

Abhijit Mahalunkar

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OVERVIEW	I am a skilled researcher with expertise in training and fine-tuning Language Models and unraveling the complexities of Long-Distance Dependencies in sequence data. My research work, complemented by hands-on experience in machine learning, positions me as a dynamic professional, bridging the gap between theoretical knowledge and practical applications.	
EDUCATION	Ph.D. Deep Learning , Technological University Dublin, Ireland. (exp.) 2023 <ul style="list-style-type: none">"The Complexity of Long-Distance Dependencies in Sequence Data and their Impact on the Representational Capacity and Performance of the Language Models", Supervised by Prof. John D. Kelleher B.E. Electronics & Telecommunications , Goa College of Engineering, Farmagudi, Goa. 2010	
SKILLS	Research: Data Collection, Statistical Analysis, and Research Design and Methodology. Natural Language Processing (NLP): Trained and fine-tuned language models, e.g., BERT, Huggingface. Large Data Processing: Examined the scaling properties of large natural language datasets. Programming Languages: C, C++, Visual C++, Python, Java, R, SQL, LabView, MATLAB, Octave. Libraries: PyTorch, TensorFlow, Keras, Scikit-Learn, Pandas, Matplotlib, OpenCV, CUDA. Tools: Anaconda, GIT, Jupyter Notebook, Eclipse, Visual Studio, Android SDK, Nokia Qt Applications.	
RESEARCH EXPERIENCE	Doctoral Research , Technological University Dublin, Ireland. 2017–2023 The research is centered on uncovering the limitations of Language Models (both Transformer-based and RNN-based) in effectively capturing Long-Distance Dependencies present in datasets. <ul style="list-style-type: none">Conducted research to investigate Long-Distance Dependencies within large sequence datasets, identifying variations in the dependency decay patterns across different sequence datasets. Notably, discovered a broken power-law relationship in the dependency decay of natural language datasets.Analyzed the broken power-law dependency decay in natural language datasets, elucidating this phenomenon through an investigation of word co-occurrences within these datasets.Compared the representational capacity of RNN-based and Transformer-based Language models using artificial grammars, providing valuable insights into their relative strengths and weaknesses.Accelerated the grid-search optimization process for Language Model hyper-parameters by narrowing down the hyper-parameter space, informed by examining how different hyper-parameters are influenced by the dependency decay pattern, resulting in an improved and finely tuned model performance.Investigated the nuanced relationship between the scaling properties of natural language datasets and the evaluation of Language Models, offering rich insights for the enhancement of Language Models.Trained language models (RNN-based and Transformer-based) using TensorFlow and PyTorch. Applied fine-tuning methodologies to pre-trained language models to examine their ability to learn Long-Distance Dependencies, thus improving model performance.	
WORK EXPERIENCE	Technical Consultant , Qubiseed Technologies LLP, Goa, India. Nov 2015–Dec 2017 <ul style="list-style-type: none">Developed a differential diagnosis system for endocrine diseases by consulting medical experts.Developed the web application architecture for the doctor's appointment system using Amazon AWS. Co-founder & Product Architect , Spitiq, Goa, India. April 2015–July 2017 <ul style="list-style-type: none">Led and managed a team that designed wireless sensor nodes using Atmega128RFA1 microcontroller, smart home sensors, and electric switching to be integrated with a home automation system.Implemented activity discovery for the home automation system by processing the interleaved sensor data collected via the wireless sensor network to assist in optimal decision making. Technical Consultant , SmartKlock Inc., Austin, TX. Oct 2014–Oct 2015 <ul style="list-style-type: none">Led a team that developed a social media device utilizing the BeagleBone Black operating on the Android OS, seamlessly combining social media functionality with that of a table clock. Project Assistant , National Institute of Oceanography (NIO), Goa, India. Nov 2010–Sept 2014 <ul style="list-style-type: none">A member of the team engaged in the development and deployment of the Autonomous Underwater Vehicle (AUV-MAYA) and Autonomous Vertical Profiler (AVP) for scientific ocean data collection.	

