Abhijit Mahalunkar

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Summary

Skilled professional with extensive project experience from concept and development to evaluation and publishing. Expertise in areas of Language Modeling, Natural Language Processing, and Deep Learning. Holding exceptional research skills to support the delivery of accurate research results. Significant experience developing minimum viable products and scaling them to production status in the areas of the Internet of Things and Web and Application Development. Talents include in-depth technical domain knowledge, acquiring new skills quickly, and maintaining exceptional ethical and quality standards.

Skills

Research Skills	Data Collection, Quantitative and Qualitative Research, Statistical Analysis, Project Planning, Experimental Designs and Methodology, and Research Dissemination.
Languages	C/C++/C#, Python, R, Java, SQL, LabView, MATLAB, Octave, Scilab, JavaScript, PHP, Go
Libraries	PyTorch, Tensorflow, Keras, Scikit-Learn, SciPy, NumPy, Pandas, Matplotlib, OpenCV
Tools	CUDA, Anaconda, GIT, Jupyter Notebook, Processing, Unix Shell, Android SDK, Eclipse, Qt Apps
Web Dev	HTML/CSS, Django, Ruby on Rails, Node.JS

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 using Amazon AWS.
- Advised on the development of the Android and iOS apps of patient's and doctor's user interface.
- Advised on the design of the differential diagnosis system using Bayes' theorem for endocrine diseases.
- Consulted with medical experts to improve the differential diagnosis system by optimizing the probabilities of the symptoms manifesting due to the presence of a disease.

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

- Designed and manufactured wireless sensor nodes or motes and a border router using Atmel's Atmega128RFA1 microcontroller with mesh connectivity to be used in home automation.
  - Designed the schematics and manufactured PCB board of a mote based on Atmega128RFA1 microcontroller that includes a wireless transceiver onboard compliant with IEEE 802.15.4 stack and 6LowPAN protocol.
  - Increased the effective range of the mote up to 1600 m by designing a Front End Module (that includes Low Noise Amplifier and Power Amplifier) for the wireless transceiver.
  - Ported Tiny OS and Contiki OS on the mote and tested the motes using a network set up on Cooja Simulator.
- Integrated smart home sensors and electric switching capability with the motes.
  - Designed a "Sensor Mote" with temperature, humidity, light, smoke, CO, and door sensors.
  - Designed a "Switch Mote" with a capability of electric switching by using power switches.
- Designed a cloud communication service using MQTT for communication between motes and the Android application.
  - Designed a communication protocol on MQTT running on Contiki OS on the mote to enable communication between motes and the broker on AWS IoT Core.
  - Implemented an MQTT broker on AWS IoT Core where motes publish sensor and switch data into AWS IoT Core and Android application subscribed to sensor data.
  - Designed a data logging system to maintain the log of 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 Developement, 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 the table clock running Android OS.
  - Ported a stable version of Android OS on BeagleBone Black Single Board Computer (SBC) and tweaked the Android OS to employ the hardware capabilities of BeagleBone Black SBC.
  - Developed a script for Android OS on BeagleBone Black SBC for extracting data from social media websites.
  - Developed a capacitive touch module with LED backlight using Atmel's QTouch technology.
  - Developed a control board for communicating between the BeagleBone Black SBC and capacitive touch module.
- Developed a program for the Raspberry Pi to enable the developer from developing applications on Raspberry Pi without any hardware or programming knowledge.
  - Developed a control program for Raspberry Pi that allowed developers to run their own tasks on the Raspberry Pi by programming their task 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 with predefined configuration in accordance with the ladder logic.
- Conducted tutorials on CUDA programming at Goa Engineering College, Goa

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

Developed and 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, maintained, and updated AUV-MAYA which is designed on Linux SBC running Embedded Linux OS.
  - Improved the wireless communication of AUV-MAYA by modifying communication protocol on TCP/IP.
  - Implemented new algorithms to enhance the control, navigation, and communication of AUV-MAYA.
  - Modified Linux drivers to interface Doppler Velocity Log, Attitude and Heading Resolution Sensor, and GPS RTK sensors with the Embedded Linux OS running on AUV-MAYA.
- Developed Hardware-In-Loop (HIL) Simulator for AUV-MAYA.
  - Developed a mathematical representation of the dynamics of the AUV-MAYA in MATLAB and C and simulated navigation sensor data of the AUV-MAYA.
  - Modified the control program and electronics of the AUV-MAYA to incorporate the HIL Simulator.
- Developed a satellite communication portal for communication between AVPs deployed in remote locations (with no Wi-Fi or mobile network) and the servers located in the lab, to transmit the status and data of the AVPs.
  - Installed a secure SELinux server and deployed a web server and a Python application to host the portal.
  - Designed a protocol for the communication between the remotely deployed AVPs and the server via Iridium satellite constellation. The protocol was designed using a Python application.
  - Designed a data archival system in SQL for the data received from the remotely deployed AVPs.
  - Designed a web app to display the real-time status of AVP and graphical plots of the data collected by the AVP.
- Developed graphical user interfaces on Windows and Android for AUV-MAYA and AVP to perform their missions.
- 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, Forensics, 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 the 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 (in spectral-domain) using Fast Fourier Transform (FFT).
- 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**.

- Linear Predictive Coding (LPC), Cepstral Coefficients, and Mel-Frequency Cepstral Coefficients (MFCC) speech data features were computed.
- 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

Peer-Reviewed Articles

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.*

Technical Reports / Preprints

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

arXiv e-prints Vaibhav Kulkarni, Bertil Chapuis, Benoît Garbinato, Abhijit Mahalunkar (2018). Addressing the Free-Rider Problem in Public Transport Systems. *arXiv e-prints.*

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

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