defined ML as follows [2] [2]:

A machines is said to be learning from **Experience** (E) with respect to **Task** (T) and **Performance** metrics P, if it performance at tasks in T, as measured by P and improves with experience E.

Then, $$E * T = P$$

Based on **Experience** E is placed against **Task** T for improvements, and measured by **Performance** metrics P.

Experience: Input data	Task	= Performance
Emails	Spam detection	Block unwanted emails

Images	Categorize and recognize images	Organize images
Transactional data	Segment user data	User classifying

Example: Playing Go

T = Playing Go

E = Gaining experience by playing practice games of GO

P = the probability of winning a game against an arbitrary opponent

Data collection

However as described in (*Guidelines for Human-AI Interaction*)[1], that an AI infused system may react differently depending on dataset continuously evolving and changing overtime, and these inconsistencies and unpredictably might confuse users, erode their confidence and lead to abandonment of an AI technology.

In typical ML process, to prepare data for machine learning initiatives one can accelerate machine learning projects to deliver an immersive business consumer experience that accelerates and automates the data-to-insight pipeline by following varies critical steps, such as standard data collection, profiling and splitting data into training and evaluation sets. This is done through streamline data from different source system that could an application portal via database or web-services.

A typical example that might reflect characteristics that given above in an AI-Infused system is voice recognition by virtual assistant like SIRI or Amazon Alexa. For example, if we set our IPhone any handheld devices in a language that is other than English or set to English but the user is non English speaker.

Then it becomes obvious that virtual assistant struggles voice recognition imbalance in the AI system. This problem is well-known in interaction with people with disabilities, it has been proven that Google speech recognition system does not work well for people who are deaf and hard of hearing.

This is a typical scenario, where system pre-learned on data that cannot handle real live issues. Where dataset that system has been trained on tackle a standard scenario but did not included in the data model set.

Take for example, SIRI on Norwegian language mode and only trained on dataset based on people from eastern region of Norway where people have certain type of dialect and the system is being used in southern or western region of Norway then voice recognition would face challenges to understand the end-user. This type of problem real live consequences in users who has speech impairments where voice recognition system is a part the smart home system [5].

Human-AI interaction design

Design guideline G5 and G7, these guidelines fall into the characteristics that been used in previous task.

G5 AI design guidelines is the guideline during interaction ensures the experience is delivered in a way that users would expect, given their social and culture context. This guideline falls directly into the problem that has been described above that if voice recognition system has been trained on certain dataset and struggles to understand user who uses different type of dialect or has speech impairments then example guideline propose application guidelines such as use of semi-formal voice during interaction with the user and use word validation at the end of every dialog with further question assistants. This will make voice recognition system more durable since semi-formal voice brings AI to a human level day-to-day interaction that could lead to use of simple set word that may implicate set of instruction and validate those instructions end the of every interaction.

Disadvantage with this guideline may lead to problem with people who has speech impairment where resulting in atypical and relatively unintelligible speech in most cases. Some characterizations of these speech impairment by a slurred, nasal-sounding or breathy speech, an excessively loud or quiet speech, problems speaking in a regular rhythm, with frequent hesitations, and monotone speech. An extreme case of these speech impairment is Dysarthric (see [5] under Dysarthric Speech for VA).

G7 AI design guideline is the guideline when wrong that support efficient invocation, that is make it easy for the user to invoke or request the AI system services such that user can a particular command to initiate. In smart home system where voice recognition AI can initiate a given task just by a command or a set of commands to complete a particular task or tasks.

In this scenario where a user struggle with speech impairment could easy get to initiate task only using task command rather than use a set of dialog with the AI system, where AI could struggle to understand the end-user because deviation in voice input by the user. This type of command implementation makes the AI to sharpen to focus on a simple sentence or word rather than to process through a large string of words or character where AI has match diagnostic based on previously trained data model, which may contain inconsistency.

