

# Rahul Vigneswaran

Research Intern

Indian Institute of Technology Hyderabad

Advisor : *Dr Vineeth N Balasubramanian*

Last Updated: August 19, 2020

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🏠 [rahulvigneswaran.github.io](https://rahulvigneswaran.github.io)

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## RESEARCH INTERESTS

**Major Interests<sup>‡</sup>** Deep learning, Computer Vision  
**Others** Natural Language Processing

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## EDUCATION

**Amrita University** India  
*Bachelor of Technology in Mechanical Engineering - CGPA: (8.34/10) - Graduated with Distinction (Top 5%)*

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## SELECTED PUBLICATIONS<sup>†</sup>

1. Adepu Ravi Shankar, Yash Khasbage, **Rahul-Vigneswaran K**, Vineeth N Balasubramanian. **A Deeper Look at the Hessian Eigen spectrum of Deep Neural Networks and its Applications to Regularization**. (Under review at a Top-tier conference)
2. **Rahul-Vigneswaran, K.**, Sachin-Kumar, S., Mohan, N., & Soman, K. P. (2019, October). **Dynamic Mode Decomposition based feature for Image Classification**. In *TENCON 2019-2019 IEEE Region 10 Conference (TENCON)* (pp. 745-750). IEEE. [\[Paper\]](#)

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## RESEARCH EXPERIENCE

**Hazy Research, Stanford - Remote Collaborator** California, USA  
Advisor : *Piero Molino* May'20 - Present

- Working on Natural Language Generation (NLG) by extending the work “Plug and Play Language Models: A Simple Approach to Controlled Text Generation<sup>1</sup>”.

**Indian Institute of Technology Hyderabad - Research Intern** India  
Advisor : *Dr Vineeth N Balasubramanian* July'19 - Present

- Worked on understanding the various properties of loss landscapes of Deep Neural Networks through the lens of statistical tools, to name a few - Hessian's Eigen Spectrum (Hessian Decomposition), PAC-Bayesian, fluctuation-dissipation. Along the way, explored its unique inherent properties like mode connectivity, flatness, induced noise and how they affect the generalization properties for image classification tasks.
- Worked on explaining the success of state-of-the-art pruning techniques like Lottery Ticket Hypothesis and why initialization plays a significant role in its success.
- Worked on setting a theoretical base for continual lifelong learning. Followed by gaining insights by looking at catastrophic forgetting in terms of loss landscape and ways these insights can help the community understand the nature of continual learning better in order to formulate better algorithms.
- ★ Work under review at a Top-Tier Conference.

**Centre for Computational Engineering & Networking (CEN) - Research Intern** India  
Advisor : *Dr Soman KP* Jun'18 - Jun'19

- Worked on ways to make algorithms learn with limited labeled data. Applied Deep Learning in Intrusion Detection Systems for Cyber Security.

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<sup>‡</sup>In no particular order.

<sup>†</sup>For full list of publications, kindly check the [website](#).

- Worked on understanding the mode collapse issue in Generative Adversarial Networks (GANs). Explored several other applications of GANs' which include super-resolution and sound to image translation.
  - Worked on model order reduction techniques and Dynamic Mode Decomposition (DMD) for shape optimization, especially in ship hulls.
- ★ Published 4 works in **SCOPUS** indexed conferences.

#### **Amrita Center for Cyber Security Systems & Networks - Research Intern**

Advisor : *Dr Prabharan Poornachandran*

India

*Jun'17 - Apr'18*

#### **Mechatronics & Intelligent Systems Research (MISR) Lab - Research Intern**

Advisors : *Dr Pramod Sreedharan & Dr Ganesha Udupa*

India

*Aug'16 - Nov'16*

#### **Ammachi labs - Research Intern**

Advisors : *Mr Vishnu Rajendran S & Mr Akshay Nagarajan*

India

*Apr'16 - Aug'16*

### **RESEARCH PROJECTS**

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#### **Incremental Loss Landscape**

*Jan'20 - Present*

Advisor : *Dr Vineeth N Balasubramanian, IIT Hyderabad*

- The theoretical literature on continual learning is minimal, and in this work, we try to fix the same. Worked on understanding how catastrophic forgetting translates to loss landscape and how understanding it can pave the way for more theoretically grounded continual learning methods.
- Worked on understanding how regularization based catastrophic forgetting mitigation techniques behave in loss landscapes and why some methods are more successful in achieving the same than others. Analyzed whether tools like, to name a few - PAC-Bayesian, Hessian's Eigen Spectrum, fluctuation-dissipation, intrinsic dimensionality can aid in understanding continual learning better.

