# Prateek Garg

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## Academic Qualifications

| Year | Degree | Institute |
|---|---|---|
| 2017 - 2021 (Expected) | B.Tech in Computer Science (Minor in Robotics) | Indian Institute of Technology, Delhi |

## Work Experience

- **Research Intern at University of Alberta, Edmonton, Canada** (*May'20-July'20*)
  - Conceptualized the effect of *state-similarities* on generalization in Monte-Carlo Tree Search using Alpha-Zero architecture
  - Built a bot on top of *KataGo*, state-of-the-art Go bot, using **Memory-Augmented MCT**S and achieved **56%** winrate.
- **Research Intern at RIKEN Center for Advanced Intelligence Project, Tokyo** (*Nov'19-Dec'19*)
  - Building a Reinforcement Learning API using **Deep Q-Learning** and **MCTS** for robots, integrating with ROS in Python
  - Implementing **MuZero** model in a Robotics Environment for building efficient self-trained robots using simulations
- **Core Team Member at Robomuse 5.0, New Delhi** (*Sept'18-Jan'2020*)
  - Deployed **vision algorithms** for obtaining **Stereo-Image** & **extracting depth data** for SLAM purposes in mobile robot
  - Used standard navigation packages in **ROS** to develop complete back end for a fully **Autonomous Navigating Robot**
  - Designed a novel vision based **Landmark Recognition** technique for estimating global state of robot ***Paper in pipeline***
  - Developed *Human Detection* and *Object Detection* modules in integration with ROS to add human safety features in bot
- **Research Intern at RIKEN Center for Advanced Intelligence Project, Tokyo** (*May'19-July'19*)
  - Performed an experimental study for the **traffic state prediction** during **Hiroshima disaster in June, 2018**
  - Prepared a comparative study between **RNNs** and Conventional Machine Learning Methods ***(SVMs, Random Forest)***
  - Conceptualized and merged the **effects of various features** on **Q-K curve** for critical nodes during the natural disaster
  - Compared the interpretation of spatio-temporal features obtained from Machine Learning models with **traffic flow theory**
  ***Co-Authored*** *a paper for submission to the* ***World Transport Policy Journal (Communicated, under Review)***
- **Project Associate at D-LIVE, Mahindra Autonomous Car Challenge, IIT Delhi** (*Feb'18-Aug'18*)
  - Received **Design Innovation Summer Award (DISA)** and sponsorship by *Institute R&D Dept., IIT Delhi*
  - **Improved odometry by 90%** at *35 kmph* using ZED Camera, GPS, IMU and obtained **correct loop closure results**
  - Worked on improving **ORB_SLAM2** to compute camera trajectory and sparse **3D reconstruction** for **visual odometry**
  - Implemented the **robot_localisation package** for accurate state approximation and integrating data obtained from GPS
  *Received a* ***Letter of Recommendation*** *for exemplary results and excellent contribution*

## Key Projects

- **PageRank**, **Prof. Rijurekha Sen**, Department of Computer Science, IIT Delhi. (*April'20-May'20*)
  - Developed an *open-source* implementation of the *Google's official* ***PageRank*** *algorithm* for large distributed systems.
  - Used **MapReduce** algorithm with **MPI** in C++ for fast processing *large graphs* (of webpages). Tested upto **300,000** edges.
- **Spine Classification & Segmentation**, **Prof. Prathosh AP**, Dept. of Electrical Engineering, IIT Delhi. (*April'20-May'20*)
  - Performed experimental study using Deep Learning techniques (**mainly CNNs**) to assess the spine structure from X-Rays
  - Used **U-Net** for segmentation and **Transfer Learning** from pre-trained model for pneumonia prediction for good results
  - While Transfer Learning helped in getting data-efficiency, trying other techniques for getting a **few-shot** learning.
- **UML Race Solver**, **Dr. Kazuki Yoshizoe**, Head, Search and Parallel Computing Unit, RIKEN AIP, Tokyo.(*June'19-Oct'19*)
  - Designed ROS node for helping robot navigate path through the maze and reach the finish point in nearly **optimal time**
  - Implemented a shallow **Monte-Carlo Tree search** for generating **potential future state** tree of the simulated robot.
  - Currently working on training a model for predicting nearly **optimal policy**, given potential future state tree from MCTS
- **AI Bots**, **Prof. Mausam**, Department of Computer Science, IIT Delhi. (*July'19-Sept'19*)
  - **Gene String Mapping**: Implemented ***Hill Climbing*** & ***Simulated Annealing*** search to find similarity between genes
  - **The Game of Cannon**: Made AI bot for the game by constructing ***MinMax Tree*** and implementing *Alpha-Beta Pruning*
  - **Graph Subset Mapping**: Formulated the problem as *constraint satisfaction problem* and further solved it by **SAT Solver**
- **Chat Application**, **Prof. Aaditeshwar Seth**, Department of Computer Science, IIT Delhi. (*Aug'19-Sept'19*)
  - Built a chat application similar to *WhatsApp* that allows user to do **encrypted chat**, which cannot be decrypted at server
  - Simulated on different network configurations by dynamically running for **multiple senders**, receivers on parallel threads
- **Multi-Cycle Processor Design**, **Prof. Anshul Kumar**, Department of Computer Science, IIT Delhi. (*Jan'19-April'19*)
  - Developed a multi-cycle processor for **ARM** language, supporting memory access, arithmetic operations and functions
  - Designed on **VHDL**, using **Xilinx** for simulation and generation of bitstream so it works on the **BASYS 3** board
- **Krivine and SECD Machine**, **Prof. Sanjiva Prasad**, Department of Computer Science, IIT Delhi. (*Jan'19-April'19*)
  - Designed **Krivine** and **SECD** machines for low level *toy language* with **lazy and eager** operational semantics
  - Converted the tokens to *Abstract Syntax Trees* using **Recursive Descent Parser** and programmed a *type-checker* for it
  - Generated low level code to be executed by the machines; Machines supported **scoping** and **recursion**

