SUMIT BINNANI
Data Scientist • AI Enthusiast

Brief Synopsis of a Few Selected Projects

Sr.	Name of Project	Broad Field
1	Artificial Intelligence Projects	Artificial Intelligence
2	Deep Learning for Self-Driving Car **(Multiple Projects in Description)**	Deep Learning (Computer Vision)
3	Predicting Building Abandonment	Machine Learning
4	Predict (Predicting Users for Advertising)	Real-time Prediction
5	Predictive Client-side Profiling for Behavioral Advertising	Real-time Prediction
6	Audience Pooling Framework	Big Data
7	Map Reduce Framework for Fast Geo-Spatial Queries (Locate)	Big Data
8	AWS Bot	Productivity
9	Deep Learning for Parking Slot Occupancy	Deep Learning (Computer Vision)
10	Analyzing Social Network	Visualization
11	Pupil Detection for Gaze Tracking	Computer Vision
12	Geo-cleansing of Location Data	Natural Language Processing
13	Extraction of Bio-Medical Implant	Computer Vision
14	Histogram Equalization for Facial Features Extraction	Computer Vision
15	Virtual Immersive Cognitive Exercises	Game Engine Development
16	Recreation of Virtual 3D-World from SLAM Map	Computer Vision
17	Unit Commitment: Optimizing Operation Schedule for Power Generation	Mathematical Modelling
18	Billing and Inventory Management System	Software Development
19	Real-time Reactor Control Simulator	Mathematical Modelling
20	Electronics Aid for Elder and Sick	Human Computer Interaction

the broad fields are for indication only, click on the project name for details

Artificial Intelligence Projects

Jan 2016 – Present (expected completion: Apr 2017), Artificial Intelligence Nanodegree, Udacity
Keywords: Search and Optimization, Logic and Planning, Computer Vision, Natural Language Processing
Technology: Python
Number of Team Members: 1
Description: The projects involves topics covering search and optimization, logic and planning, probability models, natural language processing, computer vision with focus on exposure to the latest tools and techniques being used in the industry to operationalize artificial intelligence. The projects also encompass cloud-based, large-scale data processing skills, and fostering a product-oriented mindset to discover new and novel applications of AI.
Sudoku Solver: https://github.com/sumitbinnani/AIND-Sudoku
Projects would be added as and when they are under progress.

Deep Learning for Self-Driving Car

Nov 2016 – Present (expected completion: Feb 2017), Self-Driving Car Nanodegree, Udacity
Keywords: Deep Learning, Behavioral Cloning, Transfer Learning, Computer Vision
Technology: Python, TensorFlow, Keras, Pandas
Number of Team Members: 1
Description: The project is divided in various sub-tasks including detection of traffic lanes, identification of moving vehicles, classification of traffic signs using *Deep Learning* and *Computer Vision* techniques. The project also involves use of *Deep Neural Network* for *Behavioral Cloning* to imitate driving behavior. Currently, I am working on advance lane detection for autonomous driving.
Lane-Detection: https://github.com/sumitbinnani/CarND-LaneLines-P1
LeNet-Architecture *(Accuracy 98.9%)*: https://github.com/sumitbinnani/CarND-LeNet-Lab
Traffic-Sign-Detection *(Top-5 Accuracy: 99.46%)***:** https://github.com/sumitbinnani/CarND-Traffic-Sign-Classifier-Project
Transfer Learning: https://github.com/sumitbinnani/CarND-Transfer-Learning-Lab
Behavioral Cloning: https://github.com/sumitbinnani/CarND-Behavioral-Cloning-P3
Advance Lane Detection (*in progress*): https://github.com/sumitbinnani/CarND-Transfer-Learning-Lab
Projects would be added as and when they are under progress.

Predicting Building Abandonment

Nov 2016 – Dec 2016, Data Science Specialization, Coursera
Keywords: Machine Learning, Data Visualization, XGboost
Technology: Python, scikit-learn, pandas
Number of Team Members: 1
Description: The project involved predicting building abandonment ("blight") based on several public datasets including criminal incidents and permit violation. The datasets include latitude and longitude, which have been grouped together for identification of building. The grouping was accomplished by using *Google Reverse Geo-Coding API*, however considering millions of records to be fetched, the building had been approximated as 7-char *geohash* corresponding to the given latitude-longitude pair of incidents. The labelled dataset for training had been generated using blight-incidents dataset having incident marked as 'Dismantle'. The code and report for the same can be found in following GitHub repository.
Link: https://github.com/sumitbinnani/DataScienceAtScaleCapstoneProject

Predict (Predicting Users for Advertising)

Nov 2016 – Present, Media IQ Digital India Ltd., Bengaluru
Keywords: Machine Learning, Naïve Bayes, Random Forest, K-Means Clustering, Behavioral Targeting, Big Data
Technology: Hive, Spark MLlib, Spark Streaming, Kafka
Number of Team Members: 4
Description: The project aims at predicting users who would take desirable action after an advertisement is displayed to them, and target them in real time. The current model is powered by *Naives Bayes Classifier* built by aggregating user's browsing behavior and geo-location. We are under the process of migrating the model to *Random Forest* which have provided about 10% uplift in preliminary analysis. To combat memory issues stemming out of the large feature set while using *Random Forest*, we grouped the features by *K-Means Clustering*, and used aggregated count of the group to train the model. Moving forward we would be incorporating temporal behavior in the model's feature set, and move to real-time prediction using Spark Streaming.

