Siddharth Chandak | CV

Contact Information

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Research Interests

Communication Systems, Machine Learning, Information and Coding Theory, Probability and Statistics

Education

Indian Institute of Technology (IIT) Bombay, Mumbai, India
Bachelor of Technology, Electrical Engineering, *Expected:* Summer 2021
- **Honors** in Electrical Engineering
- **Minor** in Computer Science and Engineering
- **Cumulative Performance Index (CPI)**: 9.89/10.00

Academic Achievements

- Recipient of the **Stanford Graduate Fellowship**
- **President of India Gold Medal** at IIT Bombay for best academic standing in B.Tech. in 2021
- Among the **top 50** candidates in the **Indian National Olympiads in Chemistry and Physics** and chosen to attend respective **Selection Camps** for **International Olympiads** in 2017
- **All India Rank 346** in JEE Advanced 2017 among 220,000 students
- **All India Rank 73** in JEE Main 2017 among 1.18 million students
- Recipient of **KVPY Fellowship** with an **All India Rank 86** in 2016 (KVPY is a Fellowship in Basic Sciences, initiated by the Department of Science and Techology, Govt. of India)
- **NTSE** Scholar (National Talent Search Exam conducted by NCERT, Govt. of India) since 2015

Publications

Journal

- S. Chandak, F. Chiariotti, P. Popovski, "Hidden Markov Model-Based Encoding for Time-Correlated IoT Sources," in *IEEE Communications Letters*, doi: 10.1109/LCOMM.2020.3044210.

Preprints

- S. Chandak, V. S. Borkar, "Concentration of Contractive Stochastic Approximation and Reinforcement Learning", *arXiv (2021)*, 2106.14308. *Submitted to Stochastic Systems.*
- V. S. Borkar, S. Chandak, "Prospect-theoretic Q-learning", *arXiv (2021)*, 2104.05311. *To appear in Systems and Control Letters.*

Research Projects

- **Prospect-Theoretic Q-Learning**   August 2020 - January 2021
  Guide - Prof. Vivek Borkar, EE, IIT Bombay
  Studying classical Q-learning from a prospect theoretic viewpoint, i.e., when the valuation of future returns is distorted by a subjective map that accentuates perceived higher returns and diminishes perceived losses
    - Analyzing asymptotic behaviour of the resulting Q-learning scheme using monotone dynamical systems, in particular, determining number and locations of equilibrium points under different conditions
    - Simulated Q-learning scheme and the equivalent differential equation to verify theoretical results

- **Hidden Markov Model-Based Encoding for Time-Correlated IoT Sources**   April - July 2020
  Guide - Prof. Petar Popovski, Department of Electronic Systems, Aalborg University, Denmark
  Proposed encoding and decoding scheme for transmitting short IoT packets with time correlation across a noisy channel by modeling source dynamics using Hidden Markov Models
    - Proposed selective puncturing of Markov state bits and higher error protection for random bits in a packet, instead of source compression used in traditional approaches
    - Used forward-backward decoding to exploit Markov source dynamics and achieve low decoding latency
    - Tested approach for Binary Symmetric Channel using BCH and Convolutional codes
    - Proposed scheme achieves significantly lower packet error rate than traditional compression-based encoding schemes in simulations

- **Social Network Inference from Survey Data**   May - July 2019
  Guide - Prof. Nick Jones, Mathematics, Imperial College London, UK
  Investigated the difference between social networks in UK, ICL and "Hackspace" - a smaller technical community at ICL, by analyzing survey data on friendships within and across communities
    - Modeled the social network using a stochastic block model and inferred the model parameters and error bounds using Bootstrapping and Bayesian Inference
    - Analyzed "Hackspace" survey to examine if innovative spaces promote friendships between communities (defined with respect to gender, age, education, etc.)
    - Used notions of distance between probability distributions to define a statistic for "Homophily", the tendency to socialize within one's own community
    - Related Homophily to people's subjective health for different regions of the UK

