

# XINYI WU

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Academic Homepage

Github

## Education

### Southern University of Science and Technology

Sep. 2021 – June 2024

Master of Engineering in Electronic Science and Technology, GPA:3.71/4

Shenzhen, Guangdong

### Huaqiao University

Sep. 2017 – June 2021

Bachelor of Engineering in Network Engineering, GPA:4.5/5(TOP 1)

Xiamen, Fujian

## Research Experiences

### Endogenous Functional Safety and Economic Optimization of Industrial Control Systems: A Reinforcement Adversarial Framework

Sep 2022 – April 2024

Main Researcher — Dept of Computer Science and Engineering, Southern University of Science and Technology

Supervisors: Associate Professor Yulong Ding, Professor Shuang-Hua Yang

Supported in part by the National Natural Science Foundation of China (Grant No. 92067109, 61873119, 62211530106), and in part by Shenzhen Science and Technology Program (Grant No. ZDSYS20210623092007023, GJHZ20210705141808024) and Shenzhen Key Laboratory of Safety and Security for Next Generation of Industrial Internet.

- Developed and extended an innovative Reinforcement Adversarial Framework to enhance both safety ability and economic optimization in Industrial Control Systems (ICS).
- Phase 1 (Sep 2022 - July 2023):
  - Proposed a novel framework integrating Deep Reinforcement Learning (DRL) to explore Unexpected Abnormal (UA) behaviors in ICS, focusing on misoperations or malicious attacks on setpoints.
  - Developed a behavioral rule model continuously assimilating newly discovered patterns during training, thereby expanding the repertoire of known rule patterns.
  - Successfully validated the framework's efficacy through testing on the Tennessee Eastman Process, a complex industrial benchmark.
- Phase 2 (July 2023 - April 2024):
  - Advanced the framework by integrating economic considerations, introducing a dual-agent collaborative adversarial strategy to explore both Unexpected Abnormal (UA) and Unexpected Normal but Economically suboptimal (UNE) behaviors.
  - Expanded behavioral rule models to accommodate both safety and economic factors.
  - Applied the enhanced framework to the Tennessee Eastman Process, demonstrating significant improvements in both functional safety and economic efficiency.
- Achievements:
  - Published a conference paper at ICCAE (2024).
  - Currently preparing a manuscript titled "Dual-Agent Reinforcement Adversarial Framework for Endogenous Safety and Economic Optimization in ICS" for submission to IEEE Transactions on Industrial Informatics.

### Anomaly Data Collection for Industrial Cyber-Physical Systems (iCPS)

Mar 2022 – May 2022

Co-Researcher — Dept of Computer Science and Engineering, Southern University of Science and Technology

Supervisor: Associate Professor Yulong Ding

- Designed and implemented a semi-physical simulation system for iCPS using MATLAB/Simulink and physical PLCs.
- Utilized the Tennessee Eastman Process to simulate complex industrial control processes with diverse fault types.
- Generated a comprehensive dataset capturing normal and abnormal iCPS operations, including time-varying, strongly coupled, and nonlinear characteristics.

### Intrusion Detection System Based on Deep Reinforcement Learning

Sep 2020 – June 2021

Main Researcher — School of Computer Science and Technology, Huaqiao University

Supervisors: Lecturer Hanyu Quan, Associate Professor Yulong Ding

- Developed a Deep Q Network (DQN) based intrusion detection system using the CICIDS2017 dataset.
- Achieved 99.997% accuracy in binary classification (attack vs. benign traffic) and 98.36% in multi-class classification of attack types.
- Demonstrated the superiority of the DQN-based approach over ML methods in accuracy, precision and recall.
- Achievements: Scored 92 points in the graduation project review; appraised as an excellent graduation design of HQU. [repository]

## Projects

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### Genetic Algorithm Optimization for Multi-Traveling Salesman Problem (mTSP) Dec 2021

- Goal: To design and implement an improved genetic algorithm that outperforms a given baseline algorithm in solving the mTSP, focusing on reducing tour costs and avoiding local optima in high-dimensional instances.
- Actions & Achievements:
  - \* Developed an improved genetic algorithm with: Hybrid KMeans-based initialization, Novel Two-Part Chromosome Crossover (TCX) inspired operator, Intra-chromosome mutation and Optimized distance calculations.
  - \* Quantified the improvements (e.g. 15-30% reduction in costs, 20% improvement in efficiency) and highlighted validation methods (e.g., Wilcoxon rank-sum test) to demonstrate the effectiveness of the proposed algorithm based on 6 TSPLIB instances (51-226 cities).

### Contagion of Change: Analyzing COVID-19's Effect on University Students' Job Prospects May 2020

- Goal: To assess the effects of the COVID-19 pandemic on university students' career planning and recent graduates' employment situations using data science techniques.
- Actions & Achievements:
  - \* Developed Python scripts for web scraping on Zhihu, collecting extensive textual data.
  - \* Implemented sentiment analysis and Chinese word segmentation (jieba library) to identify key themes and emotional trends.
  - \* Applied statistical methods to analyze data and formulate evidence-based recommendations.
  - \* Awarded 2nd Prize in the Fujian Province Selection of the 10th National "Zhengda Cup" College Students' Market Survey and Analysis Competition.

### Public Opinion Analysis System Based on Big Data June 2019

- Goal: To develop a comprehensive public opinion analysis system based on WeChat public account platform, enabling the assessment of public harm levels, sentiment analysis, and public opinion search.
- Actions & Achievements:
  - \* Designed and implemented Python-based web crawlers for data extraction from popular Chinese websites.
  - \* Developed a machine learning model for message classification and sentiment analysis.
  - \* Integrated backend processing with WeChat public account interface using the werobot framework.
  - \* Collected and processed over 300,000 data points for model training.
  - \* Won the third prize of the next cross-strait information service innovation competition.

## Publication and Conference

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### A Reinforcement Adversarial Framework Targeting Endogenous Functional Safety in ICS: Applied to Tennessee Eastman Process Mar 2024

*Xinyi Wu, Yulong Ding, Shuang-Hua Yang*

*2024 16th International Conference on Computer and Automation Engineering (ICCAE), DOI:10.1109/ICCAE59995.2024.10569963*

### 2024 16th International Conference on Computer and Automation Engineering (ICCAE) Mar 2024

*A Reinforcement Adversarial Framework Targeting Endogenous Functional Safety in ICS: Applied to Tennessee Eastman Process(Oral)* *Melbourne, Australia*

## Skills

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**Programing Languages:** Python, C++, HTML/CSS, JavaScript

**Technologies/Tools:** Linux, Git, Latex, Markdown

**Communications:** Chinese Mandarin(Native), English(Advanced), Wu Chinese Dialect(Native)