

# Manaar Alam

Secured Embedded Architecture Laboratory  
Department of Computer Science and Engineering  
Indian Institute of Technology Kharagpur, West Bengal, India.

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## Current Position

**Indian Institute of Technology, Kharagpur**

**Kharagpur**

*Ph. D. in Computer Science and Engineering,*

*July 2016–Present*

I am working under the supervision of *Prof. Debdeep Mukhopadhyay*. My research interest mainly lies in the application of machine learning techniques in the field of hardware and software security. I have interest on designing robust machine learning based countermeasure for against side-channel attacks, malwares, and ransomwares. I am also interested in different security aspects of machine learning like fault-resistance, privacy leakages, adversarial attacks, etc. I have also worked on analyzing side-channel leakages from secured embedded devices using machine learning to retrieve the secret key.

## Education

**Indian Institute of Technology (Indian School of Mines), Dhanbad**

**Dhanbad**

*M. Tech. in Computer Science and Engineering, OGPA - 9.7/10*

*July 2014–June 2016*

Received M. Tech. with *Distinction* and secured 3<sup>rd</sup> place from the department.

**Institute of Engineering and Management (under WBUT)**

**Kolkata**

*B. Tech. in Computer Science and Engineering, DGPA - 8.88/10*

*August 2009–May 2013*

**Hindu School (under WBCHSE)**

**Kolkata**

*Higher Secondary Examination (10+2), Overall - 92.6%*

*July 2007–May 2009*

Secured 13<sup>th</sup> place in all over West Bengal. Scored 100% in Mathematics.

**Modern School (under WBBSE)**

**Kolkata**

*Secondary Examination (10), Overall - 89.37%*

*May 2007*

## Internship Experience

**Nanyang Technological University, Singapore**

**Title:** *Lightweight Assessment of Malware for Embedded Architectures.*

**Supervisor:** Dr. Siew-Kei Lam.

**Description:** Worked in a team and developed a light-weight application to detect and prevent Malware for embedded platforms based on statistical  $t$  – *test*. The prototype of the application are implemented for both x86 and ARM processors.

**Duration:** August 2017 - January 2018.

## Academic Projects

**M. Tech. Thesis**

**Title:** *A Novel Parallel Search Technique for Multi-Objective Optimization.*

**Supervisor:** Dr. Haider Banka.

**Description:** Developed a new Parallel Search Technique to deal with various Multi-Objective Optimization Problems. With binary encoding scheme this novel technique performs better than most of the existing multi-objective optimization algorithms like NSGA-II, and MOPS.

**Duration:** July 2015 - April 2016.

**B. Tech. Dissertation**

**Title:** *Web Sentiment Analysis.*

**Supervisor:** Dr. Satyajit Chakraborty.

**Description:** Designed a web tool which allows visitors to assess the web sentiment on any subject. For each topic a pie chart expresses the current real-time sentiment along with a list of the latest news headlines associated with the subject. The pie chart and the headlines allow seeing what issues or events drive the sentiment in a positive or negative way.

**Duration:** August 2012 - July 2013.

## Other Projects

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### Industrial Collaboration.....

**Title:** *Security Analysis of Kubernetes Container-Orchestration System*

**Collaborator:** IBM Research India

**Description:** Analyze the security guarantee provided by Kubernetes container-orchestration system. The main objective is to find out possible vulnerabilities and design efficient countermeasures.

**Duration:** August 2019 - Present.

**Title:** *De-anonymization of TOR Network*

**Collaborator:** The Chatterjee Group

**Description:** Design of an efficient and low-cost solution to build traffic correlation attack on anonymized TOR network in order to de-anonymize TOR user and clients.

**Duration:** September 2018 - April 2019.

### Vocational Training.....

**Title:** *Online Job Portal using PHP and MySQL.*

**Organizer:** NIVT India.

**Description:** Designed an online job portal which helps both the job seekers and the recruiters to find the right organization and the employees respectively.

**Duration:** June 2012 - July 2012.

**Title:** *Online Photo Gallery using J2EE and MySQL*

**Organizer:** NIVT India.

**Description:** Developed an online photo gallery allowing every user to create online albums, organize digital photos and to share with other users.

