

“A.I Research Task”

1. List of innovations, services where A.I has been successfully applied:

1. A.I in predicting protein folding and analyze the functions associated using deep neural networks to develop new vaccines, drugs, medicines.
2. A.I in generating video of a person talking with a single static image of that person, exactly like a source/reference video of a random person talking (without stitching).
3. A.I in predicting the aesthetic value of a photos and generating highly aesthetic photos.
4. A.I in extracting structured information from business documents without detailed annotations such as checks, invoices, agreements, bonds to speed up document processing time called document intelligence.
5. A.I in generating brand new artwork in the forms of images, videos using nature of one artwork with the style of another artwork.

Some of the other innovations, services where A.I has been successfully applied are (1) A.I in 3D creation, (2) A.I in pathogen detection from medical scans/images, (3) A.I in strategic planning, marketing and promotions of a service or product., (4) A.I in generating music, (5) A.I in cloud resource allocation.

2. Brief idea on the above chosen applications of A.I:

1. A.I in prediction of protein folding and functions of associated proteins is one of the revolutionizing applications in field of science. Deep learning has also proven its efficacy in field of science by winning the CASP 14 in 2020. The application can be used in pharmaceutical research labs to develop drugs and vaccine for various viruses, diseases in less time. This application by analyzing the protein properties can help to find the folding and functions associated. The research team at Google's deep mind has published a paper with a novel architecture that predicted various proteins with an accuracy of 94 in CASP 14. The paper <https://www.nature.com/articles/s41586-021-03819-2> has all proven methods and concepts used in alphafold algorithm that participated and competed in CASP 14 with 100 other teams. The working and development of alphafold's architecture can be better understood in <https://youtu.be/gg7WjuFs8F4>.
2. A.I in generating video of a person talking with a single static image of that person, exactly like a source/reference video of a random person talking (without stitching). Deep learning has reportedly been one of the fast-evolving fields. The deep learning had earlier enabled to create video of a person talking exactly same stuff like in a source video of a random person talking by taking various video clips of target person talking and stitching together but now it is possible with just a single static image of target person to create video of that person talking same stuff of a source person in his video. The idea is better understood by an example released by the research team at <https://www.youtube.com/watch?v=l82PxsKHxYc>. This application comes under innovation using A.I and is not included in apps or websites but it's just a programmed algorithm to generate some of these wonders.
3. A.I in predicting the aesthetic value of photos. Deep learning has proven its robustness in various fields form health care to education but one of the top tasks it often fails is photo aesthetic assessment. Photo aesthetic assessment is widely used in industries such as e-commerce, matrimonial services and pet shops. These industries use the photo aesthetic assessment tools to better recommend products to their customers and users. Deep learning often fails in this task for the constraint that neural networks especially convolutional neural network architectures often input fixed image sizes for the sake of which pre-processing operations like resizing, cropping, scaling is applied. These pre-processing operations often has a natural tradeoff with the aesthetic value of image due to which deep learning models often fail at it. Some of the recent advancements and research has proposed novel operations called multi-level spatial pooling operation that resizes the image without any tradeoff with the aesthetic value. One of the best research paper that I have come across is https://www.cv-foundation.org/openaccess/content_cvpr_2016/papers/Mai_Composition-

[Preserving Deep Photo CVPR 2016 paper.pdf](#). This application comes under gap-fulfilment for a service since it has always been a gap for companies and customers in recommending good products and services like e-commerce companies has included this feature in their internal recommendation engine for user's apps, accounts.

4. A.I in extracting structured information from business documents without detailed annotations such as checks, invoices, bills, agreements, bonds. One of the time-wasting and hectic tasks for humans is to go through different documents, applications, attachments at different organizations such as banks, schools, companies. Various algorithms proposed in recent past have proven to be far better in processing documents in less time, less effort. These algorithms are widely adopted by various organizations from educational institutions to software companies to reduce their document processing time such as tech companies who are using deep learning to screen various resumes to filter out the appropriate candidates to further rounds in hiring processes. One of research paper that highly impacted the performance of these algorithms is <https://arxiv.org/abs/2103.05908>. This application comes under service requirement as its one of the highly hectic and inevitable phases in any organization.
5. A.I in generating new artwork such that the generated artwork has the nature of one popular art and style of another trendy art. One of the most sort after researches in the field of deep learning is creating artwork from scratch. Deep learning has always ended up synthesizing low aesthetic images due to unorganized learning of neural networks. A paper called "Neural style transfer" has proposed an interesting method to create artwork from other master pieces. The network creates new images with nature being inspired from a unique art and style from another. The artwork generation and working can be better understood from the resource <https://youtu.be/Khuj4ASldmU>. This application comes under innovation. The application is not any services and purely used to synthesize some of the revolutionary arts. The highly effective paper for this task that proposed a novel architecture was <https://arxiv.org/abs/1508.06576>.

