# Essay Question 1 - What has enabled Machine Learning in recent years? Explain the specific advancements that have enabled Machine Learning and outline where this has been applied in industry.

With the dawn of human civilization, we have witnessed some of the tremendous changes which has in many ways defined our future in one way or the another. Scientific advancements have been the cornerstone for many of these remarkable developments. From the onset of the cyber-age, we are seeing massive groundbreaking works by the people of science which has opened and made avenues possible which were not possible earlier. In the recent years, one such area in the field of computer science, which has garnered intrest of people from all the industries has been linked straight to machine learning algorithms. It basically is based on mathematical models which enable computer systems to recognize and learn directly from patterns in data and thus helps in prediction/decision making based on it. It has became one of the most-notable trends of the 21st century. Companies have gained competative and financial advantages because of it's applications.

In 1763 Thomas Bayes came with Bayes Theoram which holds central ground in some of the approaches of machine learning (Bayes, 1763). On to 1950, Alan Turing ideas in his papers, were pointing straigt to the point whether machine can think intelligently. He conducted the Turing Test in order to prove if there responses come to as intelligent (Turing, 01 October 1950). In 1952, through the creation of Arthur Samuel we saw the arrival of first computer game which could learn as it ran in the game of checkers (Learning, n.d.). Following, Frank Rosenblatt, designed first Artificial Neural Network called Perceptron. This helped in pattern and shape recognition (Rosenblatt, 1960). 1960s, the researches on use of multilayers opened new path in neural network research. This led to feedforward and backpropagation in 1970s (timeline, n.d.).

In 1995, Tin Kam Ho from IBM released a significant paper on random decision forest, a method on ensemble learning (Ho, 1995). AT&T Bell Labs researchers Vladimir Vapnik and Corinna Cortes published influential paper on support vector machines (Cortes Vapnik, 1997). 1997, Deep Blue developed by IBM, used computing power to perform large scale searches from potential moves to select the best moves in order to beat the reigning chess champion in chess (timeline, n.d.). Sepp Hochreiter and Jurgen Schmidhuber published their work on LSTM recurrent neural network, which proved pivotal for speech recognition application using machine learning (Sepp Hochreiter, 1997).

2002 saw the release of Torch, the first open source library for machine learning. In 2006, Geoffrey Hinton coined the term 'deep learning' to describe algorithms that helped computers recognize different types of objects and text characters in pictures & videos. 2011, Google Brain was developed its deep neural network (Timeline, 2020). 2012, this year saw the publication of an influential research paper by Alex Krizhevsky, Geoffrey Hinton, and Ilya Sutskever, describing a model that can dramatically reduce the error rate in image recognition systems (Alex Krizhevsky, 2012). 2014, DeepFace by facebook was able to recognize and verify individuals on photos with accuracy as a human (Timeline, 2020).

Apart from the technological adavancements being made in the field, I believe the possibility of machine learning and deep learning being able to reach a reality more now then previously between 1950s - 1990s is because of the development of GPUs and the growth in computing powers in nutshell. Neuralnet was made leaps and bound more practical. GPUs have 200 times more processors per chip than CPUs. They are tailored to only specific use cases, where operations have to performed on vectors, which are essentially lists of numbers. CPUs perform this operation one by one whereas GPUs do it parallelly hence much higher computing (Kayid, 2018). Nvidia has been credited with the creation of the first GPU in 1999 and since then have became leader for providing hardware specific to machine learning and AI tasks (wikipedia, n.d.).

AlexNet (Alex Krizhevsky, 2012) success demonstrated the impact of GpUs.This has thus benefitted them hugely and hence has seen significant rise in their share prices. Nvidia launched tensor cores in 2017, which proved to have much more computing possible then GPUs. Google uses Tensor Processing Units for running it's main services like Search, Street, Translate.

Though, GPUs, TPUs and Tensor Cores have arrived and made the general use of the machine learning/ deep learning algorithms a possiblilty, but the cost of these equipments for everyone was always a thinking point. Small or Medium range industry hasn't been benefitted immensly because of GPUs in Cloud. Now, companies or users don't have to worry much in terms of price/cost. Thus has encouraged more innovation in this field.

On another factor which has played very critical role for the rise has been Data or more precisely Big Data. The model in machine learning or deep learning applications is as good as the data. The more the data the better learning of the machine and thus an intelligent outcome which could be as close to the best we can get. The explosion of data with the rise activity online and generation more and more data, has given the right envvironment for it to grow. Initiatives such as language translation and image, facial, activity and emotion recognition - are based on predictive analytics that get more accurate as the data behind them gets richer.

Apart from popular applications such as Speech Recognition, Facial Recognition, machine learning has found great applications in widerange of other industries. Ecommerce sectors has benefitted with recommendors systems, Content Personalization through ML for Clients, Chatbots. Whereas companies in Healthcare have used it for detection and diagnosis in case of diseases such as cancer or patient risk identification systems with Smart watches. Finance has seen system such as Fraud Detection, Credit Scoring or Money Laundering Prevention coming in place with the use of machine learning techniques (flair, n.d.).

In total it can been seen that machine learning growth has only been possible because of coming together of various aspects of computer science spectrums in place. Transition from theories to making it practical has factors like right hardware, right software and more and more people collaborating to innovate with it's techniques has thus find great applications and usage in the industries of their factors.