**Duration:** December 2011 - January 2012.

## Competitions

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**Cyber Security Awareness Week - Applied Research Competition in India**

**2019**

*Indian Institute of Technology Kanpur*

*Kanpur*

Presented a hardware activity based monitoring approach to evaluate privacy leakages in Deep Learning Algorithms. Secured 2<sup>nd</sup> place in the competition from all over India.

**HOST: Hardware Demo**

**2018**

*IEEE International Symposium on Hardware Oriented Security and Trust (HOST)*

*Washington DC*

Designed a lightweight malware detection methodology for embedded platforms along with a fast ransomware detection techniques using Hardware Performance Counters. Reached Final round in the competition from all over the world.

**Cyber Security Awareness Week - Embedded Security Challenge in India**

**2016**

*Indian Institute of Technology Kanpur*

*Kanpur*

Designed a novel hardware mitigation technique for memory corruption and control flow integrity attacks in embedded systems. Secured 2<sup>nd</sup> place in the competition from all over India.

**International Championship for Artificial Intelligence & Networking**

**2015**

*Indian Institute of Technology Bombay*

*Mumbai*

Designed a cost effective prototype of a carom playing bot from scrap materials. Secured 2<sup>nd</sup> place in the competition from all over India. Demonstration can be found on the following link. ([https://www.youtube.com/watch?v=18lkxVzs\\_Zk](https://www.youtube.com/watch?v=18lkxVzs_Zk)).

**National Round of Indo-US Robo League**

**2015**

*Indian Institute of Technology Bombay*

*Mumbai*

Reached Pre-Final round for designing a cost effective Line Follower Robot.

## Invited Talks

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- Workshop on Cyber Physical System Security, Indian Institute of Technology Kharagpur, December 2019.
- Workshop on Advanced Side Channel Evaluation of Hardware Security, Indian Institute of Technology Kharagpur, July 2018.

## Achievements

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- 2nd Best Presentation Award in Applied Research Competition at CSAW 2019.
- Best Student Paper Award at CARDIS 2019.
- IBM PhD Fellowship Award for the Academic Year 2019-20.
- DSCI Excellence Award as a team - felicitated by Bharat Chamber of Commerce.
- 3rd Best Poster Award in Young Researcher's Forum at SPACE 2018.
- Finalist of Qualcomm Innovation Fellowship India 2017 and 2019.
- National Merit-cum-Means Scholarship awarded by WBMDFC from 2009 to 2013.
- Certificate of Excellence on ERP – Essentials from Research Software Solutions (P) Ltd. (Microsoft Gold Certified Partner), April 2010.
- National Merit Scholarship awarded by Govt. of India for securing position among Top 20 in Higher Secondary Board Examination in 2009.

## Professional Services

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- **Reviewer of Journals:** *IEEE TVLSI*, *ACM TECS*, *Springer Sādhanā*
- **Sub-Reviewer of Conferences:** *COSADE '18,'20*. *DAC '18,'19,'20*. *TCHES '19,'20*
- **Sub-Reviewer of Workshops:** *TopinHES '18*

## Teaching Assistance

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<b>Computer Programming Lab:</b> Autumn, 2015 and Spring, 2016	<i>IIT(ISM) Dhanbad</i>
<b>Data Structures Lab:</b> Autumn, 2015	<i>IIT(ISM) Dhanbad</i>
<b>Algorithm Design &amp; Analysis Lab:</b> Spring, 2016	<i>IIT(ISM) Dhanbad</i>
<b>Programming and Data Structures Lab:</b> Spring, 2017	<i>IIT Kharagpur</i>
<b>Foundation of Algorithm Design and Machine Learning:</b> Spring, 2018	<i>IIT Kharagpur</i>
<b>Cryptography and Network Security:</b> Autumn, 2018 and Autumn, 2019	<i>IIT Kharagpur</i>
<b>High Performance Computer Architecture:</b> Spring, 2019 and Spring, 2020	<i>IIT Kharagpur</i>

## Extra-Curricular Activities

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- Awards and Positions in inter-school sit-and-draw competitions.
- Participated and secured 3<sup>rd</sup> Prize in a Mathematics Competition at FESTRONIX 2011 held at Institute of Engineering and Management, Kolkata, February 2011.

