

Abhiram Singh

RESEARCH SCHOLAR · DEEP/MACHINE LEARNING, COMPUTER NETWORKS, BRAIN COMPUTER INTERFACE

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Research Interest

MACHINE LEARNING, DEEP LEARNING, COMPUTER NETWORKS, BRAIN COMPUTER INTERFACE

My research focuses in the development of machine learning models to improve performance of computer networks. I am currently working on the intelligent computation models for routing in IP networks and developing scalable network verification tools. In past, I have also worked in the exciting area of the brain-computer interface.

Education

CSE	Doctor of Philosophy (Ph.D.) , Indian Institute of Technology Bombay (IIT Bombay)	2016 - Present
CSE	Master of Technology (M.Tech) , National Institute of Technology Hamirpur (NIT Hamirpur)	2012 - 2014
CSE	Bachelor of Engineering (B.E.) , Oriental Institute of Science and Technology Bhopal (OIST Bhopal)	2008 - 2012

Projects

IIT Bombay

Powai, Mumbai, India

PH.D PROJECT 1 (PROF. ASHWIN GUMASTE)

Jan 2019 - PRESENT

- Formulated a graph neural network based deep learning model (Grafnet) to predict the output ports directly based on the IP address contained in the packets.
- Implemented Grafnet in Tensorflow and shown that Grafnet achieves high accuracy in predicting the correct output ports on a large network of 2000 nodes with 5 million IP addresses.
- Designed a single agent based deep reinforcement learning model (Trailnet) that learns to forward IP packets depending on the cost of packet forwarding from the neighbors.
- Implemented Trailnet in Tensorflow and shown that the cost estimates provided by Trailnet are close to optimal in a network of 145 nodes with 1 million IP addresses.
- Created a machine learning model (Tapin) that takes destination IP address of a packet as its input and predicts the index of a rule in a forwarding table that provides the packet forwarding decision.
- We tested Tapin on a forwarding table containing 1 million entries. Tapin significantly reduced the search space to less than 500 entries for around 98% of table lookups.

PH.D PROJECT 2 (PROF. ASHWIN GUMASTE)

Jan. 2020 - PRESENT

- Aim of project is to solve the network verification problem in a fast and scalable manner.
- Formulated a linear algebra based solution (LeSQnet) to find the set of reachable IP addresses between two nodes, detect loops and packet drops, model packet header transformations and check for ACL rules.
- Implemented LeSQnet in python and shown that after a rule update, LeSQnet checks for reachability within a millisecond on different networks containing millions of forwarding rules. LeSQnet is also shown to improve the complexity bounds for checking reachability.

PH.D PROJECT 3 (PROF. ASHWIN GUMASTE)

Jan. 2017 - Jan. 2019

- Aim of project is to generate words that user speaks in mind without moving any body parts.
- Tested various features and machine learning models to classify a group of words based on their complexity. Used Python Scikit-learn framework to develop machine learning models and shown up to 11% performance improvement in correctly identifying imagined words over state-of-the-art methods on publicly available datasets.
- Designed graphics user interface using Python Tkinter library and integrated it with trained brain thought classifier to simulate real-time detection of brain thoughts.

COURSE PROJECT (PROF. GANESH RAMAKRISHNAN)

Sept 2016 - Nov 2016

- Researched the problem of predicting answer of a question after learning from a set of sentences or from paragraphs.
- Implemented ANN, LSTM and Memory based neural network (Memn2n) in Tensorflow.
- Utilized Facebook bAbI dataset to show that Memn2n models outperforms other models in the task with 99% success rate on test data.

COURSE PROJECT (PROF. VIRENDRA SINGH)

Oct 2016 - Nov 2016

- Researched and implemented different branch predictors using Simple-scalar simulator written in C.
- Compared performance of implemented predictors with built in branch predictors on different benchmark programs provided with simulator.
- Shown that perceptron branch predictor outperformed other predictors with an average margin of 2-4% in miss prediction rate.

COURSE PROJECT (PROF. BHASKARAN RAMAN)

Mar 2016 - Apr 2016

- Researched different ways to predict the data transmission rate (TX rate) of a Wi-Fi device.
- Implemented Deep Learning model (in MatLab) to predict the behaviour of Operating System implemented algorithm for TX rate estimation.
- Shown that implemented model was able to achieve same performance in 60-65% cases to which data-rate prediction algorithm will converge.

