Sumanta Dey, Machine Learning Researcher *at* ***Indian Institute of Technology Kharagpur***

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Research Summary

My primary research objective addresses the need for trustworthy and safe Reinforcement Learning (RL) policies, particularly in safety-critical applications like autonomous vehicles, robots, and drones. Deep Reinforcement Learning (DRL) algorithms are used in these applications due to their impressive learning capabilities, but unfortunately, they come at the cost of limited interpretability. This institutes a trust deficit for their real-world deployment as they can potentially lead to accidents that hinder societal acceptance. My research focuses on two critical aspects of achieving trustworthy and Safe RL (SRL). *Firstly* we develop techniques to ensure RL agents learn without violating safety constraints, thus incurring a surge in training costs or fatal accidents. This involves constant runtime monitoring and devising new learning algorithms to ensure safety adherence. *Secondly,* we have explored methods to reduce the size and complexity of learned DRL policies while preserving their performance. Such reduced-sized policies are more interpretable and facilitate verification, enabling broader trust and acceptance of these technologies.
We have also developed a framework with Intel for generating targeted stimuli to boost simulation-based test coverage using machine learning models. At the same time, we have devised a strategy to find the root cause of an event from the traces of pre-silicone (RTL) hardware simulations. My research's ultimate goal is to contribute to the widespread adoption of dependable and trustworthy ML-based systems that benefit society.

Working Experience

Jun'19 – till date
- **Research Scholar** *at*, Indian Institute of Technology Kharagpur
  My research primarily includes devising reinforcement learning (RL) training algorithms for safety-critical systems to reduce safety infractions while training via constant runtime monitoring and also modifying the RL algorithm to ensure safety adherence in the learned policies. Along with this, proposed methods for compacting the learning policies to make those suitable for deployment in edge devices and verification to ensure safety post-deployment.
- **Teaching Assistant** *at*, Indian Institute of Technology Kharagpur
  Artificial Intelligence, Machine Learning, Programming and Data Structures Lab, Computer Architecture Lab, etc.
- **Reviewer** *for Annual AAAI Conference on Artificial Intelligence (AAAI)*

Dec'22 – Jun'24
- *Research Project on* **AI Assisted Stimuli Prediction** *at*, Intel, India
  We have developed a framework for generating targeted stimuli to boost simulation-based test coverage using machine learning models. We have also devised a strategy to find the root cause of an event from the traces of pre-silicone (RTL) hardware simulations.

Oct'20 – Apr'21
- **AI Safety Researcher (Intern)** *at*, Ericsson Research, India
  Devised the Adaptive Safety Shield framework that works with the existing RL Agent to improve the Cellular Network performance while helping to reduce unsafe state exploration.

Jul'18 – Sep'18
- **AI Safety Researcher (Intern)** *at*, WMG, University of Warwick, Warwick, UK
  Devised a sample efficient testing strategy for autonomous vehicles using Bayesian optimization.

Jul'17 – Jun'19
- **Teaching Assistant** *at*, Indian Institute of Technology Kharagpur
  High-Performance Computer Architecture, Programming and Data Structures Lab

Feb'13 – Jul'17
- **IT Analyst** *at*, Tata Consultancy Services Ltd., Kolkata, India
  Role: Lead Java Developer

Education

2024
- **Ph.D** *in* **Computer Science & Engineering**
  Indian Institute of Technology Kharagpur

2019
- **M.Tech** *in* **Computer Science & Engineering** [9.2/10]
  Indian Institute of Technology Kharagpur

Education (continued)

2012 **B.Tech** *in* **Computer Science & Engineering** [GPA: 7.7/10]
West Bengal Unversity of Technology, India

Research Publications

Journal Articles

1. S. Dey, A. Mujumdar, P. Dasgupta, and S. Dey, "Adaptive safety shields for reinforcement learning-based cell shaping," *IEEE Transactions on Network and Service Management*, vol. 19, no. 4, pp. 5034–5043, 2022.

Conference Proceedings

1. B. Gangopadhyay, S. Khastgir, S. Dey, P. Dasgupta, G. Montana, and P. Jennings, "Identification of test cases for automated driving systems using bayesian optimization," in *2019 IEEE Intelligent Transportation Systems Conference (ITSC)*, IEEE, 2019, pp. 1961–1967.
2. S. Dey, P. Dasgupta, and B. Gangopadhyay, "Safety augmentation in decision trees.," in *AISafety@IJCAI*, 2020.
3. S. Dey, P. Dasgupta, and S. Dey, "Safe reinforcement learning through phasic safety oriented policy optimization," in *SafeAI@AAAI*, 2023.
4. S. Dey, B. Gangopadhyay, P. Dasgupta, and S. Dey, "Magnets: Micro-architectured group neural networks," in *Proceedings of the 23rd International Conference on Autonomous Agents and Multiagent Systems*, 2024, pp. 2650–2658.
5. S. Dey, P. Dasgupta, and S. Dey, "P2bpo: Permeable penalty barrier-based policy optimization for safe rl," in *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 38, 2024, pp. 21 029–21 036.
6. S. Singh, S. Hazra, S. Dey, and S. Dey, "Certifying learning-enabled autonomous cyber physical systems-a deployment perspective," in *2024 37th International Conference on VLSI Design and 2024 23rd International Conference on Embedded Systems (VLSID)*, IEEE, 2024, pp. 270–275.
7. S. Dey, S. Bhat, P. Dasgupta, and S. Dey, "Imperative action masking for safe exploration in reinforcement learning," in *International Workshop on Explainable, Transparent Autonomous Agents and Multi-Agent Systems*, Springer, 2023, pp. 130–142.

Achievements

2024 **Football Runners up in ASL, IIT Kharapur** organized by *BR. Ambedkar Hall, IIT KGP*
Football Champions in RSPL organized by *IIT Kharapur*

2020 **Finalist in Qualcomm Innovation Fellowship (QIF)** organized by *Qualcomm*

2017 **GATE** percentile 99.82
AIR 3 in Scientist (CS) Exam organized by *ISRO*

2016 **Awarded 'Star of the Month'** by Tata Consultancy Services Ltd.

2013 **Awarded 'On Spot Award'** by Tata Consultancy Services Ltd.

Skills & Trainings

Coding	C, Python, Java, C++, CUDA, JavaScript, VB.Net
Tools & Technology	Matlab, Oracle DB, Git, IPG CarMaker, Carla, Power World, Uppal, Sherlock
Certifications	Oracle Programming in Java
Workshops	*Volunteer at the workshop for the indo-german collaborative research centre (IGSTC) on intelligent transportation systems (futuretrans)* organized by Indian Institute of Technology Kharagpur, *Training on VB.Net* organized by HP Training Institute,
Web Dev	Html, css.
Languages	Bengali, English, Hindi