## Personal Details

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**Date of Birth:** 11<sup>th</sup> February, 1991.

**Gender:** Male.

**Languages Known:** English, Bengali, Hindi.

**Nationality:** Indian.

## Patents

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- [pt1] **Manaar Alam**, Sarani Bhattacharya, Debdeep Mukhopadhyay, and Anupam Chattopadhyay. A System for Detecting Ransomware in a Computer System and a Method Thereof. [**Filed Indian Patent**. Patent Application No.: TEMP/E-1/49892/2018-KOL]

## Journals

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- [j2] **Manaar Alam**, Sarani Bhattacharya, Sayan Sinha, Chester Rebeiro, and Debdeep Mukhopadhyay. IPA: An Instruction Profiling based Micro-Architectural Side-Channel Attack on Block Ciphers In *Springer Journal of Hardware and Systems Security (HASS)*, Volume: 3, Issue: 1, March 2019, pages 26–44. DOI: 10.1007/s41635-018-0060-3
- [j1] Debapriya Basu Roy, **Manaar Alam**, Sarani Bhattacharya, Vidya Govindan, Francesco Regazzoni, Rajat Subhra Chakraborty, and Debdeep Mukhopadhyay. Customized Instructions for Protection Against Memory Integrity Attacks. In *IEEE Embedded Systems Letters (ESL)*, Volume: 10, Issue: 3, September 2018, pages 91–94. DOI: 10.1109/LES.2018.2828506

## Journals Under Review

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- [sj6] **Manaar Alam**, Arnab Bag, Debapriya Basu Roy, Dirmanto Jap, Jakub Breier, Shivam Bhasin, and Debdeep Mukhopadhyay. Neural Network-based Inherently Fault-Tolerant Cryptographic Primitives without Explicit Redundancy Checks. In *ACM Journal on Emerging Technologies in Computing Systems (JETC)*. [Under Review]
- [sj5] Sayandeep Saha, **Manaar Alam**, Arnab Bag, Debdeep Mukhopadhyay, and Pallab Dasgupta. Leakage Assessment in Fault Attacks: A Deep Learning Perspective. In *IACR Transactions on Cryptographic Hardware and Embedded Systems (TCHES)*. [Under Review]
- [sj4] Anirban Chakraborty, **Manaar Alam**, and Debdeep Mukhopadhyay. A Good Anvil Fears No Hammer: Automated Rowhammer Detection using Unsupervised Deep Learning. In *IEEE Transactions on Computer (TC)*. [Under Review]
- [sj3] **Manaar Alam**, Sarani Bhattacharya, Sourangshu Bhattacharya, and Debdeep Mukhopadhyay. Victims can be Saviors: A Machine Learning based detection for Micro-Architectural Side-Channel Attacks. In *ACM Journal on Emerging Technologies in Computing Systems (JETC)*. [Under Review]
- [sj2] Sai Praveen Kadiyala, **Manaar Alam**, Yash Shrivastava, Sikhar Patranabis, Muhamed Fauzi Bin Abbas, Arnab Biswas, Debdeep Mukhopadhyay, Siew-Kei Lam, and Thambipillai Srikanthan. LAMBDA: Lightweight Assessment of Malware for emBeddeD Architectures. In *ACM Transactions on Embedded Computing Systems (TECS)*. [First Revision Submitted]
- [sj1] **Manaar Alam**, Debdeep Mukhopadhyay, Sai Praveen Kadiyala, Siew-Kei Lam, and Thambipillai Srikanthan. Improving Accuracy of HPC-based Malware Classification for Embedded Platforms using Gradient Descent Optimization. In *Springer Journal of Cryptographic Engineering (JCEN)*. [First Revision Submitted]

