Sahana Ramnath | Curriculum Vitae

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Predoctoral Researcher at Google Research, India. Research interests lie in applying Machine Learning and Deep Learning to NLP and multimodal systems, particularly with the incorporation and analysis of interpretability.

Education & Experience

- **Google Research, Bangalore, India** **2020 - current**
  Predoctoral Researcher, Advertising Sciences and Machine Translation
- **Indian Institute of Technology (IIT) Madras, Chennai, India** **2015 - 2020**
  *Interdisciplinary Dual Degree with BTech in Electrical Engg. and MTech in **Data Science***
  CGPA: 8.87/10
- **PSBB, K.K.Nagar, Chennai, India** **2015**
  XII (CBSE), 479/500 (95.8%)
  Computer Science - 100%, Chemistry - 100%, Math - 98%
- **PSBB, K.K.Nagar, Chennai, India** **2013**
  X (CBSE), 10/10 (CGPA) School Topper

Publications

- **Sahana Ramnath**, Melvin Johnson, Abhirut Gupta, Aravindan Raghuveer. HintedBT: Augmenting Back-Translation with Quality and Transliteration Hints. (long paper at **EMNLP 2021**)
- **Sahana Ramnath**, Preksha Nema, Deep Sahni, Mitesh M. Khapra. A Framework for Rationale Extraction for Deep QA models. (short paper, **arXiv preprint**)
- **Sahana Ramnath**, Preksha Nema, Deep Sahni, Mitesh M. Khapra. Towards Interpreting BERT for Reading Comprehension Based QA. (short paper at **EMNLP 2020**)
- **Sahana Ramnath**, Amrita Saha, Soumen Chakrabarti, Mitesh M. Khapra. Scene Graph based Image Retrieval - A case study on the CLEVR Dataset. (extended abstract, awarded **Best Paper** at **LINGIR Workshop, ICCV 2019**)
- Akshun Yadav, **Sahana Ramnath**, Pradeep Unde. Performance Benchmarking of Data Stores. (Published in Mastercard Technology Network Conference (TLN))

Notable Projects

- **HintedBT & Segmented Handling of Data for Low-Resource MT** **Aug 2020 - current**
  Ad Sciences & Machine Translation *Google Research, Bangalore, India*
  - **Hinted Back-Translation:** Enabling effective usage of back-translation data for machine translation of low-resource, cross-script language pairs through hints/tags. Working on news-domain sentence data (WMT).
    - ⋆ tags on the source that indicate the ***quality*** of the source-target pair (enabling the model to learn efficiently from noisy data as well)
    - ⋆ tags on the target that indicate the ***operation*** to be done on the source (only translation, or translation+transliteration)
  - Achieved strong empirical results **competent with current SOTA's** for three WMT news-translation datasets.
  - Relevant Links: Paper
  - **Segmented Measurement of Model Performance:** Splitting cross-script MT dev/test sets into orthogonal segments based on translation-type/presence of entities, to analyze models' performances more effectively. Working on internal data (short, entity-rich phrases).
  - A single BLEU score on a dev/test set is not fully interpretable, since a model can have widely different performances on different logical segments (such as no entities in source vs. source is completely entities).
  - This *segmented analysis* of performance leads to more **transparency**, and **improved understanding** of data augmentation (generation and/or cleaning) methods.
  - **Segmented Data Selection:** Using the above segmented BLEU scores to identify which data generation/filtering techniques give rise to train sets that lead to the best model performances in each segment.

- Combining relevant segments of these identified train sets, to train a final model that will perform well in *all* the logical segments while testing.
- Achieved **20%** improvement in model performance over baseline.

- **Analyzing Interpretability of Deep RCQA Systems** **Aug 2019 - May 2020**
  Guide : Dr. Mitesh M. Khapra *IIT Madras, Chennai, India*
  - Defining and analyzing the interpretability of four existing deep models (BERT, BiDAF, DCN, QANet) for the task of Reading Comprehension based Question Answering, on the dataset SQuAD.
  - Using attribution methods (integrated gradients) to find passage words most important to the model.
  - Testing the model's interpretability by manipulating these important words, and analyzing results both qualitatively (sample wise analysis, t-SNE plots), and quantitatively (decision flips, layer functionality analysis, JSD plots, etc.).
  - Relevant Links: DDP Thesis, Paper-1, Paper-2, Paper-1-code

- **Dialog-Based Image Retrieval** **May 2019 - May 2020**
  Guides : Amrita Saha (IBM Research), Dr. Soumen Chakrabarti (IITB), & Dr. Mitesh M. Khapra (IITM) *AI Horizons Network, IBM*
  - Implementing an novel, explainable system for dialog-based image retrieval, on the CLEVR-Dialog dataset.
  - Designing a scene-graph based image retrieval framework that models the task as a learnable graph matching problem between a catalog of images and the caption (query).
  - Extending this neural-symbolic technique to an iterative retrieval framework, strategizing multiple rounds of questioning and answering between two jointly trained models, to reach the target.
  - Relevant Links: DDP Thesis, Paper

- **Reading Comprehension based (Multi-hop) Question Answering (RCQA)** **May 2018 - Feb 2019**
  Guide : Dr. Mitesh M. Khapra *IIT Madras, Chennai, India*
  - Implemented a deep learning architecture with a novel query-refinement module for the task of multi-hop question answering based on reading comprehension.
  - Experimented with different instantiations of the architecture with respect to the model structure and hyperparameter configurations.
  - Obtained a competent accuracy of **63.9%** on the validation task of Qangaroo-WikiHop (contemporary SOTA: 67.6%).
  - Relevant Links: Report

- **Memory-Based Multi-Tasking A3C Agent** **Aug 2018 - Nov 2018**
  Guide : Dr. Balaraman Ravindran *IIT Madras, Chennai, India*
  - Implemented a novel deep RL architecture which introduces long-term and short-term memories into an A3C network for single and multi-tasking agents.
  - Achieved significant improvements in terms of sample efficiency and regret optimality on Atari games.

