

Artifact Abstract and Reproducibility Guide

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This artifact accompanies the paper “Swarm in EM Hay: Particle Swarm-guided Probe Placement for EM Side-channel Analysis” and provides a reproducible implementation of automated electromagnetic (EM) side-channel analysis. The core idea of the artifact is to automate electromagnetic (EM) side-channel analysis by combining Mutual Information (MI)-based leakage evaluation with Particle Swarm Optimization (PSO) for adaptive probe localization. The artifact further integrates Matrix-based Rényi Entropy (MRE), Nyström approximation for scalable MI estimation, Gaussian Mixture Model (GMM)-based spatial modeling, and PSO-guided navigation to efficiently identify high-leakage probe positions.

The main focus of the artifact is the analysis and MATLAB workflow. The analysis notebook computes MI and TVLA heatmaps, exports the data needed to build GMM models, and can also perform CPA to estimate the minimum number of traces required for key recovery. The MATLAB scripts then use the exported data to build the GMM model and run PSO-based search to localize informative probe positions. The capture workflow is included as an optional extension for generating new traces, but it is not required to evaluate the main artifact claims.

Evaluation should check that the analysis notebook produces the expected MI, TVLA, and CPA outputs, that the exported data are sufficient to construct the GMM inputs, and that the MATLAB pipeline successfully builds the model and finds probe locations using PSO. The repository includes the notebooks, MATLAB scripts, processed datasets, and supporting utilities needed to reproduce these steps end to end.

Overall, the artifact is designed to provide a fully reproducible and end-to-end implementation of automated EM side-channel analysis using information-theoretic leakage estimation and swarm-guided probe navigation.