Predictive Client-side Profiling for Behavioral Advertising

Jun 2016 – Present, Media IQ Digital India Ltd., Bengaluru
Keywords: Real-time Prediction, Machine Learning, Client-side Profiling, Behavioral Targeting, Ad-exchange Architecture
Technology: JavaScript, HTML, Python, Kafka
Number of Team Members: 3
Description: The idea was harnessed as part of a Hackathon at Media IQ Digital India Ltd. Leveraging know-how of Web Development and Data Science, I proposed a novel scalable approach for client-side user profiling to offer personalized advertising experience. The proposed methodology's merit includes near-real-time user profiling, high scalability, low-bandwidth requirement, privacy issues redressal, and minimal changes to existing ad-exchange architecture. The scalability and privacy issue are address by avoiding server-side data aggregation, which in turn also reduces server's storage and computational requirements. The approach can be easily integrated with existing ad-exchange platforms, and bid optimization frameworks, allowing advertisers highly-granular ad personalization without significant infrastructure investments. **The methodology is currently under scrutiny for patent application**.

Audience Pooling Framework

May 2016 – Oct 2016, Media IQ Digital India Ltd., Bengaluru
Keywords: Map-Reduce, Hadoop Streaming, Data Structures, Design Pattern, Scalable Search Platform, Big Data
Technology: Hadoop Streaming, Java
Number of Team Members: 1
Description: The aim of the project was to develop query engine to filter data from daily feed satisfying any given combination of rules. Since the aim was fast retrieval of records satisfying predefined conditions, I implemented data structures, which despite higher insertion and deletion cost, were fast when it came to retrieval. Storing this data structure in memory of individual mappers, and using Hadoop streaming API, the platform is capable of handling complex queries. Also, the current code can be easily scaled to define new rules owing to the modular code which is built upon design patterns like *Factory Pattern*, *Command Pattern*, and *Chain of Responsibility*. For the ease of usage, I also added a UI on top of the platform for configuring rules. The platform now powers insights which previously were quite difficult to obtain.

Map Reduce Framework for Fast Geo-Spatial Queries (Locate)

Mar 2016 – May 2016, Media IQ Digital India Ltd., Bengaluru
Keywords: Map-Reduce, Data Structures, Hashing, Hadoop Streaming, Big Data
Technology: Hadoop Streaming, Java
Number of Team Members: 1

Description: The location-based user behavior can be captured by pooling in the users who had visited locations in the areas of interest. However, given the sheer volume of data to be processed (as of Jan 16, 2016, **more than 7.5TB daily**), and number of locations to be matched (as of Jan 16, 2016, **more than 110k**), joining the location dataset and input feed is expensive in terms of storage and computation. To address the issue, and put learnings to practice, as a pet project over the weekend, I independently wrote a custom Map-Reduce job for geo-spatial queries, where I converted latitude-longitude-radius triplets to list of Geohashes. This dimensionality reduction (interleaving Latitude, Longitude and Radius) by appropriate hashing technique (Geohash), gave **60x speedup** over hive queries. The custom job reduced the processing time taken **from couple of hours to merely 2 minutes** for the same number of nodes. The job is linearly scalable with respect to size of input feed, and now, is an integral part of all the location based insights and reporting tools at the company.

AWS Bot

May 2016, Media IQ Digital India Ltd., Bengaluru
Keywords: Notification Bot, Productivity Tool
Technology: Node JS
Number of Team Members: 1
Description: This is a Slack Bot which is used for monitoring AWS EMR Clusters spawned at the company, and provide notification in case the cluster is idle. It also automatically terminates clusters which had been idle for more than 2 hours. The bot had been paramount in cost saving with monthly saving greater than USD 1k monthly.

Deep Learning for Parking Slot Occupancy

Apr 2016 – May 2016, Startup in Stealth Mode, Bengaluru
Keywords: Deep Learning, Computer Vision, Transfer Learning
Technology: TensorFlow, Keras
Number of Team Members: 1
Description: The aim of the project was to develop vision based model for identification of empty parking slot. I used PKLot dataset (Almeida, P., Oliveira, L. S., Silva Jr, E., Britto Jr, A., Koerich, A., PKLot - A robust dataset for parking lot classification, Expert Systems with Applications, 42(11):4937-4949, 2015) for training the model. As preprocessing I resized all the images to 32x32 before proceeding with the training. The model was designed as multinomial classification, and was built upon Google's Inception Model. By using Transfer Learning Technique, I achieved classification accuracy of **96%** on balanced dataset. Further, randomly sampling images with replacement for generation of training batches gave better results as compared to predefined batches, and boosted the accuracy to **98%**.