## Conferences

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- [c10] Anirban Chakraborty, **Manaar Alam** and Debdeep Mukhopadhyay. Deep Learning based Diagnostics for Rowhammer Protection of DRAM Chips In *28th IEEE Asian Test Symposium, ATS 2019, Kolkata, India, December 10-13, 2019*, pages 86–91. DOI: 10.1109/ATS47505.2019.00016.
- [c9] **Manaar Alam**, Astikey Singh, Sarani Bhattacharya, Kuheli Pratihar and Debdeep Mukhopadhyay. In-situ Extraction of Randomness from Computer Architecture through Hardware Performance Counters In *18th Smart Card Research and Advanced Application Conference, CARDIS 2019, Prague, Czech Republic, November 11-13, 2019*. [Accepted] [Best Paper Award]
- [c8] **Manaar Alam** and Debdeep Mukhopadhyay. How Secure are Deep Learning Algorithms from Side-Channel based Reverse Engineering? In *ACM/IEEE Design Automation Conference, DAC 2019, Las Vegas, United States of America, June 2-6, 2019*, pages 226. DOI: 10.1145/3316781.3322465.
- [c7] **Manaar Alam**, Sarani Bhattacharya, Swastika Dutta, Sayan Sinha, Debdeep Mukhopadhyay, and Anupam Chattopadhyay. RATAFIA: Ransomware Analysis using Time And Frequency Informed Autoencoders. In *IEEE International Symposium on Hardware Oriented Security and Trust, HOST 2019, McLean, United States of America, May 6-10, 2019*, pages 218–227. DOI: 10.1109/HST.2019.8740837.
- [c6] Nimesh Kirit Shah, **Manaar Alam**, Durga Prasad Sahoo, Debdeep Mukhopadhyay, and Arindam Basu. A 0.16pJ/bit Recurrent Neural Network Based PUF for Enhanced Machine Learning Attack Resistance. In *24th Asia and South Pacific Design Automation Conference, ASP-DAC 2019, Tokyo, Japan, January 21-24, 2019*, pages 627–632. DOI: 10.1145/3287624.3287696.
- [c5] **Manaar Alam**, Sayan Sinha, Sarani Bhattacharya, Swastika Dutta, Debdeep Mukhopadhyay and Anupam Chattopadhyay. RAPPER: Ransomware Prevention via Performance Counters. In *Australian Workshop on Offensive Cryptography, Kangacrypt 2018, Adelaide, Australia, December 7–8, 2018*.
- [c4] **Manaar Alam**, Debdeep Mukhopadhyay, Sai Praveen Kadiyala, Siew-Kei Lam, and Thambipillai Srikanthan. Side-Channel Assisted Malware Classifier with Gradient Descent Correction for Embedded Platforms. In *7th International Workshop on Security Proofs for Embedded Systems, PROOFS@CHES 2018, Amsterdam, Netherlands, September 13, 2018*, pages 1–15. DOI: 10.29007/5sdj.
- [c3] **Manaar Alam**, Sarani Bhattacharya, and Debdeep Mukhopadhyay. Tackling the Time-Defence: An Instruction Count Based Micro-architectural Side-Channel Attack on Block Ciphers. In *7th International Conference on Security, Privacy, and Applied Cryptography Engineering, SPACE 2017, Goa, India, December 13-17, 2017*, pages 30–52. DOI: 10.1007/978-3-319-71501-8\_3.

- [c2] **Manaar Alam**, Debapriya Basu Roy, Sarani Bhattacharya, Vidya Govindan, Rajat Subhra Chakraborty, and Debdeep Mukhopadhyay. SmashClean: A hardware level mitigation to stack smashing attacks in OpenRISC. In *ACM/IEEE International Conference on Formal Methods and Models for System Design, MEMOCODE 2016, Kanpur, India, November 18-20, 2016*, pages 1–4. DOI: 10.1109/MEMCOD.2016.7797764.
- [c1] **Manaar Alam**, Soumyajit Chatterjee, and Haider Banka. A novel parallel search technique for optimization. In *3rd International Conference on Recent Advances in Information Technology, RAIT 2016, Dhanbad, India, March 3-5, 2016*, pages 259–263. DOI: 10.1109/RAIT.2016.7507912.