#### **Layer-wise Hessian Analysis**

*July'19 - Jan'20*

Advisor : *Dr Vineeth N Balasubramanian, IIT Hyderabad*

- Recent works<sup>2,3</sup> have demonstrated a bulk and outlier trend in their Hessian's Eigen Spectrum. In this work, we have discovered a similar trend in the layer-wise spectrum, too, which indicates an implicit similarity between the overall loss landscape and layer-wise loss landscape, which is a community first.
- We leverage this observation and formulate a regularizer that forces the optimizer to converge to a minima of better generalization properties. Further, through this analysis, we have substantiated that studying the layer-wise loss landscape is worth the community's efforts.

#### **Shape Optimization using DMD and POD**

*Dec'18 - Apr'19*

Advisors : *Dr Soman KP & Dr Gopalakrishnan EA, CEN*

- Explored the idea of Data-driven shape optimization, especially in ship hulls. Used Proper Orthogonal Decomposition based model order reduction approach and Dynamic Mode Decomposition (DMD) to reduce the time of turbulent flow simulation involved.

#### **Intrusion Detection Systems**

*Jun'18 - Aug'18*

Advisors : *Dr Soman KP & Dr Prabharan Poornachandran, CEN*

- Implemented and Contrasted Deep and Shallow Neural Nets in the Cybersecurity use case of Intrusion Detection Systems (IDS) while studying the various SOTAs of Host and Network-based Intrusion Detection Systems (IDS).

★ Work accepted at a **SCOPUS** indexed conference held at IISC Bangalore.

## ACADEMIC PROJECTS

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### Learning with limited labeled Data

Dec'18 - Jun'19

Advisors : *Dr Soman KP & Mr Sachin Kumar S, CEN*

- Worked on understanding the existing techniques used for learning with limited labeled data and explored non-conventional techniques for efficiently learning a distribution with limited-resource.
- Used Dynamic Mode Decomposition (DMD) to extract the dominant features of images for classifying with limited labeled data.

★ Accepted for an oral presentation at **TENCON'19**.

### Trace metal analysis of Pre-flood and Post-flood drinking water in Kerala

Oct'18 - Dec'18

Advisor : *Ms Geena Prasad, Amrita University*

- Conducted a detailed study on various contents of the water samples, especially trace metals, which were collected Pre and post to a Flood in the state of Kerala.

## RELEVANT SKILLS

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<b>Languages</b>	Python, C, C++
<b>Frameworks</b>	Pytorch, Keras, Scikit-learn, MATLAB

## RELEVANT MOOCs AUDITED

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<b>Optimization</b>	<a href="#">Convex Optimization 1: Stanford<sup>§</sup></a> (Stephen P. Boyd)
<b>Machine Learning</b>	<a href="#">Machine Learning: Stanford</a> (Andrew Ng), <a href="#">CNN: Stanford</a> (Fei-Fei Li)
<b>Others</b>	<a href="#">Linear Algebra (18.06): MIT</a> (Gilbert Strang), <a href="#">Matrix Methods in Data Analysis, Signal Processing, and Machine Learning (18.065): MIT</a> (Gilbert Strang)

## EXTRAS

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1. *Teaching Assistant* to Dr Vineeth N Balasubramanian for the course CS6360 : Advanced Topics in Machine Learning at Indian Institute of Technology, Hyderabad.
2. *Teaching Assistant* to Dr Vineeth N Balasubramanian for the course : Deep Learning for Computer Vision at NPTEL.
3. Served as *Subreviewer* for IJCAI'20.
4. Served as student volunteer at ICML'20.

## REFERENCES

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1. *Dr Vineeth N Balasubramanian*, Head of Department - Department of Artificial Intelligence / Associate Professor - Department of Computer Science and Engineering, Indian Institute of Technology, Hyderabad - India
2. *Dr Soman KP*, Head, Centre for Computational Engineering and Networking (CEN) - India

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<sup>§</sup>Yet to be completed.