Harsh Deshpande

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Research Interests

Statistical Modeling, Machine Learning, Reinforcement Learning, Voice Conversion, Language Models

Education

Indian Institute of Technology, Bombay *2016-Present*
Dual Degree (Bachelor + Master in Technology) in Electrical Engineering
Specialization: Communication and Signal Processing
Major GPA: 9.5/10 (5^{th} among 70+ students)
Completed a minor in Computer Science with a Minor GPA of 10/10

Patents & Publications

Exploratory Navigation and Selective Reading *Paper*
Natwar Modani, Paridhi Maheshwari, **Harsh Deshpande**, Saurab Sirpurkar, Diviya, Somak Aditya
AAAI Conference on Aritificial Intelligence 2020 at New York, USA

Age-of-Information Bandits with Heterogeneous Data Rates *Paper*
Harsh Deshpande, Sucheta Ravikanti, and Sharayu Moharir
Under Review at IEEE International Conference on Communication 2021, Montreal, Canada

Contextual Bandits Evolving Over Finite Time *Paper*
Harsh Deshpande, Vishal Jain, Sharayu Moharir
Presented at COMSNETS 2020 at Bangalore, India

Automated Identification of Concept Labels for a Text Fragment *Patent*
Filed at the United States Patent and Trademark Office (US-PTO)
Date of filing: Feb 6, 2020; Patent number: us 16/784,000

Automated Identification of Concept Labels for a Set of Documents *Patent*
Filed at the United States Patent and Trademark Office (US-PTO)
Date of filing: Feb 6, 2020; Patent number: us 16/784,145

Research Experience

Adobe Research | **Automated Identification of Concept Labels** **May-July 2019**
Guide: Natwar Modani | *Summer Internship* *Adobe Research, Bangalore*

Introduction: Motivated from the idea of a tool for Adobe Acrobat DC which would help readers traverse a large amount of related text documents. Navigating a collection of documents can be facilitated by obtaining a human-understandable concept hierarchy with links to the content.

- Conceptualized and built a tool *"NAVIGATION.AI"*, that automatically decomposes a set of documents into semantic units and assigns concise, human-understandable concepts to them
- Developed an algorithm using Explixit Semantic Analysis and Gram Schmidt Optimization to create a semantically meaningful yet intuitive hierarchical representation of the underlying topics facilitating selective reading
- Conducted a user-study to evaluate the quality of conecpts & hierarchy retrieved by the tool and obtained an average rating of 3.72 on a 5-point Likert Scale with over 75% people rating it 4 or higher

Parametric Time Dependent Entropy of EEG **May 2018 - July 2018**
Guide: Prof. Anastasios Bezerianos | *Cognitive Engineering, SINAPSE* *NUS, Singapore*

- Developed and implemented algorithms to calculate and analyze four distinct **Parametric Time-Dependent Entropies** (TDE) of an EEG (Electroencephalogram) signal and perform **real-time mental fatigue monitoring**
- Applied Support Vector Machine(SVM) to classify Cognitive Fatigue and Mental Workload achieving **75%** and **82%** classification accuracy respectively

Voice Conversion in Low Resource Domain **January 2020 - Present**
Guide: Prof. Preethi Jyothi | Research Project *IIT Bombay*

Introduction: Voice Conversion(VC) is a technology that modifies the speech of a source speaker and makes their speech sound like that of another target speaker. A lot of the state-of-the-art VC models rely on the availability of a large amount of clean training data. We propose a model to perform it on low-resource & noisy datasets.

- Working on Variational Auto-Encoder (VAE) based models to achieve voice conversion with **accent-transfer**
- Proposed and implemented an **adversarial model to facilitate voice conversion** on a high-resource dataset consisting utterances from native speakers and then transfer the learning on low-resource & dataset with utterances from both native and non-native speakers
- Experimenting with various augmentation pipelines to produce accent-converted speech on noisy data

Age of Information Bandits: Arms with Heterogeneous data rates **May 2020 - Present**
Guide: Prof. Sharayu Moharir | Master's Thesis *IIT Bombay*

Introduction: This work is motivated by Internet-of-Things (IoT) based applications like smart-cars, whose performance is extremely sensitive to communication delays. We consider a setting where one sensor is communicating to the receiver via one of K channel configurations each having a time-period and success rate.

- Modelled channel configurations as a Multi-Armed Bandit problem with arms having heterogenous data-rates
- Conceptualized novel variants of standard Multi-Arm Bandit algorithms like UCB & Thompson Sampling that minimize the Age-of-Information (AoI) and obtained theoretical upper bounds which **prove sub-linear regret**
- Further, proposed and implemented **AoI-aware variants** of these novel policies. Performed simulations and experimentally proved that the proposed policies perform better than their AoI-agnostic counterparts

Awards and Scholastic Achievements

- Awarded **AP** grade for excellent performance in Probability and Random Processes *2019*
- Secured **All India Rank 474** in IIT JEE-Advanced among 150,000 candidates *2016*
- Bagged **All India Rank 458** in JEE Mains among 1.3 million candidates *2016*
- Amongst the **top 300** students in INPhO, Indian National Physics Olympiad, HBCSE *2016*
- Awarded the prestigious **KVPY Fellowship** by DST, Govt. of India with **All India Rank 106** *2014*
- Awarded the prestigious **NTSE** Fellowship by NCERT, Government of India *2014*

