Abhijit Mahalunkar

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Summary

Skilled professional with extensive project experience from concept and development to evaluation and publishing and holding exceptional research skills to support the delivery of accurate research results. Expertise in Language Modeling, Natural Language Processing, Machine Learning and Deep Learning. Significant experience developing minimum viable products and production systems in the areas of the Internet of Things and Web Application Development. My talents include acquiring skills quickly and maintaining exceptional ethical and quality standards.

Skills

Research	Data Collection, Statistical Analysis, Research Design and Methodology, Research Dissemination.
Languages	C, C++, Visual C++, Python, Java, R, SQL, LabView, MATLAB, Octave, Scilab, Assembly
Libraries	PyTorch, Tensorflow, Keras, Scikit-Learn, SciPy, NumPy, Pandas, Matplotlib, OpenCV, CUDA
Tools	Anaconda, GIT, Jupyter Notebook, Eclipse, Visual Studio, Android SDK, Nokia Qt Applications
Web Dev	HTML/CSS, Django, Ruby on Rails, Node.JS, JavaScript, PHP, Go

Education

2017 – 2023 **Ph.D. in Deep Learning**, Technological University Dublin, Ireland.

Thesis: ***The complexity of long-distance dependencies in sequential data and their impact on the representational capacity of recurrent and attention-based language models.***

- Supervisor: Prof. John D. Kelleher
- Main Contributions:
  - Examine the complexity of long-distance dependency in natural and synthesized sequential datasets.
  - Examine the representational capacity of language models (recurrent and attention-based architectures) in their ability to represent sequential datasets with varying complexity of long-distance dependency.
- Relevant Courses: Machine Learning, Deep Learning, Algorithms & Approximation.

2006 – 2010 **B.E. in Electronics and Telecommunications**, Goa Engineering College, Goa, India.

Project: ***Design and implementation of an optimized speech recognition system.***

- Relevant Courses: Artificial Neural Networks, Probability Theory and Random Processes, Robotics, Digital Signal Processing, Data Communication, Control System Engineering, and Advanced Microprocessors.

Work Experience

Nov 2015 – Feb 2020 **Technical Advisor**, Cyanodoc Healthcare, Goa, India.

- Designed the web application architecture of the doctor's appointment system and deployed it on Amazon AWS. Advised on developing the Android and iOS apps of patient and doctor's user interface.
- Consulted with medical experts in designing the differential diagnosis system for endocrine diseases and optimizing the probabilities of the symptoms manifesting due to the presence of a disease.

April 2015 – July 2017 **Product Architect**, SpitiQ, Goa, India.

- Designed the schematics and manufactured circuit board of a wireless sensor node (mote) based on Atmega128RFA1 microcontroller that includes a wireless transceiver onboard compliant with IEEE 802.15.4 stack and 6LowPAN protocol to be used in home automation. Ported Tiny OS and Contiki OS on the mote and tested the motes using a network set up on Cooja Simulator.
- Increased the effective wireless communication range of the mote up to 1600m by designing a Front End Module (that includes Low Noise Amplifier and Power Amplifier) for the wireless transceiver.
- Integrated smart home sensors (temperature, humidity, light, smoke, CO, and door sensors) and electric switching capability with the motes to be used in home automation applications.
- Designed a communication protocol on Contiki OS via MQTT on the mote to enable communication between motes and the broker on AWS IoT Core. The motes published (transmitted) sensor and switch data to the Android application (subscribed to sensor data) via the MQTT broker on AWS IoT Core.
- Designed a data logging system to maintain the log of the sensor and switch data for data analytics.
- Designed an Android application to view the sensor and switch data and send instructions to the motes.

Sept 2010 – July 2017 **Freelance Developer**, Freelance Development, India.