## Poster Presentations

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- [p6] **Manaar Alam** and Debdeep Mukhopadhyay. How Secure are Deep Learning Algorithms from Side-Channel based Reverse Engineering? *POSTER: ACM/IEEE Design and Automation Conference (DAC)*, Las Vegas, United States of America, June 2019.
- [p5] **Manaar Alam**, Arnab Bag, Debapriya Basu Roy, Dirmanto Jap, Jakub Breier, Shivam Bhasin, and Debdeep Mukhopadhyay. Enhancing Fault Tolerance of Neural Networks for Security-Critical Applications. *POSTER: ACM/IEEE Design and Automation Conference (DAC)*, Las Vegas, United States of America, June 2019.
- [p4] **Manaar Alam**, Sarani Bhattacharya, Debdeep Mukhopadhyay, and Anupam Chattopadhyay. Detecting Malware and Ransomware using Hardware Performance Counters. *POSTER: Security, Privacy, and Applied Cryptography Engineering (SPACE)*, Kanpur, India, December 2018. **[Third Best Poster Award]**
- [p3] **Manaar Alam**, Sarani Bhattacharya, Debdeep Mukhopadhyay, and Anupam Chattopadhyay. Detecting Malware and Ransomware using Hardware Performance Counters. *POSTER: IEEE International Symposium on Hardware Oriented Security and Trust (HOST)*, Washington DC, United States of America, May 2018.
- [p2] Sai Praveen Kadiyala, Muhamed Fauzi Bin Abbas, Yash Shrivastava, Sikhar Patranabis, **Manaar Alam**, Debdeep Mukhopadhyay, Siew-Kei Lam, and Thambipillai Srikanthan. LAMBDA: Lightweight Assesment of Malware for emBeddeD Architectures. *POSTER: Singapore International Cyber Week (SICW)*, Singapore, September 2017.
- [p1] **Manaar Alam**, Debapriya Basu Roy, Sarani Bhattacharya, Vidya Govindan, Rajat Subhra Chakraborty, and Debdeep Mukhopadhyay. SmashClean: A Hardware level mitigation to stack smashing attacks in OpenRISC. *POSTER: Cyber Security Awareness Week (CSAW)*, Kanpur, India, November 2016.

## arXiv/ePrint Papers

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- [i6] **Manaar Alam**, Arnab Bag, Debapriya Basu Roy, Dirmanto Jap, Jakub Breier, Shivam Bhasin, and Debdeep Mukhopadhyay. Enhancing Fault Tolerance of Neural Networks for Security-Critical Applications In *arXiv, CoRR, abs/1902.04560*, February 2019. **[Accepted as Work-in-Progress in DAC 2019]**
- [i5] Nimesh Shah, **Manaar Alam**, Durga Prasad Sahoo, Debdeep Mukhopadhyay, and Arindam Basu. A 0.16pJ/bit Recurrent Neural Network Based PUF for Enhanced Machine Learning Attack Resistance In *arXiv, CoRR, abs/1812.05347*, December 2018. **[Accepted in ASP-DAC 2019]**
- [i4] **Manaar Alam** and Debdeep Mukhopadhyay. How Secure are Deep Learning Algorithms from Side-Channel based Reverse Engineering? In *arXiv, CoRR, abs/1811.05259*, November 2018. **[Accepted as Late-Breaking-Results in DAC 2019]**
- [i3] Anirban Chakraborty, **Manaar Alam**, Vishal Dey, Anupam Chattopadhyay, and Debdeep Mukhopadhyay. Adversarial Attacks and Defences: A Survey. In *arXiv, CoRR, abs/1810.00069*, September 2018.
- [i2] **Manaar Alam**, Sarani Bhattacharya, Debdeep Mukhopadhyay, and Anupam Chattopadhyay. RAPPER: Ransomware Prevention via Performance Counters. In *arXiv, CoRR, abs/1802.03909*, February 2018. **[Modified Version Accepted in Kangcrypt 2018]**
- [i1] **Manaar Alam**, Sarani Bhattacharya, Debdeep Mukhopadhyay, and Sourangshu Bhattacharya. Performance Counters to Rescue: A Machine Learning based safeguard against Micro-architectural Side-Channel-Attacks. In *Cryptology ePrint Archive, Report 2017/564*, July 2017.

## References

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- **Dr. Debdeep Mukhopadhyay**, Professor, Department of Computer Science and Engineering, Indian Institute of Technology Kharagpur, debdeep@cse.iitkgp.ac.in
- **Dr. Haider Banka**, Associate Professor, Department of Computer Science and Engineering, Indian Institute of Technology (Indian School of Mines) Dhanbad, banka.h.cse@ismdhanbad.ac.in