Deep learning

This is a form of machine learning uses both supervised and unsupervised and subset of machine learning and AI. It uses the method of artificial neural network (ANN) with representation learning. ANN is inspired by the human brain neural network system whether human brain network is dynamic (Plastic) and analog at the same time the ANN is static and symbolic. It can learn, memorize, generalized and prompted modelling of biological neural system. ANNs are more effective to solve problems related to pattern recognition and matching, clustering and classification. The ANN consist of standard three layer input, output and hidden layer, the output layer can be the input layer for the next output the simple network of neural system ,if there many hidden layer are present that ANN known as Deep Neural Networks", or briefly DNN, can be successfully expert to solve difficult problems. Deep learning models yield results more quickly than standard machine learning approaches.

Example: EEG based pattern recognition which uses brain computer Interface (BCI) to control prosthetic arm, Neuroprosthesis etc.

Other artificial intelligence techniques :

Artificial Intelligence is the intelligence of machine that simulates the human intelligence which programmed in such way that it thinks and act like human. It includes; reasoning, knowledge representation, planning, learning, natural language processing, perception, the ability to move and manipulate objects and many more subjects. AI has four main components Expert systems, Heuristic problem solving, Natural Language Processing (NLP) and Vision. In human the intelligent agents like eyes, ears, and other organs act as sensors, and hands, legs, mouth, and other body parts act as per instruction known as effectors similarly the robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the effectors. A software agent has encoded bit strings as its precepts and actions. Similarity between human and artificial intelligence is shown in Table 1. AI can be divided into two categories as per its function as symbolic learning (SL) and machine learning (ML). SL is perform the functions like image processing through computer vision and understands the environment through robotics. ML computes the large amount of data to get a solution to the problem in terms of pattern recognition. Statistical machine learning embedded with speech recognition and natural language processing. Deep learning recognizes objects by computer vision through convolution neural network (CNN) and memorize past by recurrent neural network (RNN).

The methods or techniques used for the AI are classifier and prediction. Classifier is an algorithm that implements classification; the classifiers are Perceptron, Naïve Bayes, Decision trees, Logistic regression, K nearest Neighbour, AANN/DL and support vector machine . Perceptron is the basic building block of the neural network it breakdown the complex network to smaller and simpler pieces. The classifier used in the myoelectric

prosthetic hand is LDA classifier, Quadratic discriminant classifier and Multilayer perceptron neural network with linear activation functions etc. LDA (linear discriminant classifier) is a simple one that helps to reduce the dimension of the algorithm for application of neural network model. Prediction is a method to predict a pattern an output noise free data with a model from input data in hidden layer.

Examples: EMG CNN based prosthetic hand, EGG based Mind controlled prosthesis with sensory feedback, robotic arm, exoskeleton Orthosis.

Artificial intelligence in prosthetics and orthotics :

Implementation of artificial intelligence in controlling prostheses has increased drastically and thus enables the amputee to operate the prosthesis more desirably. Adaptive controlling would enable a system to perform closer to the desired output by adjusting the input with the help of a feedback system. Recently, a mind-controlled limb (type of myoelectric controlling) was introduced as the latest advancement in the artificial intelligence-aided control system. A joint project between the Pentagon and Johns Hopkins Applied Physics Laboratory (APL) has come up with a modular prosthetic limb which would be fully controlled by sensors implanted in the brain, and would even restore the sense of touch by sending electrical impulses from the limb back to the sensory cortex [25]. Chang et al. (2009) proposed a multilayer artificial neural network (ANN)-based model to discover the essential correlation between the intrinsic impaired neuromuscular activities of people with spina bifida (SB) and their extrinsic gait behaviors [26]. The application of AI in prosthetics and orthotics is divided into various subparts according to the involvement of the region that get affected i.e. Lower extremity prosthesis and Orthosis, Upper extremity Orthosis and prosthesis, and rehabilitation aids like motorized mobility devices.