- **A Survey in Pedagogy**   December 2018 - December 2019
  Guide - Prof. D. Manjunath, EE, IIT Bombay
  Conducted a department-wide survey to improve curriculum design and pedagogy process
    - Designed a questionnaire about course related issues such as factors affecting grades, evaluation structure and course feedback
    - Conducted the survey for 40 students and 20 professors chosen randomly from the EE department
    - Performed statistical analysis of survey data to investigate how students from different grade ranges approach academics
    - Suggested methods to improve course experience for students and professors on the basis of survey data

Other Projects

- **Spanning Tree Protocol and Learning Bridges**   Autumn 2020-21
  Computer Networks - Course Project, Guide - Prof. Varsha Apte
  Studied and implemented protocols for packet transfer at link layer
    - Implemented distributed spanning tree algorithm in Python according to IEEE 802.1D standards
    - Implemented algorithm for learning forwarding tables in bridges

- **Image Deblurring**   Autumn 2020-21
  Digital Image Processing - Course Project, Guide - Prof. Ajit Rajwade
    - Implemented deblurring of images using reverse heat equation and stabilization in MATLAB

- **Processor Design**   Autumn 2019-20
  Microprocessors - Course Project, Guide - Prof. Virendra Singh
    - Designed a 6-stage pipelined processor with forwarding, hazard control and branch prediction using VHDL and tested it on Altera FPGA board
    - Designed a CISC processor (subset of 8085 ISA) using hardware flowchart method

- **Application Form Reader**   Summer 2018
  Institute Technical Summer Project
    - Created an autonomous system to read multiple application forms using Intelligent Character Recognition & sort them according to their content
    - Built a feeding mechanism using motors, Arduino and IR sensors to move pages one at a time and stop pages below camera
    - Detected text boxes in form with high accuracy using OpenCV library in Python
    - Trained a neural network for character recognition using Keras library in Python

- **Gamification of Safety Training**   Summer 2018
  Guide - Prof. Narendra Shiradkar, EE, IIT Bombay
    - Created a road safety game using Unity and C# with multiple scenarios depicting traffic rules
    - Used Unity to build a quiz game on fire safety connected to a MySQL database using PHP

- **Digital Phase Meter**   Spring 2017-18
  Electronics - Course Project, Guide - Prof. Subhananda Chakrabarti
    - Designed a circuit to calculate and display the phase difference between two sinusoidal input waveforms of the same frequency
    - Used Timer, Comparator and Counter ICs to display angular phase difference

Technical Skills

- **Programming Languages:** C++, Python, MATLAB, LaTeX, C#, SQL
- **Hardware and Software Skills:** VHDL, Assembly, Embedded C, Unity, Arduino IDE, SolidWorks, AutoCAD, Ngspice

Selected Courses

- **Advanced EE Courses:** Queuing Systems, Error Correcting Codes, Stochastic Optimization, Advanced Probability and Random Processes, Information Theory and Coding, Number Theory and Cryptography, Optimization, Applied Linear Algebra
- **Core EE Courses:** Digital Communication, Data Analysis and Interpretation, Control Systems, Digital Systems, Microprocessors, Digital Signal Processing

- **Computer Science:** Advanced Machine Learning, Theoretical Machine Learning, Data Structures and Algorithms, Logic for CS, Computer Networks, Digital Image Processing, Operating Systems
- **Miscellaneous:** Biology, Chemistry, Economics, Sociology, Environmental Studies, Complex Analysis, Differential Equations

Teaching Experience

Served as undergraduate teaching assistant for a batch of 50 freshmen, conducting weekly tutorial sessions, special doubt sessions, and grading answer sheets for the following courses:

- MA106: Linear Algebra   Spring 2019-20
- MA105: Calculus   Autumn 2019-20
- PH108: Basics of Electricity and Magnetism   Spring 2018-19
- PH107: Quantum Physics and Applications   Autumn 2018-19

Extra-Curricular Activities

- Participated in outreach activity aimed at students and professors from other universities under the 'Knowledge Incubation under TEQIP' ('KITE') Initiative of the MHRD, Govt. of India in 2018
  - Presentation on Network Epidemiology adjudged 2nd among 25 groups
- Completed one year Yoga training in 2017-18
- Attended 10-day Vipassana meditation camps