With the widespread integration of Artificial Intelligence (AI) in various sectors, the security and safety of AI-enabled systems have not yet been fully ensured. Just like conventional systems having software bugs or errors, applications leveraging AI are not free of bugs. In this talk, I will present an optimization-based framework for identifying and mitigating backdoor vulnerabilities in machine learning models. My talk will cover novel optimization techniques that more efficiently and effectively detect backdoors in both white-box and black-box settings, achieving substantial improvement in performance. My work contributed to the Purdue team securing the first place in IARPA TrojAI Trojan Detection Competition (Rounds 1-4). I will share insights on the essence of backdoors and their presence in naturally pre-trained models. I will also introduce the first hardening framework for mitigating backdoor vulnerabilities. Finally, I will conclude with an outlook on securing emerging AI techniques, such as generative AI (GenAI), and the evolving ecosystem enabled by GenAI.

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