Analyzing Social Network

Jan 2016 – Feb 2015, Self-Motivated Project
Keywords: Visualization, Mathematical Modelling, Social Network, Graphs, WebCrawler
Technology: Python, Selenium, PhantomJS, d3.js
Number of Team Members: 3
Description: The aim of the project was to visualize my social network, and find clusters on basis of connections. To accomplished the task, I wrote a python based web crawler using PhantomJS and Selenium to crawl friends' list on Facebook (as Graph API restricts number of results substantially). The data so obtained was then used to draw graph by modelling people as charges and connection between them as spring. The modelling of charge and spring, brought together the clusters which were closely connected, and thus provided clusters without any other attributes. The clusters obtained once the people (charges) are similar despite their random initialization. Closely looking at the clusters, we find that there are clusters within clusters. Also, the people lying between two clusters are usually common to both of the clusters.
Visualization Link: https://sumitbinnani.github.io/projects/analyzing-facebook-social-network.html
Image with Explanation: https://sumitbinnani.github.io/projects/Social-Network.png

Pupil Detection for Gaze Tracking

Nov 2015 – Dec 2015, Hackathon Project, Oracle India Pvt. Ltd., Bengaluru
Keywords: Pupil Detection, Support Vector Machines, Kalman Filter
Technology: Python, OpenCV, scikit-learn, pandas
Number of Team Members: 3
Description: The aim of the project was to generate heatmap by tracking user's gaze on screen. We implemented gaze tracking system by implementing pupil capturing using eye center localization as proposed by Timm F. and Erhardt B. in their paper *Accurate Eye Centre Localisation by Means of Gradients VISAPP 11 (2011)*, and later trained SVM model to track user's gaze on screen. The output by SVM model was wavy and to get a smoother distribution, we later added unimodal probability distribution obtained by Kalman Filter. The module developed during the hackathon was later taken for integration by UX Researchers at Oracle to perform visual analysis of attention span for web content

Geo-cleansing of Location Data

Aug 2015 – Feb 2016, Oracle India Pvt. Ltd., Bengaluru
Keywords: Natural Language Processing, Phonetic Algorithm, Soundex, Fuzzy Login
Technology: PLSQL
Number of Team Members: 1
Description: The project aimed at cleansing massive geographical datasets to get rid of typographical errors and duplicate records. I initially found similar records by using *Levenshtein Distance* as similarity matrix, however this led to high number of false positives (about 30% of predicted duplicates). To tighten the false positives, I later implemented fuzzy logic using *Levenshtein Distance*, *Soundex*, and *New York State Identification and Intelligence System*. The accuracy of the model was further enhanced by imposing hierarchy constraints on locations (e.g. only cities in same states would be considered for matching, and the states should have been already cleansed before proceeding with cities). The precision for the tool was **88%**, with miss of **4%**.

Extraction of Bio-Medical Implant

Jan 2015 – May 2015, GlobalLogic India Pvt. Ltd.
Keywords: Biomedical Imaging, Image Processing, Pattern Matching, Morphological Transformations
Technology: MATLAB, OpenCV, Android SDK
Number of Team Members: 1
Description: At GlobalLogic, I worked for one of the top-3 medical technological conglomerate in the world, and worked on development of image processing pipeline for extraction of bio-medical implant from x-ray. The task was preceded by denoising image using median filter, and improving contrast in image by applying adaptive histogram equalization. The denoised-contrast-enhanced image was then passed to morphological filters to find possible candidates for implant, and finally the candidates were narrowed down using pattern matching (on image descriptors). The final decision still to select the position of implant still lied with the operator. The prototyping of the approach was done using MATLAB, and the code was later ported to Android.

Histogram Equalization for Facial Features Extraction

Aug 2014 – Dec 2014, Central Electronics Engineering Research Institute, Pilani
Keywords: Image Processing, Computer Vision, Contrast Enhancement, Adaptive Histogram Equalization
Technology: C, MATLAB, Python, OpenCV
Number of Team Members: 2 (Guided Mr. Sanjay Singh, CEERI)
Description: The project aimed at developing robust image processing pipeline for enhancing contrast and edges in facial image as a precursor to facial feature extraction. The task was accomplished by implementing *Contrast Limited Adaptive Histogram Equalization (CLAHE)*. The image so obtained was noisy and to suppress the same, the CLAHE was followed by applying *Bidirectional Weighted Median Filter*. The Proof-of-Concept was tested using MATLAB and Python, and the code was later ported to VHDL for FPGA programming.