3. Technical details and targeted audience:

1. A.I in prediction of protein structure used the architecture in the paper <https://www.nature.com/articles/s41586-021-03819-2>. The paper has proposed a novel method integrates the understanding of molecular driving forces into either thermodynamic or kinetic simulations of protein physics or statistical approximations. The method imposes some constraints on protein structure derived from bioinformatics through the evolution of various proteins and their structures. These proteins poses different kinds of correlations between their structures and function which are to be learnt by neural network to predict the angles of protein folding. The network used in the paper is one of the complex networks in implementing through code.
2. A.I in generating videos of a person talking from a source video has used the concepts of transferring the style of source video similar to those used in neural style transfer for creating artwork along with generative models like GANs (generative adversarial neural networks paper explains all the architecture details at <https://arxiv.org/abs/1406.2661>). The architecture proposed in GAN paper is integrated with some of the concepts in Neural Style Transfer paper. The application additionally uses NLTK module to mix the voice of the source video into the target video. This application is not for any service but is an innovation of A.I for all the public that can increase the interest, positive attitude in people on A.I. This application can be used in film making. This application has some of the implications and policies to be maintained.
3. A.I in photo aesthetic assessment mainly uses the standard architecture of computer vision which is a sequence of 2 convolutional layers followed by pooling layer for 5-7 times. The output layer is a sigmoid layer whose value multiplied by 100 gives the aesthetic score of the input image. Additionally, the architecture also uses advanced pooling layer that preserves the composition of the images during resizing which makes the algorithm strong at its predictions i.e., multi-level spatial pooling layer. The targeted audience are other companies, business such as e-commerce company like amazon.com, pet shops like petfinder.com.
4. A.I in extracting structured information from business documents without detailed annotations uses an architectural method proposed in deep CPCFG paper from research scientists of EY D.I (document intelligence) team. The paper proposed a context free learning grammar which is

conditional probabilistic to make the extraction accurate. The paper that highly impacted the performance of these algorithms is <https://arxiv.org/abs/2103.05908>. The algorithm proposed is an end-to-end deep learning neural network to extract information from scanned documents. The targeted audience are all kinds of organizations such as companies, industries, institutions who deal with applications, documents.

5. A.I in generating new artwork from existing masterpieces uses a dual input neural network that inputs two artworks to learn from, at two levels. The artwork for nature is learned on the bottom layers and the style art is learnt on the earlier layers of neural net while training in order to create hybrid art. The methods demonstrated in the paper <https://arxiv.org/abs/1508.06576> has proven better results with more esthetic value than other existing architectures. The targeted audience are all public who enjoys artworks. These incredible artworks can be sold to an art shop that sell art or can be put for exhibitions. The video can get you the original power of this algorithm <https://youtu.be/Khuj4ASldmU>.

4. Deploying Machine Learning Algorithms into apps, services:

Machine learning models can be deployed in multiple ways such as (1) on Cloud platforms like AWS (EC2 instance), (2) model as an API, (3) model as a web server, (4) model as a pickle or RDS object. One of the highly efficient ways to deploy models is to deploy them on cloud. Various cloud platforms have pre-defined internal frameworks to let users easily deploy models and put them for execution with less time. I have experience working with EC2 instance in deploying the Forex price prediction built using one of the proven architectures in my former intern role.

Some of the important things to keep into consideration during deployment are:

1. Proper creation and implementation of data pipelines to input data to the machine learning model.
2. Proper allocation of resources on cloud for example allocation of CPU cores and setting proper schedulers to call the recursive functions.
3. Proper libraries and frameworks in the environment of docker container i.e., setting up complete environment required to run machine learning algorithms on cloud.
4. Proper arrangement of supporting files like “.yaml”, “.py” etc.
5. Proper connection and workflow between DBs, docker containers, lambdas and ns_ml.

Some of the cloud platforms are (1) Google cloud, (2) AWS, (3) Azure for deploying machine learning models as either API using flask, django, dash framework or in the form of models for example ns_ml in EC2 instance for deploying machine learning model and AWS API for deploying machine learning algorithm as API. The AWS lambdas are not advisable to use for putting a machine learning algorithm which is often many times misunderstood.

Vasudeva Kilaru.

I have tried my best to convey the research outcomes through this document but in case you find any thing unclear, I will be happy to elaborate.