

# VIDESH SUMAN

Undergraduate Senior

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## RESEARCH INTERESTS

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My primary research interests lie in the domain of Applied Machine Learning and Data Science. I like solving inter-disciplinary research problems using Deep Learning methods, mainly relevant to Computer Vision, Climate Science & Medical Imaging. Recently, I have developed an interest in Deep Reinforcement Learning.

## EDUCATION

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**Indian Institute of Technology (IIT) Bombay, Mumbai, India**  
B.Tech in Civil Engineering

[Jul '15 - Present]

## UNDERGRADUATE THESIS

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**Statistical Downscaling of Rainfall Projections using CNNs** [\[Report\]](#) [\[Poster\]](#) [Jul '18 - Present]  
*Guides: Prof. [Subimal Ghosh](#)(CE) and Prof. [Amit Sethi](#)(EE)* *IIT Bombay, Mumbai*

- The goal is to leverage super-resolution CNNs to generate daily [observed rainfall projections](#) of  $0.25^\circ$  ( $\sim 25$  km) resolution from [coarse reanalysis simulations](#) in  $2.5^\circ$  ( $\sim 250$  km) resolution like temperature, pressure, specific humidity, etc. for the entire Indian landmass.
- Multiple variants of very deep CNNs (owing to the  $10\times$  scaling factor) were trained with [cyclic learning rate schedulers](#). Though, the results haven't been convincing so far, there are plausible future plans.
- Literature confirms that varying geophysical processes govern the local rainfall patterns in different regions of India, so it's extremely difficult to train a single generalized model for such a large landmass.
- Hence, now the plan is to divide the entire region into [seven meteorologically homogeneous zones](#) and train a shallower CNN for each zone individually. I'm also planning to [introduce a time invariant topographical feature like elevation](#) as an auxiliary variable available in very high resolution, into the model. This might provide some extra local information governing a region's rainfall.
- **Major Tools:** [PyTorch](#), [netCDF4](#)

## KEY TECHNICAL PROJECTS

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**Progressive Neural Networks for Multitask Learning** [\[Report\]](#) [\[Code\]](#) [Oct '18 - Nov '18]  
*Intelligent & Learning Agents under Prof. [Shivaram Kalyanakrishnan](#)* *Computer Science, IIT Bombay*

- In a team of two, we investigated the prospects of multitask learning by introducing [lateral connections](#) to the [A3C framework](#). The idea was to transfer knowledge from the previous task to the target task to improve the results in the target task.
- The games [Pong](#) and [Breakout](#) were the test environments of our experiments. First, A3C was first trained on Pong and the weights were frozen. The lateral connections were then introduced into the next column of A3C that was used to train on Breakout.
- **Major Tools:** [PyTorch](#), [OpenAI Gym](#)

**Single Image Super-resolution using Adversarial Learning** [\[Report\]](#) [\[Code\]](#) [Oct '18 - Nov '18]  
*Deep Learning under Prof. [P. Balamurugan](#)* *Operations Research, IIT Bombay*

- The goal was to implement a [GAN based model for single image super-resolution](#) task on natural images ([Pascal VOC2012](#)). A pre-trained MSE-based [SRResNet](#)(5 residual units) was used as the generator, while the discriminator was an 8-layered VGGNet followed by 2 fully connected layers to classify images as fake or real.
- For photo-realistic results, the generator was trained on [Perceptual Loss](#) - a combination of the adversarial loss and the content loss obtained from a higher-dimensional feature space of pre-trained VGG-19.
- **Major Tool:** [PyTorch](#)

## Deep Learning for Medical Image Analysis | Literature Review [\[Slides\]](#)

[Jan '18 - Apr '18]

R&D Project under Prof. [Amit Sethi](#)

Electrical Engineering, IIT Bombay

- An extensive study was conducted on deep learning methods for instance segmentation and classification of [whole slide images](#) (WSI). In the end, I presented an in-depth analysis on two prominent research works.
- First, training a CNN classifier to [detect clinical heart failure](#) from [H&E stained](#) WSI, comparing the model with one trained on a [random forest](#) based on handcrafted features.
- Second, training a [conditional random field](#) to obtain the final pancreas segmentation output based on the fused result from two separate CNNs, one for tissue detection and the other for boundary segmentation.

## Analytics in Tool Condition Monitoring [\[Report\]](#)

[Aug '17 - Nov '17]

R&D Project under Prof. [Asim Tewari](#)

Mechanical Engineering, IIT Bombay

- I applied predictive analytics on a [publicly available force/vibration dataset](#) from the milling operations of cutting tool and predicted the states using various regression models. Highest  $R^2$  score of 98.97% was achieved by the [SVM](#) algorithm (with [RBF kernel](#)) when trained on RMSE loss.
- Inspired by these results, we performed a series of milling experiments on the [CNC](#) Machine. For this data, I worked on extracting signal lobes, corresponding to the actual cutting of the workpiece, from the [frequency domain analysis](#) of the collected signals. The resulting analysis was a part of later experiments by the group working in tool health monitoring.
- **Major Tools:** [R](#), [Python](#)

## Flappy Bird AI [\[Blog\]](#) [\[Code\]](#)

[Mar '18 - Apr '18]

Machine Learning under Prof. [Amit Sethi](#)