- **Multi-Armed Bandits** **Feb 2018**
  Course Assignment, Reinforcement Learning *IIT Madras, Chennai, India*
  - Implemented various algorithms such as Eps-greedy, Softmax, UCB1 and MEA, for Multi-Armed Bandits, using numpy (Python).
  - Performed extensive analysis and comparison of these algorithms based on average score achieved and % optimal actions taken on different implemented testbeds and established that UCB1 and MEA were the better algorithms.
  - Relevant Links: Code

- **Performance Benchmarking of Key-Value Datastores** **May 2017 - Aug 2017**
  Industrial Internship *Mastercard Technology Pvt Ltd, Pune, India*
  Guides : Mr. Krishna Vasireddy, Mr. Pradeep Unde
  - Benchmarked three datastores : Redis, Hazelcast and Apache Ignite, on the basis of workloads with varying dataset sizes, operations, number of client threads and server cluster size using Yahoo! Cloud Service Benchmark (YCSB).
  - Submitted a report with extensive analysis of the results to be used as a baseline for further benchmarks on bigger workloads and on more complex cache stores.

- **Virtual Instruments** **Aug 2016 - Dec 2016**
  Shaastra, the technical fest of IITM *IIT Madras, Chennai, India*
  - Worked on implementing virtual (structure-less) musical instruments with the goal of bringing virtual reality to the field of music.
  - Implemented six such instruments using Arduinos, sensors (IMU, flex, magnetometer) worn on gloves to track hand movements, HC-05 Bluetooth Serial Module for wireless communication and FL Studio to produce sounds

- Instruments used by professional players for performance in front of a 1000+ audience at Shaastra
- Relevant Links: Code

- **Object-Detection** **May 2016 - Oct 2016**
  Computer Vision Group, CFI *IIT Madras, Chennai, India*
  - Implemented a model to detect specific objects in images using a SVM trained on HoG (Histogram of Oriented Gradients) features, using OpenCV C++
  - Taught a session on the same to the Computer Vision Group, IITM
  - Presented the same at Open-House, CFI, IITM
  - Relevant Links: Code

- **Hand-Gesture-Based-Control** **Feb 2016 - Apr 2016**
  Computer Vision Group, CFI *IIT Madras, Chennai, India*
  - Implemented a code which tracks movements of a person's hand in a live video using the Mean-Shift algorithm
  - Translated the tracked gestures to up-down-right-left movements and used it to control the sound of a system
  - Relevant Links: Code

Pending Patents

- Provisional patent application filed for **"Many-in-one Wearable Virtual Music Instruments"** (Provisional Patent Application Number : 201841000533) as a part of the Virtual Instruments Project

Technical Skills

- **Machine Learning Libraries :** Tensorflow, PyTorch, scikit-learn
- **Programming Languages :** Python, C, C++, Octave, MATLAB (intermediate)
- **Databases :** Working knowledge in Redis, Hazelcast, Apache Ignite and MySQL

Relevant Coursework

Machine Learning

- Deep Learning (S: 10/10)
- Machine Learning (B: 8/10)
- Dynamic Games - Theory and Applications (S: 10/10)
- Reinforcement Learning (A: 9/10)
- Topics in Reinforcement Learning (A: 9/10)
- Causal Inference (A: 9/10)

Research Projects

- Dual Degree Project (MTech) (S: 10/10)
- Creative Engineering Project (S: 10/10)

Data Analytics

- Mathematical Foundations of Data Science (A: 9/10)
- Introduction to Data Analytics (B: 8/10)
- Data Analytics Laboratory (A: 9/10)
- Big Data Laboratory (S: 10/10)

Programming

- Applied Programming Lab (A: 9/10)
- Introduction to Programming (A: 9/10)

Mathematics

- Linear Algebra for Engineers (A: 9/10)
- Probability, Statistics and Stochastic Processes (A: 9/10)

Academic Achievements

- All India Rank **779** in JEE ADVANCED 2015 and **1252** in JEE MAINS 2015
- School topper in Class 10, and was awarded the **top 1% merit award** for outstanding performance in academics for five consecutive years from Class 8 to 12, 2011-15
- Obtained the 'V.Subramanian Memorial Cash Award' and 'Prativadi Bhayangaran Anangaracharier Award' for excellent performance in Computer Science in Class 12, 2015
- Obtained the 'Padmavathy Subramaniam Memorial Award' for excellent performance in Chemistry in Class 12, 2015
- Awarded certificate of merit for being placed in the **Statewise Top 1%** for the National Standard Examination in Junior Science (NSEJS), 2012

- Selected for a two week training program on 'Information Technology - Concepts and Applications' at Infosys Technologies Limited, 2011

Positions of Responsibility

- **Teaching Assistant** for Analog Systems and Lab (Jan 2020 - May 2020) offered by Electrical Engineering department of IIT Madras
- **Teaching Assistant** for Data Analytics Lab (Aug 2019 - Dec 2019) offered by Electrical Engineering department of IIT Madras
- **Undergraduate Student Mentor**, Saathi, a student body in IIT Madras (Aug 2017 - Apr 2018)
- **Coordinator** for Computer Vision Group, Center For Innovation, IIT Madras (Aug 2016 - May 2017)
- **Coordinator** for Envisage, Shaastra, the technical fest of IIT Madras (Aug 2016 - Dec 2016)

Extra-Curricular Activities

- Badminton and Table Tennis, part of NSO (National Sports Organization) for Badminton in IITM
- Carnatic Music, trained for 10 years, performed in concerts at various temples