Mentoring & Leadership Experience

- **IITB Mars Rover Project | Team Head**
  Introduction: The IITB Mars Rover project is a student initiative at IIT Bombay to build a prototype Mars Rover capable of extra-terrestrial robotics.The team represented India at the finals of University Rover Challenge-2018 and bagged 31st position out of 95 participating teams from around the world.
  - Leading a **3-tier** team of **40 members** to design & build an all-terrain rover prototype
  - Spearheaded the team at the IRDC 2020 securing **4th place** amongst 28 international teams
  - Implemented onboard sensor fusing of GPS and IMU via **Extended Kalman Filter** for robust localization
- **Institute Student Mentor** - Mentor to **14 freshmen students**, helping them cope with the curriculum and focusing on their holistic development, selected via a rigorous procedure comprising of interviews
- **Teaching Assistant** - Among the **6 students** selected across all batches for teaching a class of **70+** second-year students for the undergraduate course on Signals and Systems. Coordinated with the Electrical Dept. to conduct regular **tutorial sessions** & **evaluate exam papers**

Notable Projects

Language Models for Morphologically Rich Languages **July 2019 - November 2019**
Guide: Prof. Preethi Jyothi | CSE Department *IIT Bombay*

- Worked with **morphologically rich languages** having low labeled resources, such as word segmentations
- Proposed a factored-output model with jointly learned mixture weights that predicted the next word using word and morpheme-level probability distributions
- Worked on a stem-based Language Model that uses **multi-task learning** and observed drastic reductions in perplexities (upto 50%) across 4 morphologically-rich languages as compared to competitive baselines

Contextual Multi Arm Bandits **September 2018 - November 2018**
Guide: Prof. Sharayu Moharir | EE Department *IIT Bombay*

- Analysed a variant of Multi-Armed Bandits with underlying (user) context that influences rewards and actions, and evolves over time based on them; specifically dealt with **positive externality** on user arrivals
- Explored existing bandit algorithms and conceptualized a new Rejection-Based Arm Elimination policy

Texture Synthesis by Non-parametric Sampling **August 2019- December 2019**
Guide : Prof. Suyash Awate | Course Project *IIT Bombay*

- Synthesized a texture from a seed image on MATLAB to accomplish **hole filling** and **image expansion**
- Modeled the image as a **Markov Random Field** to find the probability distribution of a pixel

Kalman filtering based sensor data fusion **February 2019 - March 2019**
Guide: Prof. V. M. Gadre | Course Project *IIT Bombay*

- Conceptualized and simulated an algorithm for fusing **GPS** and **IMU** readings using a **Kalman** Filter
- Designed and simulated a digital circuit to implement **Fadeev's** algorithm for achieving the same in O(n) complexity
- Was among the **top 5** best projects among the 37 groups that presented their work in this course

Digitally Programmable Analog Computer **February 2019 - March 2019**
Prof. Mukul Chandorkar | Course Project *IIT Bombay*

- Proposed a hybrid system of analog and digital modules which solves non-linear differential equations in 8 variables
- Designed an analog module using integrators and interfaced it with a micro-controller to compute non-linearities
- Implemented the system on a two-layered printed circuit board with on-board power management using EagleCad

Semiconductor Device Parameter Extraction **November 2017 - December 2017**
Guide: Prof. M. B. Patil | EE Department *IIT Bombay*

- Conducted a literary survey of how variation in values of parameters of the **SPICE model** of a bipolar junction transistor BC547 affect its device characteristics and how they can be tweaked to obtain desirable features
- Developed an iterative method based on **Particle Swarm Optimization** to determine parameters of the transistor from device characteristics accurately and in a short convergence time

Technical Skills

Programming	C++, C, Python, Java, Bash, MATLAB, Prolog, VHDL, SQL
Web Development	HTML, CSS, Javascript, PHP, Bootstrap
Packages	TensorFlow, Pytorch, Keras, Android Studio, OpenCV, NumPy, Pandas
Software	Gnuplot, Git, LaTeX , OpenFST, AutoCAD, Android Studio, Xilinx ISE, Kaldi

Key Courses Undertaken

Computer Science	Data Analysis and Interpretation, Data Structures & Algorithms, Computer Networks, Introduction to Machine Learning, Operating Systems, Fundamentals of Digital Image Processing
Electrical Engg.	Speech Processing, Neuromorphic Engineering, Error Correcting Codes, Analog and Digital Systems, Microprocessors
Mathematics & Statistics	Information Theory and Coding, Estimation and Identification, Linear Algebra, Advanced Concentration Inequalities, Probability and Random Processes, Introduction to Stochastic Models, Calculus

Extracurriculars

- Volunteered for the **Green Campus initiative** of National Service Scheme(NSS),IIT Bombay
- **Quaterfinalist** at the Freshman Squash Open organised by IIT Bombay
- Bagged 2nd place at **Vigyasa**, an Inter-College GK quiz where more than 20 colleges across the state competed
- Elected **School Captain** to lead a 15 member school council
- Awarded **Silver Medal** in IKEN Scientifica Robotics Olympiad
- Maharashtra State Champion in Abacus Mental Arithmetic Exam oraganised by UCMAS