Electrical Engineering, IIT Bombay

- In a team of two, we trained an environment agnostic bot for the game using [Q-learning](#) & [Deep Q-Network](#) to produce a comparative analysis between the two frameworks. The DQN framework learnt significantly faster.
- While training, early convergence was ensured by incorporating  $\epsilon$ -greedy & [experience replay](#) strategies.
- **Major Tool:** [Keras](#)

## INTERNSHIPS

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### Conversational Platform | The Walt Disney Company

[May '18 - Jul '18]

Consumer Technologies Division under Mr. [Aftab Sheikh](#)

Mumbai, India

- I was responsible to devise a proof-of-concept of virtual conversational assistants for multiple internal & consumer facing use-cases like Helpdesk Assistance and in-app Voice Search.
- I had to design the conversations and train each agent with effective intent & context recognition using custom entities. The pre-existing databases were integrated and deployed on cloud for fulfilled responses.
- **Major Tools:** [Dialogflow](#), [Node.js](#), [Firebase](#), [Actions on Google](#)

### Optical Character Recognition | NCAIR, IIT Bombay

[May '17 - Jul '17]

Cyber Systems Engineering & Analytics Group under Prof. [Asim Tewari](#)

Mumbai, India

- Implemented a license plate recognition system through a pipeline of contour detection and recognition steps.
- A similar image processing pipeline (with [seven-segmented algorithm](#)) was devised for capturing relevant contours for the digit recognition task from the images of health monitor displays.
- This brute-force approach didn't produce satisfactory results due to the high variation in image samples. Due to unavailability of enough data and GPUs deep learning frameworks weren't tested.
- **Major Tools:** [Python](#), [OpenCV](#)

## SCHOLASTIC ACHIEVEMENTS

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- Secured a national rank of **1490** among ~140k candidates in [JEE Advanced](#) [2015]
- Conferred with the prestigious [KVPY](#) fellowship; national rank of **374** among ~100k students [2014]
- Procured a national rank in the top **99** percentile among ~1.4M candidates in [JEE Main](#) [2015]
- Secured a national rank of **213** in the final round of [National Cyber Olympiad](#) by SOF [2010]

## MISCELLANEOUS PROJECTS

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### Gap Classification of Minor Vehicles [\[Report\]](#) [\[Code\]](#)

[Oct '17 - Nov '17]

Transportation Engineering under Prof. [Gopal R. Patil](#)

Civil Engineering, IIT Bombay

- The safety of a 3-legged unsignalized road intersection was analyzed using multiple classification algorithms viz. [ANN](#), [SVM](#) and [BLM](#), comparing their [F-measure](#), [false alarm ratio](#) and accuracy. The model achieved maximum accuracy of 93.73%(daytime) and 92.03%(nighttime) with the finely-tuned ANN model.
- **Major Tool:** [R](#)

### BB8 | Tinkering Project [\[Video\]](#)

[May '16 - Jun '16]

Freshmen Year Summer Project under [Robotics Club](#)

Students' Technical Body, IIT Bombay

- In a team of 3, we designed and developed an app controlled [holonomic](#) spherical bot ([hamster-ball](#) mechanism) with a freely moving domed head, inspired by the [famous droid](#) in the movie [Star Wars: The Force Awakens](#).
- **Major Tools:** [Arduino Uno](#), [HC-05](#), [App Inventor](#)

## RELEVANT COURSEWORK

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<b>Computer Science</b>	Design and Analysis of Algorithms*, Data Structures & Algorithms, Computer Programming, Discrete Structures†
<b>Artificial Intelligence</b>	Machine Learning, Deep Learning*, Intelligent and Learning Agents*, Computer Vision†, Medical Image Computing†
<b>Mathematics</b>	Probability and Statistics*, Multivariate & Vector Calculus, Linear Algebra, Differential Equations I & II
<b>Online Courses</b>	Convolutional Networks, Sequence Models, CNNs for Visual Recognition, Regularization & Optimization, Neural Networks, Machine Learning

\* completed in Nov '18

† tentative courses in final semester

## TECHNICAL SKILLS

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<b>Programming</b>	Python, C++, Java, R, Javascript
<b>Data Science</b>	PyTorch, scikit-learn, OpenCV, MATLAB
<b>Software Tools</b>	Dialogflow, Actions on Google, $\text{\LaTeX}$

## ORGANIZATIONAL EXPERIENCE

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- **Convener, Web and Coding Club ([WnCC](#))** (2016-17) - Part of the 12-member team responsible for holding workshops, talks, sponsored hackathons with the spirit of fostering institute-wide coding culture. Some of the highlights of my WnCC tenure: [Community Wiki](#), [Seasons of Code](#), research meetings.
- **Marketing Coordinator, [Mood Indigo](#)** (2016) - Part of the 13-member team responsible for pursuing the marketing budget of Asia's largest college cultural festival through corporate sponsorship and brand integration.
- **Web Coordinator, [Mood Indigo](#)** (2016) - Part of the 7-member technical team responsible for developing websites and online portals for the fest, also providing technical assistance during the four days of the fest.

## REFERENCES

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**Amit Sethi**  
Associate Professor  
Electrical Engineering, IIT Bombay  
[Webpage](#)  $\diamond$  [Email](#)

**Asim Tewari**  
Chair Professor  
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