



# Deep Karkhanis

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## Education

### Indian Institute of Technology, Bombay

July '16 - Aug '20

- B.Tech (with Honors) in **Computer Science** and Engineering
- Core GPA : **9.58**/10.0 ◦ Honors GPA : **10.0**/10.0
- Minor Degree in Applied Statistics and Informatics

## Work Experience

### Research Fellow

Microsoft Research Lab, India

Since Aug '20

### Co-Founder and CTO

Kwikpic Tech Services [[www.kwikpic.in](http://www.kwikpic.in)]

Since June '20

## Publication

- Krishnendu Chatterjee, Martin Chmelík, **Deep Karkhanis**, Petr Novotný and Amélie Royer, "Multiple-Environment Markov Decision Processes: Efficient Analysis and Applications", **ICAPS 2020**, Nancy, France [[AAAI Link](#)]

## Research Internships

### Software Verification and Modelling Group

Prof. Dr. Ir. Joost-Pieter Katoen

RWTH Aachen, Germany

May '19 - July '19

### Chatterjee Group

Prof. Krishnendu Chatterjee

IST Austria

May '18 - July '18

## Research Experience

### Microsoft Research Fellowship

#### Graph based Indices for Fast & High Accuracy k-Nearest Neighbour Search

MSR India

Dr. Harsha Vardhan Simhadri | Dr. Ravishankar Krishnaswamy | Received Letters of Recommendation

- Designing a system for **>98%** accuracy kNN search on datasets with **> 10<sup>6</sup> points & > 100 dimensions** with high-rate of inserts and deletes
- Employed a **hybrid model** which performs incremental **Vamana Indexing** (Microsoft DiskANN) on top of streaming **FAISS clustering** (Facebook)
- Improving the system to provide high QPS on low (**<5MB**) **memory** servers suffering from high pre-emption rates and limited disk access (**no SSDs**)
- The expected number of distance calculations are **50% less** than current state of the art low memory solutions

### Bachelor's Thesis

#### Tractable Policy Iteration for POMDPs [BTP Report]

IIT Bombay

Prof. Shivaram Kalyanakrishnan | Undergraduate Research Award | Received Recommendation

- Made policy iteration in POMDPs more controllable by regulating the update of Finite-State Controllers (FSCs)
- Designed algorithms to **combine multiple FSCs** & improve **arbitrary subsets** of FSC-nodes while ensuring Policy Improvement
- Solver found policies with **20%** higher rewards to show superiority over Value Iter & MCTS on complex infinite-horizon problems

### Internships

#### Bounded Model Checking in MDPs

RWTH Aachen, Germany

Prof. Dr. Ir. Joost-Pieter Katoen | Received Letters of Recommendation

May '19 - July '19

- Combined concepts of Stochastic Model Checking & **Counting-SAT** to compute Bounded Reachability Probabilities in MDPs
- Achieved **10x faster** solving by designing a succinct CNF encoding for Markov Chains using the transition probabilities **BDD**

#### Multiple Environment MDPs (MEMDPs)

IST Austria

Prof. Krishnendu Chatterjee | Published at ICAPS 2020 | Received Recommendations

May '18 - July '18

- Improved the **POMCP** algorithm to create an online MEMDP solver and established its superiority over POMDP solvers

- o Exploited the sparse transitions in MEMDPs to have faster belief updates [ $O(n)$  as opposed to  $O(n^2)$ ]
- o Solver was **50x** faster & a **20x** better environment detector with higher success & **crash-less** navigation on Hallway benchmarks

## Awards and Scholastic Achievements

- o Conferred the **Institute Academic Excellence Award** by the Dean for securing **Institute Rank 1** at the end of 1<sup>st</sup> year
- o Received the **Undergraduate Research Award**, IIT Bombay for distinguished research in POMDP solvers
- o Secured a Perfect **10/10 GPA** in *3 out of 7 semesters*. Only student (1 of 950) with 10.0 GPA in both Freshman semesters
- o Awarded **3 AP grades** (Advanced Performer) for having the best performance in Linear Algebra, Biology and Env. Engineering
- o Awarded the **DAAD scholarship** by the *German Federal Ministry* for pursuing advanced research in Germany
- o Secured the highest available grade (AA) in **all research and honors** courses

## Start-Up

### Co-Founder and CTO, Kwikpic.in [<https://kwikpic.in/>]

- o Adopted leading **face-recognition** technologies to create an automatic service to instantly identify and deliver photos in which the user is present
- o Optimized the algorithm on Indian faces to handle varied lighting conditions thus achieving an accuracy of **>98%** for indoor & **>95%** for night events
- o Established a **stable revenue stream within one month** of registering the firm by securing contracts with wedding and corporate event planners, without the need for external funding
- o Single-handedly developed the full-stack of the web application on AWS. **Managing a team of 6** developers thus, handling **>10** live events per month