Simplicity in this process, a manufacture could still pre-train an AI beforehand before put in a production environment where making errors during runtime would be minimum rather than a trained AI with fully speech recognition on incomplete dataset and that requires the AI to learn over longer period of time and eventually alteration in UI input which might end up with discouraging the end-user to use the AI system altogether.

As recommended in (*Guidelines for Human-AI Interaction*)[1], that building in a safeguards like verification steps or controlling levels of autonomy to help prevent unwanted adaptations or action from intelligent systems. Which goes back to inconsistencies and unpredictability in using an AI-infused system where user had to struggle to adapt as well how AI evolving over time.

Chatbot / conversational user interfaces

In luger and Sellen (2016) key challenges revolves around the human and machine reliance, that is interaction mostly becomes who the users are and their prior background. In luger and Sellen user profile was most dominating aspect whether a user would be effective in using a AI conversional agent (CA). In some instance where they show a cultural implication that motivates the users trust in AI to completing a task rather than make trust-decision solely based on the AI capabilities. So challenges are very dynamic some part of it based on user and machine interaction evolves over time, in some cases in good direction and in some otherwise. Challenges that have been presented in Luger and Sellen are some of the same problems we have discussed in the previous sections.

Some of the key challenges that have been mentioned are:

Uncertainties in system capabilities, such as how competent is the CA system, which lead user to believe that some interaction to complete certain tasks limited and could have been done more efficiently if they knew intelligence limit of the CA system. The other side of this problem was users did not know if the system has learned from their interactions over time, that might imply if the CA has altered its capabilities.

Users wanted some form of validation from the CA system such as learned or know, or this could initiate as a learning process for the CA as user by themselves could initiate learn command to the AI to learn from the interaction or build up its knowledge base for future interaction where AI could automatically make suggestions to the users. Basically, what users were recommending are system feedback loop where user can personalize the CA system based on their preferences.

Assessing system intelligence, In terms of perceptions of CA intelligence, This resulted in the majority of users being unsure as to the interaction dynamic; is the computer learning to adapt to the user or visa versa. However, for those with lower levels of technical knowledge, a combination of (a) the system's failure to learn/adapt to either their accents or the ways in which their questions were posed, and (b) its tendency to resort to web search, led them to frame the CA as simply a voice-based search engine extension. These lead many users to believe that a CA system is just a voice recognition system that convert speeches into word string and uses web search engine to only look up the information that has been queried but not making an intelligent decision based on the commands.

Users expected the CA to be able to infer, from all previous interactions, the context of the current task. In particular, once an interaction/task was complete, the majority of users expected the CA to remember the context of the preceding interaction. Equally, more positive ‘conversational’ experiences were reported when the CA was perceived to have understood the context of use, for example knowing that reading a message would likely lead to the user wanting to reply.

AI design Guidelines G1, make clear what the system can do. Help the user understand what the AI system is capable of doing. This guideline preciously tackles the problem of systems capabilities that is present all the metrics it tracks and present it to the users. Metrics that involves data it has been tracking over time by interaction and previous choices that have been made by the users categorised by application or search commands and results.

AI design Guidelines G2, make clear how well the system can do what it can do. Help the user understand how often the AI system may make mistakes. As it mentioned in assessing system intelligence where users expect system to come up with suggestion based on user preferences that AI can infer suggestions based on previous choices.

Iteration 3

Collaboration and levels of automation

Philips at al. (2016) give a taxonomy and examples of human robots collaboration. Pages 2-4

In this section we following biomimicry for design and categorizing different levels of interactions for human-robot's collaboration. It may help to use existing human-animal teams as a guide for modelling less complex teammate relationships.