- Developed websites with content management system (CMS) for Open Source Drug Discovery, Bangalore, India, and Bharatiya Vidya Bhavan, Goa, India.
- Designed a social media device that integrates social media with a table clock. It was designed on BeagleBone Black Single Board Computer (SBC) running a tweaked version of Android OS to employ its hardware capabilities. An Android app was developed for extracting updates from social media websites.
- Developed a capacitive touch module using Atmel's QTouch technology and a control board for communicating user touch inputs to the BeagleBone Black SBC to affect the social media application.
- Developed a control program for the Raspberry Pi to enable the developer in designing tasks on Raspberry Pi without much hardware or programming knowledge by programming their tasks using ladder logic.
- Developed an Android app to create a ladder logic program for the Raspberry Pi and upload the program.
- Designed an expansion board for Raspberry Pi to be used with control logic resembling ladder logic.
- Conducted tutorials on CUDA and MATLAB programming at Goa Engineering College, Goa.

Nov 2010 – Sept 2014 **Project Assistant**, National Institute of Oceanography, Goa, India.

Maintained two robots (i) Autonomous Underwater Vehicle (AUV-MAYA) and (ii) Autonomous Vertical Profiler (AVP), at Marine Instrumentation Division. Participated in field trials of AUV-MAYA and AVP.

- Developed and maintained AUV-MAYA, by updating the control, navigation, and communication programs of AUV-MAYA running on Linux Single Board Computer running Embedded Linux OS. Enhanced the wireless communication protocol of AUV-MAYA by modifying the protocol written in TCP/IP. Worked on POSIX threads to introduce parallelism on the AUV-MAYA to improve the performance of the algorithm.
- Interfaced new robotics sensors with AUV-MAYA by modifying Linux drivers of the Embedded Linux OS.
- Developed Hardware-In-Loop (HIL) Simulator for AUV-MAYA by modifying the AUV-MAYA's control program and electronics to incorporate the HIL. Then, designed a mathematical representation of the dynamics of the AUV-MAYA in MATLAB and C and simulated navigation sensor data of the AUV-MAYA.
- Developed a communication protocol between the AVPs deployed in remote locations (no Wi-Fi or mobile network) and a secure SELinux server located in the NIO lab via the Iridium satellite constellation to transmit the status and data of the AVPs. This portal was written in Python.
- Designed a data archival system in SQL for the data received from the remotely deployed AVPs.
- Designed a web application to display the real-time status and graphical plots of the data from the AVP.
- Developed GUIs for Windows (VC++) and Android OS to perform tasks using AUV-MAYA and AVP.
- Developed a mission planner for AUV-MAYA that allowed the operator to plan mission paths for AUV-MAYA on Google Earth and converted them into mission files to be uploaded on AUV-MAYA.

Teaching Experience

Sept 2017 – June 2021 **Assistant Lecturer/Senior Demonstrator**, Technological University Dublin, Ireland.

Conducted labs and tutored students in the School of Computer Science and the School of Engineering.

- Subjects: Machine Learning, Computer Networks, Operating Systems, Databases, Mobile Robotics.

June 2019 – July 2019 **Instructor**, CTYI - Dublin City University, Ireland.

Instructor of Robotics at Centre for Talented Youth Ireland (CTYI).

- Designed and conducted a robotics course for high school students and guided them in the field of robotics.

June 2009 – Dec 2015 **Instructor**, Inventrom, India.

Instructor of robotics and embedded systems at Inventrom, India.

- Conducted workshops in robotics, embedded systems, MATLAB, and Octave for engineering students.
- Conducted workshops on Raspberry Pi for professionals from Tata Consultancy Services and Persistent Systems and students from BITS Pilani and IIT Roorkee,

Projects

2015 **Improved Speech Recognition System**.

- Time-domain speech was represented as spectral maps (spectral-domain) using Fast Fourier Transform.
- Convolutional Neural Network (CNN) classified different speech signals via spectral maps.

2011 **Design of Speech Synthesis System**.

- Extract speech parameters i.e., Mel-Frequency Cepstral Coefficients (MFCC) from phonemes.
- Construct a database of text to phoneme lookup.
- Synthesize speech using TD-PSOLA.

2010 **Design and Implementation of an Optimized Speech Recognition System**.