# Essay Question 2 – “Deep Learning is Deeply Unethical” Critically analyse the ethical considerations of applying Deep Learning to different domains in society.

Artificial Intelligence, Machine Learning and Deep Learning in this current world economy has almost proved their self worth in one way or the another. Industries from all walks of the economies be it healthcare, ecommerce, human resource or even government's public administration are swayed by their application in solving some of the most intricate and typical problems being faced through out the course by them and also in almost all the cases bettered their outcomes in terms of results required. But, that being said and seen, like everything good comes the flip side which in here, completely tarnish and also puts up questions on the practices associated with the algorithms being employed and which in turn caused series damages to the organization's reputation and puts up the series question on the ethics of deep learning/ai/ml overall and clearly asks us to seek the answer whether 'deep learning is deeply unethical'.

DL/AI/ML relies on the basically two core components, one of which is the algorithms and second being the data fetched to the algorithm to learn and make intelligent decision. The insights derieved from these models which have in time became more sophisticated and pervaisive tools for automated decision making (DeAngelius, 2014). Algorithms are harnessing macro and micro data to influence decisions affecting people in range of tasks, be it helping bank determine credit worthiness, movie recommendations (Kearns, 2018). But, there have been instances where the some algorithms run the risk of replicating and even amplifying human biases, particularly to some affected sections of societies who have faced that same bias before (Chodosh, 2018).

Amazon has to shutdown it's recruitment algorithms because of the fact that it was basically gender biased as it favored male candidates over female candidates (Hamilton, 2018). The sole reason for it was data being fed was derived from resumes submitted over past 10 years and since the company employs 60 percent male and where men hold 74 percent of the managerial positions thus the algorithms started recognizing word patterns in the resumes rather than relevant skill sets i.e. it downgraded word like 'women' in any resume (Vincent, 2018).   
Princeton University researhers analyzed DL software and found that it perceived European names as more pleasant than those of African Americans, and words like 'woman' or 'girl' was associated with arts instead of science and maths. Algorithms in here picked on the racial and gender biases previously shown by humans (Hadhazy, 2017). If this would have been used in any of the search engines then definately it would have reinforced racial and gender biased.   
MIT researhers Joy Buolamwini found that algorithms which were part of 3 commercially available facial recognition software systems failed to recognize darker-skinned complexions (Hardesty, 2018). Latanya Sweeney, a Harvard Researcher and former CTO at FTC, discovered that online search queries for African-American names were more likely to returns ads to that person from a services that renders arrest records in comparison to ad results for white (Sweeney, 2013). She also discovered the it targeted them with higher intrest credit cards (Sweeney L. a., 2014).   
ProPublica published that COMPAS(Correctional Offender Management Profiling for Alternative Sanctions) algorithm, used by judges to predict the judgment whether to detain or release a defendent was found to be biased for African Americans (Angwin, 2016).

Though the causes of it can be many but Barocas and Selbst mentioned that it can come as in any phase of project building“…whether by specifying the problem to be solved in ways that affect classes differently, failing to recognize or address statistical biases, reproducing past prejudice, or considering an insufficiently rich set of factors.” (Selbst, 2016).   
So, framing the problem where in the computer scientists zero on what the deep learning model will actually acheive. The problem here is decisions like that are made on various business reasons rahter being fairness or discrimation as explained by Solon Barocas of Cornell University. For a credit giving company if the algorithm discovered that giving subprime loans was an effective way to maximize profit, it would end up engaging in predatory behavior even if it was't company's intention.  
Also at the time of collecting the data there are two main ways bias shows up in training data; firstly the data collected is unrepresentative of reality or it might reflect existing prejudices. Like if deep learning model is fed with fetched more photos of light skinned then it will be incapable of detecting darker skinned faces.   
Second secanrios is what was the case faced by Amazon recruiting system as it was trained on historical hiring decisions and thus ended up dismissing female candidates. Bias can also be inculcated while preparing data i.e. selecting attributes which you want to consider. Like for creditworthiness, we can select attribute as customer's age, income or number of paid off loans. There is reason why we are pondering on this question as it is quite difficult to find and fix the breach in general ethics by deep learning based models.

As introduction of bias and it's impact are not visible till much later and even more difficult to fix it out to get rid of it. Like in case of Amazon even after fixing the model for the fact it was penalizing female candidates, it was soon discovered that the reprogrammed system still picking implicitly gendered words (page, 2019) The process of building deep learning models is not made with bias detection in mind thus it will fail flag skewed results from test and train data. Plus the way the problem statement is framed by computer scientist is also not mostly in sync with problems. As mentioned by Andrew Selbst Within in his research, it is considered good practice to design a system that can be used for different tasks in different contexts. “But what that does is ignore a lot of social context,” says Selbst. “You can’t have a system designed in Utah and then applied in Kentucky directly because different communities have different versions of fairness. Or you can’t have a system that you apply for ‘fair’ criminal justice results then applied to employment. How we think about fairness in those contexts is just totally different. (Selbst, 2016)”

Awareness about the aboves have raised AI researchers working hard to mitigate the issues; more rules with stricter norms about the breach of conduct have come in place or algorithms to find hidden bias. Though it is a long road but like everything else in human civilization hope we will bring things to level suited for everyone.