- Researched problem to find average packet latency in a switch and measure switch throughput as a function of packet size.
- Simulated a switch of 16 ports (10Gbps) in Simpy and found that on increasing packet size, switch throughput increased and on the other hand average packet latency decreased.
- Did observed a considerable difference in average port to port latency of 0.6ms for packet size of 2000 Bytes and 250 Bytes.

NIT Hamirpur (Prof. T. P. Sharma)

Hamirpur, Himachal Pradesh, India

M.TECH PROJECT

Jul 2013 - Jul 2014

- Formulated an area coverage scheme in Wireless Sensor Network (WSN) to obtain full coverage of target area by providing 3 way connectivity of sensor nodes and simultaneously minimizing number of active sensor nodes.
- Showed that the proposed approach can also provide network routing of data packets by providing tree structure among active sensor nodes.
- Implemented all the functionalities in Omnet++ simulator and obtained state-of-the-art performance in the field.

Publications

MACHINE LEARNING

- Abhiram Singh, Sidharth Sharma and Ashwin Gumaste, *Grafnet: Using Graph Neural Networks to Create Table-Less Routers*, Published in IEEE Transactions on Network Science and Engineering (TNSE)
- Abhiram Singh, Sidharth Sharma and Ashwin Gumaste, *Using Deep Reinforcement Learning for Routing in IP Networks*, Published in International Conference on Computer Communications and Networks (ICCCN 2021)
- Abhiram Singh, Aniruddha Kushwaha and Ashwin Gumaste, *TAP-IN: Table Address Prediction using Intelligent Learning for SDN Networks*, to be submitted in IEEE International Conference on Dependable Systems and Networks (DSN 2022)
- Abhiram Singh and Ashwin Gumaste, *Decoding Imagined Speech and Computer Control using Brain Waves*, arXiv preprint arXiv:1911.04255, Published in Elsevier Journal of Neuroscience Methods (JNM 2021)
- Abhiram Singh and Ashwin Gumaste, *Interpreting Imagined Speech Waves with Machine Learning techniques*, arXiv preprint arXiv:2010.03360, to be submitted in Elsevier Journal of Neuroscience Methods

COMPUTER NETWORKS

- Abhiram Singh, Sidharth Sharma and Ashwin Gumaste, *LeSQnet: Least Squares for Holistic and Expressive Verification of Networks*, Under review in ACM SIGCOMM 2022.
- Abhiram Singh and T. P. Sharma, *Position and Hop-count Assisted Full Coverage Control in Dense Sensor Networks*, Published in Springer Journal of Wireless Networks 2015
- Abhiram Singh and T. P. Sharma, *A survey on area coverage in wireless sensor networks*, Published in International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT 2014)

PATENT APPLICATIONS

- Abhiram Singh, Sidharth Sharma and Ashwin Gumaste, *Grafnet: Using Graph Neural Networks to Create Table-Less Routers*, USPTO Publication Number: US-2021-0297324-A1.

Experience

Teaching Assistant IIT Bombay, Mumbai, Jan 2016 – Present**Software Engineer** Aricent, Gurgaon, Oct 2014 – Aug 2015**Teaching Assistant** NIT Hamirpur, Himachal Pradesh, July 2012 – Aug 2014**Reviewer** IEEE Transactions on Cognitive Communications and Networking (TCCN), Wireless Networks (Springer Journal)**Talks** Using Deep Reinforcement Learning for Routing in IP Networks (ICCCN 2021), A survey on area coverage in wireless sensor networks (ICCICCT 2014)

Skills

Programming Python, C/C++, MatLab, LaTeX**ML Framework** Tensorflow, Scikit-learn**Simulators** Simpy, Omnet++, Simple-scalar

National Examinations Cleared

2012 **All India Rank: 1115**, The Graduate Aptitude Test in Engineering (GATE)-Computer Science

India

2013 **All India Rank: 528**, The Graduate Aptitude Test in Engineering (GATE)-Computer Science

India

Jun 2013 **Assistant Professorship**, National Eligibility Test (NET)-Computer Science and Applications

India

Dec 2013 **Assistant Professorship**, National Eligibility Test (NET)-Computer Science and Applications

India

Dec 2013 **Junior Research Fellowship (JRF)**, National Eligibility Test (NET)-Computer Science and Applications

India