- Speech signal data features i.e., Linear Predictive Coding (LPC), Cepstral Coefficients, and Mel-Frequency Cepstral Coefficients (MFCC) were computed for the recorded speech.
- Vector Quantization (VQ) was used to create templates for matching.
- Pattern similarity of speech features was measured using Dynamic Time Warping (DTW) algorithm.

Grants

2019 **Travel Grant by Naver Labs**, *to attend ACL 2019 workshop on Deep Learning and Formal Languages: Building Bridges.*

2018 **ENNS Student Travel Grant**, *to attend International Conference on Artificial Neural Networks (ICANN), Rhodes, Greece, 2018.*

2017 **NVIDIA GPU grant**, *donation of one NVIDIA TITAN Xp GPU.*

Awards

2019 **TU Dublin Scholarship**, *to pursue PhD at Technological University Dublin, Ireland.*

2019 **ADAPT Auxiliary Fund**, *to pursue PhD at Technological University Dublin, Ireland.*

2017 **DIT Fiosraigh Award**, *to pursue MPhil at Dublin Institute of Technology, Ireland.*

Selected Publications

ICONIP 2020 Abhijit Mahalunkar, John D. Kelleher (2020). Mutual Information Decay Curves and Hyper-parameter Grid Search Design for Recurrent Neural Architectures. *Proceedings of The 27th International Conference on Neural Information Processing, ICONIP 2020.*

LREC 2020 Filip Klubička, Alfredo Maldonado, Abhijit Mahalunkar, John D. Kelleher (2020). English WordNet Random Walk Pseudo-Corpora. *Proceedings of The 12th Language Resources and Evaluation Conference 2020.*

Entropy 2019 Vaibhav Kulkarni, Abhijit Mahalunkar, Benoit Garbinato, John D. Kelleher (2019). Examining the Limits of Predictability of Human Mobility. *Entropy.*

ACL Workshop 2019 Abhijit Mahalunkar, John D. Kelleher (2019). Multi-Element Long Distance Dependencies: Using SPk Languages to Explore the Characteristics of Long-Distance Dependencies. *Proceedings of the Workshop on Deep Learning and Formal Languages: Building Bridges.*

GWT 2019 Filip Klubička, Alfredo Maldonado, Abhijit Mahalunkar, John D. Kelleher (2019). Synthetic, yet natural: Properties of WordNet random walk corpora and the impact of rare words on embedding performance. *Proceedings of the 10th Global Wordnet Conference 2019.*

ICANN 2019 Vaibhav Kulkarni, Abhijit Mahalunkar, Benoît Garbinato, John D. Kelleher (2019). On the Inability of Markov Models to Capture Criticality in Human Mobility. *Artificial Neural Networks and Machine Learning - ICANN 2019: Image Processing.*

ICANN 2018 Abhijit Mahalunkar, John D. Kelleher (2018). Using Regular Languages to Explore the Representational Capacity of Recurrent Neural Architectures. *Artificial Neural Networks and Machine Learning - ICANN 2018.*

ICANN 2018 Annika Lindh, Robert J. Ross, Abhijit Mahalunkar, Giancarlo Salton, John D. Kelleher (2018). Generating Diverse and Meaningful Captions. *Artificial Neural Networks and Machine Learning - ICANN 2018.*

arXiv e-prints Abhijit Mahalunkar, John D. Kelleher (2018). Understanding Recurrent Neural Architectures by Analyzing and Synthesizing Long Distance Dependencies in Benchmark Sequential Datasets.

Invited Talk

August 2019 **Using formal grammars to test the ability of recurrent neural networks to model long-distance dependencies in sequential data**, *ACL 2019 workshop on Deep Learning and Formal Languages: Building Bridges*, August 2, 2019, Florence, Italy.

July 2019 **Using Entropy and Information Theory to Analyse Human Mobility Behavior in a City**, *A seminar on Urban Intelligence After Two Centuries of Industrialization, 2-3 July 2018, Salle Triangle - Centre Pompidou.*

Other Research Activities

Reviewer Conferences: reviewer for ICANN 2019

School Attended Machine Learning Summer School (MLSS) 2016, Arequipa, Peru