Virtual Immersive Cognitive Exercises

May 2014 – Jul 2014, University of Manitoba, Winnipeg
Keywords: VR, Game Engine, Collision Detection, Electro-oculography
Technology: C, C++, Oculus Rift
Number of Team Members: 4 (Guided by Prof. Zahra Moussavi and Dr. Ahmad Byagowi)
Description: Worked on a head mounted tracking system for spatial capability assessment of humans. As part of the project, we developed Virtual Immersive Cognitive Exercises for Alzheimer and Dementia's patients using Oculus Rift as head mounted gear, and VR chair integrated with joystick to move around the virtual world. For stabilizing the rendered content, I also worked on electro-oculography to understand eye-movements while walking with Oculus Rift. We also worked on creation of a few neuro-rehabilitation games for treatment of people who have visual processing problems.

Recreation of Virtual 3D-World from SLAM Map

Jul 2014 – Aug 2014, University of Manitoba, Winnipeg
Keywords: VR, Image Processing, Morphological Transformation
Technology: Python, OpenCV,
Number of Team Members: 2 (Guided by Dr. Ahmad Byagowi)
Description: The project aimed at recreation of virtual 3d-world from the SLAM Map obtained using Laser-SLAM. The task was accomplished by denoising the image by median filter to remove speckles, and Gaussian Blur followed by contour detection. The detected contours were then scaled and used to obtain position of walls to be recreated in Virtual World.

Unit Commitment: Optimizing Operation Schedule for Power Generation

Mar 2014 – Apr 2014, as part of the course – Power Systems, BITS Pilani

Keywords: Unit Commitment, Dynamic Programming, Lagrange's Relaxation
Technology: MATLAB
Number of Team Members: 3
Description: The project aimed at determining the operation schedule for generating units for varying loads under different constraints and environments. The optimization problem was tackled by transforming it into an unconstrained optimization problem using *Lagrange's Relaxation*.

Billing and Inventory Management System

Aug 2013 – Apr 2014, Tech Team Lead, Society for Student Mess Services (SSMS), BITS Pilani
Keywords: Software System, Database Management, Credit Management
Technology: C#, MySQL,
Number of Team Members: 4 (The team was led by me)
Description: The project aimed at developing credit-based billing system for student, and inventory management system for messes and canteens in BITS Pilani. The system was designed and developed after multiple interactions with mess workers (many of whom were deprived of educations), to enhance the user experience. The system helped in increasing transparency in billing system and our team was recognized for the same by SSMS. The system is currently deployed in all the messes and canteens of BITS Pilani.

Real-time Reactor Control Simulator

Mar 2013 – Jul 2013, Bhabha Atomic Research Center (B.A.R.C.), Mumbai
Keywords: Numerical Techniques, Euler's Method, Ruge-Kutta Method, Control Systems, Feedback
Technology: MATLAB, LabVIEW, NI PCI-6031e
Number of Team Members: 3 (Guided by Dr. A. P. Tiwari, Senior Scientist, B.A.R.C., Mumbai)
Description: The project aimed at stimulating dynamics of a nuclear reactor in real-time. To simulate behavior of reactor, we solved *Point Kinetic Equation* using *Runge-Kutta Method* (which was selected after benchmarking it against other numerical techniques like *Euler Method* and *Newton-Rhapson Method* with an aim to optimize speed for bigger step sizes). We then designed feedback system by formulating relationship between error and gain value, obtained by plotting optimum gain values vs. equilibrium power, and thus, empowered the system to take decision based on a mathematical model. The system UI was built using LabVIEW and the data acquisition was done using NI PCI-6031e.

Electronics Aid for Elder and Sick

Jan 2013 – Apr 2013, Study Project, BITS Pilani
Keywords: Embedded System, Assistive Aid, Microcontroller Programming, Wireless Switches, IR Reciever
Technology: C, Arduino, Sensor Interfacing
Number of Team Members: 1 (Guided by Dr. Hari Om Bansal, Associate Professor, BITS Pilani)
Description: The project started as development of S*mart Home* module, and later got focused on development of wireless switches as an aid for elderly and sick people. The choice of infra-red for wireless communication was to avoid interference with other medical devices in hospitals. The task was accomplished by using decoding IR Signal from TV-remote controller, and triggering relays to operate electrical appliances. Since the frequency at which the IR Signals are emitted from remote controller is high, the input from IR receiver were read using lower level of abstractions. The control signals from the remote were easy to identify as the remote controller had distinctive start and end sequence. The work done was published in *IEEE Conference Proceeding of Recent Advances and Innovations in Engineering (ICRAIE), 2014*. The project was further enhanced by integrating it with a web layer, and establishing connection between Arduino and server using serial communication.