- Developed a Hardware-In-Loop Simulator for AUV-MAYA to minimize the need for extensive field trials by providing a controlled laboratory environment for testing the functionality of AUV-MAYA.
- Developed a communication protocol to transmit the data between AVP and NIO server via the Iridium satellite constellation and a web app to display the real-time location of AVP and the collected data. This enabled the AVP to operate as a Lagrangian drifter, gathering ocean column data amidst the demanding conditions of the monsoon season over a period of three months.

MACHINE LEARNING PROJECTS	Speech Recognition System Using Spectral Maps	2015
	• Classified speech signals using Convolutional Neural Networks on the speech spectral maps.	
	Design of Speech Synthesis System	2011
	• Extracted speech parameters, i.e., Mel-Frequency Cepstral Coefficients (MFCC) from phonemes, created a database for text-to-phoneme lookup, and synthesized speech using TD-PSOLA.	
TEACHING	Design and Implementation of an Optimized Speech Recognition System	2010
	• Computed speech signal data features, i.e., Cepstral Coefficients, and Mel-Frequency Cepstral Coefficients (MFCC), used Vector Quantization and Dynamic Time Warping (DTW) for matching.	
	Senior Demonstrator, Technological University Dublin, Ireland	Sept 2017–June 2021
	• Conducted labs and tutored students in Deep Learning, Machine Learning, and Databases	
AWARDS & GRANTS	Instructor, CTYI - Dublin City University, Ireland	June–July 2019
	• Designed and delivered a course on robotics and embedded systems for high school students.	
	Instructor, Inventrom, India	June 2009–Dec 2015
	• Designed and delivered a course on Robotics, embedded systems, and MATLAB for students (BITS Pilani and IIT Roorkee) and professionals (Tata Consultancy Services and Persistent Systems).	
PUBLICATIONS	TU Dublin Scholarship to pursue a Ph.D. at Technological University Dublin, Ireland.	2019
	ADAPT Auxiliary Fund to enhance computational capabilities for Language Model training.	2019
	DIT Fiosraigh Award , to pursue an MPhil at Dublin Institute of Technology, Ireland.	2017
	NVIDIA GPU grant of NVIDIA TITAN Xp GPU to enhance the computational capability.	2017
REFERENCES	[1] A. Mahalunkar, J. D. Kelleher (2020). Mutual Information Decay Curves and Hyper-parameter Grid Search Design for Recurrent Neural Architectures. <i>The 27th International Conference on Neural Information Processing, ICONIP 2020</i> . doi: https://doi.org/10.1007/978-3-030-63823-8_70	
	[2] A. Mahalunkar, J. D. Kelleher (2019). Multi-Element Long Distance Dependencies: Using SPk Languages to Explore the Characteristics of Long-Distance Dependencies. <i>The Workshop on Deep Learning and Formal Languages: Building Bridges</i> . doi: https://aclanthology.org/W19-3904/	
	[3] V. Kulkarni, A. Mahalunkar, B. Garbinato, J. D. Kelleher (2019). Examining the Limits of Predictability of Human Mobility. <i>Entropy</i> . doi: https://www.mdpi.com/1099-4300/21/4/432	
	[4] V. Kulkarni, A. Mahalunkar, B. Garbinato, J. D. Kelleher (2019). On the Inability of Markov Models to Capture Criticality in Human Mobility. <i>Artificial Neural Networks and Machine Learning - ICANN 2019: Image Processing</i> . doi: https://doi.org/10.1007/978-3-030-30508-6_39	
	[5] A. Mahalunkar, J. D. Kelleher (2018). Using Regular Languages to Explore the Representational Capacity of Recurrent Neural Architectures. <i>Artificial Neural Networks and Machine Learning - ICANN 2018</i> . doi: https://doi.org/10.1007/978-3-030-01424-7_19	
	[6] A. Mahalunkar, J. D. Kelleher (2018). Understanding Recurrent Neural Architectures by Analyzing and Synthesizing Long Distance Dependencies in Benchmark Sequential Datasets. <i>arXiv e-prints</i> .	
REFERENCES	Prof. John D. Kelleher Professor of Computer Science Hamilton Institute, Maynooth University, Ireland john.kelleher@mu.ie	Chetan Desai Co-Founder & CEO Qubiseed Technologies LLP, India chetan@qubiseed.com