Taxonomy:

Human-robot teams

Task interdependence: Task interdependencies define how team members depends on each other to perform a task. We can further classify this collaboration into:

Initiated or received interdependencies, these are sequential or reciprocal interdependencies, which relates to if task interdependence initiated by a unit of jobs and conversely a received task interdependence is determined by the degree to which on job is directly affected by the progression of work from another jobs. Example: For instance, a human–canine narcotics search team is a team with high task interdependence, characterized by a reciprocal work flow, and both high received and initiated interdependence, this example is from (Elizabeth K Phillips 2012). This characterization has same features as DARPAS micro air vehicle or in short MAV, this small crafts helps soldier on the battle ground with IEDs and etc. A MAV AI system takes input tasks from its operator and feedbacks information back to its operator for further handling action just as the human team member generally guides the dog through a search area, relying on the dog's superior smell-sense to perform the search. The dog depends on its human handler for direction and guidance, and alerts the handler when it detected something. When search has completed human–canine team moves to a different search area to begin the process again.

Mix task interdependence, an example of a mixed interdependence from (Elizabeth K Phillips 2012) team is a human-dolphin mine clearance team. Because human physical limitations, the human team member gives outputs in the form of commands. The interaction between members of this team is more sequential in nature. Human member of the team provides the dolphin with instruction, navigations plan, locating. Finding and marking mines is carried sole out by the dolphin alone. As such, outputs provided to the human teammate include navigational guidance to and location of undersea mines and other obstacles that may be hazardous to military and civilian boating traffic.

Verbal and non-verbal communication:

Team communication is relying on interaction and planning within a team and is a collaboration process between members for development of shared or combined mental models within the group. Common forms of communication or collaboration in human–animal teams involve auditory and visual communication styles, such as verbal commands and body language. Human–animal teams that use verbal and non-verbal communication are in horse racing, dog obedience trials, and hunting games. This is highly used practice for human–horse sporting teams in which the human team member uses both verbal commands as well as non-verbal communication such as body posture and pressure. (Elizabeth K Phillips 2012). In the robot world, we have example of Minerva: a second generation museum tour guide robot can guide tourist and only relies on verbal as input to communicate with people.

Time/space Complexities

The time-space taxonomy divides human-robot interaction into four categories based on whether the humans and robots are using computing systems at the same time (synchronous) or different times (asynchronous) and while in the same place (collocated) or in different places (non-collocated) (Holly A. Yanco 2002).

Robots such as the Mars Rover fall into the category of asynchronous and non-collocated because they are largely autonomous and are located remote from their team of human controllers.

Assistive robots, such as a robotic wheelchair, operate in a synchronous and collocated fashion as they are intended to help a person live better in his or her environment.

Choose 2-3 examples, describe their levels of autonomy as described in (Endsley, 2004; chapter 10.5.2), and reflect on advantages and disadvantages if we decrease/increase their current level of autonomy. Pages 2-4

Robots such as the Mars Rover fall into the category of asynchronous and non-collocated because they are largely autonomous and are located remote from their team of human controllers. These autonomies are levels of supervisory control, management by exception given in (Elizabeth K Phillips 2012). In this case advantage would good if robot is fully automated in which case it is in some form. Where this robot is disconnected over longer period of time due difference in earth and mars orbit around the sun but it would be more efficient if Martian rovers were fully automated and worked on their own. Disadvantage would be if some system failure that requires human handler input for troubling shooting and the rover is disconnected earths communication over longer period would create hazardous for the rover due climate and natural disasters on Martian surface.

Assistive robots, such as a robotic wheelchair, operate in a synchronous and collocated fashion as they are intended to help a person live better in his or her environment. This has level of autonomy as decision support by (Elizabeth K Phillips 2012). An example given, in (Holly A. Yanco 2002) where autonomy and intervention measured between user and the AI system. Like Wheelesley robotic wheelchair system takes control over low-level navigation tasks, as path centering and obstacle avoidance in indoor and outdoor environments, while the wheelchair's user was responsible for the high-level directional commands. This wheelchair system would be classified AUTONOMY=75% and INTERVENTION=25% and if we change the measure of autonomy and intervention where intervention goes up by the user then input to the system would suddenly increase enormously and this could lead to disadvantage to a wheelchair user for obvious reasons.

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