## Academic and Research Projects

### Temporal Data Support for SQL

*Prof. S. Sudarshan*

- o Extended open-source **PostgreSQL codebase** to add a new '*valid-time*' attribute: stores time frame for which data was valid
- o Designed syntax for declaring **temporal relations**, which are relations having a valid time attribute
- o Supported "*natural and theta joins*" among relations, irrespective of them being temporal or non-temporal

### Language Processor for a subset of C

*Prof. Uday Khedkar*

- o Designed a **compiler and interpreter** from scratch for processing a C style language
- o Built support for **multiple variable scopes** and datatypes, along with control-flow, conditional and arithmetic statements
- o Implemented support for "*recursion*" and user-defined functions with multiple return-types

### Restoring degraded Cave-Paintings using Deep-Image Priors

*Prof. Masaaki Nagahara*

- o Optimized image **inpainting** methods using deep-image priors & **denoising** to identify and restore damaged parts of paintings
- o Successfully restored the depicted ornaments & facial features of people and deities in paintings from **Ajanta Caves, Mumbai**

## Leadership and Mentorship Experience

<b>Teaching Assistant</b>	<ul style="list-style-type: none"> <li>o CS252, CS224: Computer Networks, MA106: Linear Algebra, MA108: Differential Equations</li> <li>o Mentored <b>200+</b> UG's, conducted weekly tutorials, created assignments and code testers</li> </ul>
<b>Institute Web Nominee, Academic Council</b>	<b>Web Secretary</b>
<ul style="list-style-type: none"> <li>o <b>Search optimized</b> UGAC website for Google Search</li> <li>o Managed portals used by <b>3000+</b> students, <b>100+</b> professors</li> </ul>	<ul style="list-style-type: none"> <li>o Received <b>Organizational Color Award</b> for exceptional work</li> <li>o Developed website &amp; app, conducted <b>digitization</b> of hostel</li> </ul>

## Relevant Coursework

Artificial Intelligence and ML, Advanced Machine Learning, Probability Theory, Statistical Inference, Regression Analysis, Derivative Pricing, Digital Image Processing, Understanding Design (UI-UX), Advanced Remote Sensing, System Dynamics

## Software & Programming Skills

C/C++, Python, Matlab, Advanced Web Development, Scheme, L<sup>A</sup>T<sub>E</sub>X, QGIS, Java, VHDL, Prolog, Clingo, Android Studio, SolidWorks

## Other Key Academic Projects

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- o *Natural Language Processing* : QnA website using **Bayesian Taggers** for tagging/grouping questions
- o *Simulating Bokeh Effect in Videos* : Grab-Cut for getting foreground, emulating Lens Blur for **simulating Bokeh**
- o **Intel SGX** Programming : Coded **Accountable Decryption**, used Merkel-Trees for decryption-requests log
- o *Diagonal Parity* : Designed an algorithm for "*2-bit error correction*" using parity along 3 directions
- o *FPGA Railway Signal* : Used VHDL based **FPGA**-boards for 8-way junctions, **USB and UART** connections with server
- o **GO** Playing **Bot** : Developed a DFS-based **territory counting** algorithm, used MCTS with UCT for move selection

## Extra Curricular Activities

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### Sports.....

- o *Rifle Shooting* : **1st** Place in National Cadet Corps (NCC) Camp (**.22 Calibre** Rifle), Perfect Score in all rounds
- o *Cricket* : 3rd Place in District Level Tournaments with 2 Man-of-the-Match Awards in the tournaments
- o *Swimming* : **1st** position in the Summer of Sports Swimming Camp, at IIT-B

### Community Service.....

- o *National Cadet Corps (NCC)* : - Participated in the Good Samaritan Mission, Vijay Ashram supporting **1800+ destitutes**  
- Organized cloth donation (**100+ kg**) and blood-donation (60+ litres) camps
- o *Daily Dosage Tracker* : Created a universal band to help patients easily track their medicine doses

### Institute Bodies.....

- o *Entrepreneurship Cell* : Organized job fair for **1000+** students and **30+ companies** at E-Summit
- o *Innovation Cell (UMIC)* : Significant contributions to the award winning Quad-Copter and Line-Following bots

### Other Awards.....

- o *Organizational **Color Award*** : For exceptional work as Web and Computer Secretary at Hostel 7, IIT Bombay
- o *Master Laureate* : Awarded for leading overall record in High School