- **Search Engine**, **Prof. Amitabha Bagchi**, Department of Computer Science, IIT Delhi. (*Sept'18-Oct'18*)
  - Implemented an **Inverted Index**, a structure that stores web-pages in a format that allows efficient text search
  - Implemented **Hash Table and AVL Tree** to store words and word-positions respectively, to allow quick access
  - Developed three searches - **AND, OR, PHRASE** each of which displays web pages in order of their relevance
- **ReMark**, **Prof. Rijurekha Sen**, Department of Computer Science, IIT Delhi. (*April'18-May'18*)
  - Developed a game for a **social cause** on **android** platform with the aim of moderating the extremist views in the society
  - Designed on **Android Studio**, game uses **Bluetooth** and was reviewed positively for it's amazing **themes** and **UI**

## Fun Projects

- **GANs**: Implemented and visualised the results of various GANs like DCGAN, Wasserstein GAN and Style GAN
- **Neural Style Transfer**: Tried generating new artificial artwork using Transfer Learning.
- **Car Racing AI**: Using RL techniques on TORCS Simulator, trying to build an AI for autonomous movement of car.
- **RL Ensemble:** Implementing and visualising most RL algorithms on various OpenAI Gym environments

## Scholastic Achievements

- **Reviewed** a paper for the ***Transportation Research Record Journal***
- **All India Rank- 96** in *Joint Entrance Examination (Advanced), 2017* among **1.5 million** students
- **All India Rank- 99** in *Joint Entrance Examination Main (B.Arch), 2017* among **150 thousand** students
- Awarded *Merit Certificate* for being in **top 1%** in **Indian National Physics and Astronomy Olympiads, 2017**
- Awarded with **Kishore Vaigyanik Protsahan Yojana, 2016** Fellowship by **IISc Bangalore** securing **All India Rank 303**
- Completed **Vijyoshi National Science Camp, 2016** organised by **KVPY** with **IISc Bangalore** and ***Government of India***
- Awarded **Scholarship** for qualifying both stages of **National Talent Search Examination, 2015** by ***Government of India***

## Technical Skills and Courses Done

- **Skills:** C, C++, Python, Java, OCaml, Bash, Tensorflow, Keras, Pytorch, Sci-kit Learn, VHDL, ROS, OpenCV, OpenGL, MPI
- **Coursework:** Deep Learning, Pattern Recognition, Computer Vision, Artificial Intelligence, Reinforcement Learning, Learning for Cognitive Robot Intelligence, Computer Architecture, Computer Networks, Programming Languages, Design and Analysis of Algorithms, Discrete Mathematics, Robotics Technology, Data Structures, Operating Systems, Theory of Computation

## Publication

- Short-term traffic prediction under non-recurrent congestion: A machine learning approach for traffic management during disaster
  *Makoto Chikaraishi,* ***Prateek Garg****, Varun Varghese, Kazuki Yoshizoe, Junji Urata, Yasuhiro Shiomi, Ryuki Watanabe (2019)*

## References

- **Prof. Martin Mueller**
  *DeepMind Chair in Artificial Intelligence*, Department of Computing Science, University of Alberta, Canada
- **Dr. Kazuki Yoshizoe**
  *Head, Search and Parallel Computing Unit*, RIKEN, Center for Artificial Intelligence Project, Tokyo, Japan
- **Prof. Makoto Chikaraishi**
  *Associate Professor, Chikaraishi Lab*, Hiroshima University, Japan