Emma Ryla Barnes

New York, NY | +1 (301) 300-8714 | emmabarnsse@gmail.com | LinkedIn | GitHub

EDUCATION

University of London.....**Graduated September 2025**
BSc Computer Science - Machine Learning & Artificial Intelligence *First Class Honours (78.58%)*
First Class in Year 3 with a 76.0% average.
First Class in Year 2 with an 82.33% average.
First Class in Year 1 with an 80.2% average.

Relevant Modules:
Databases and Advanced Data Techniques, Artificial Intelligence, Natural Language Processing, Intelligent Signal Processing

Dissertation: *"Neuro-Symbolic Reasoning Pipeline for LLM-based Mathematical Assistance"* – Orchestrated AI system for mathematical problem solving, integrating document processing, LLM reasoning, and symbolic verification.

- Implemented neuro-symbolic architecture with compiler-based error recovery achieving 94% fault classification accuracy, deterministically distinguishing between different model failures with 83% syntax error recovery to enable targeted repair.
- Achieved 70% verification accuracy vs. a 29% single-model baseline, with iterative repair improving success from 51% baseline to 76% through tiered fault recovery.
- Combines accessibility with formal correctness through verification contract pattern enabling bidirectional neural-symbolic feedback, representing the first implementation of compiler-style fault recovery for educational mathematical AI.

Tools: Python, PyTorch, SymPy, Pydantic, Fast API, React, Ollama

University of Maryland & Montgomery College.....**Graduated May 2022**
BS Mathematics

Relevant Modules:
Calculus I-III, Multivariable Calculus, Differential Equations, Discrete Structures, Linear Algebra

RESEARCH EXPERIENCE

Two Six Technologies: Machine Learning Research Scientist (High Assurance Group).....*June 2025 - Present*
Promoted From: Research Intern.....*May 2024 - May 2025*

Inductive Logic Programming for Automated Reasoning: Researched novel application of logic programming and inductive learning methods to enhance automated reasoning capabilities.

- Conducted literature review spanning ILP, answer set programming, and symbolic reinforcement learning integration.
- Designed experimental framework with intermediate evaluation benchmarks for assessing reasoning coverage and logical consistency.

Linguistic Structure Extraction via Finite State Transducers: Extended FST-based knowledge extraction pipeline to capture logical precedence and reasoning chains from linguistic structures, improving inference coverage

Hybrid Symbolic-Neural Document Understanding: Designed and evaluated LLM integration for document processing, benchmarking against rule-based extraction baselines.

- Achieved hybrid system combining neural and symbolic approaches, achieving 29% improvement in extraction accuracy.

Zero-Shot Anomaly Detection Methods: Researched sliding window approaches for temporal anomaly detection in streaming data without labeled examples.

- Analyzed statistical properties and detection thresholds for distribution shift identification.

Graph-Based Entity Resolution: Extended document modeling system to extract and structure tabular and graphical data into Neo4j graph representations, enabling semantic querying and contextual linking between table content and text.

- Formulated canonical entity resolution as optimization problem over embedding space with graph clustering constraints.
- Tuned multi-dimensional parameter space (embedding dimensionality, similarity, clustering algorithms) to disambiguate

Technical Consulting
Self-Employed.....*November 2023 - Present*

- Computer Vision: Anomaly detection pipeline for infrastructure monitoring using trained spatiotemporal autoencoder (LED fault detection in large-scale displays and AV systems).
- Information Retrieval: RAG-based semantic search system with vector embeddings for travel recommendation.

The Network Group: *Data Science Researcher (Computational Social Science)……September 2022 - November 2023*
Promoted From: Intern (Data Engineering)……March 2022 - August 2022

Network Analysis of Illicit Marketplaces: Led quantitative analysis of >1M illicit marketplace reviews on illegal trafficking industries to identify behavioral patterns, network structures, and market dynamics.

- Developed statistical models and ML algorithms for pattern detection in underground economy data
- Presented findings to executive leadership and cross-functional stakeholders, expanding data outreach and utility.

Economic Modeling of Illegal Financial Operations:

- Applied statistical inference and ML to estimate demand metrics and revenue for opaque economic activity
- Developed methodology for quantitative intelligence gathering in data-sparse environments.

INDEPENDENT STUDY

- Mechanistic Interpretability & Neural Architecture: Investigating internal representations in transformer models, with focus on sparse autoencoders for analyzing cross-lingual concept mappings and feature geometry during translation tasks.
- Logic Programming: Answer set programming, Prolog, and declarative reasoning systems for knowledge representation. Exploring how symbolic reasoning can inform neural approaches in neuro-symbolic architectures.
- Linguistics: Morphological analysis and formal linguistics to support natural language processing research. Studying structural patterns across language families and their computational implications.
- Functional Programming: Haskell and Rust for type-safe systems programming - functional approaches to program correctness and applications in verified ML systems. Additional practice engineering compilers.
- Computational Social Science: Sociological theory (habitus, field theory, social network dynamics) to inform quantitative analysis of behavioral patterns in social systems.

PROJECTS

https://github.com/ebarnes-ry

Mechanistic Interpretability in AI Translation: Understanding how neural translation models represent and transfer semantic concepts across languages.

- Applied sparse autoencoders (SAEs) to decompose transformer activations during translation between [languages], analyzing how semantic features are mapped across linguistic boundaries.
- Evaluated layer-wise evolution of concept representations and identified distinct circuits for syntactic vs. semantic transfer.
- Revealed interpretable feature specialization, with distinct subnetworks handling syntactic restructuring vs. semantic transfer as evidence for compositional processing in neural-based translation.

Tools: PyTorch, TransformerLens, Gemini

Cross-Cultural Emotion Classification in Poetic Texts: Emotion expression varies significantly across cultures and literary traditions, so can poetry be machine-translated?

- Developed models for emotion detection in poetry across English, French, Russian, and Chinese, comparing lexical features and semantic embeddings.
- Analyzed how emotional concepts are linguistically encoded differently across cultural-linguistic contexts.
- Demonstrated that because language mapping to emotion varies across cultures, poetry translation must be approached as creative re-composition rather than semantic transfer.
- Showed implications for culturally-aware NLP systems.

Tools: Python, scikit-learn, spaCy, multilingual BERT

Linguistic Ambiguity Resolution: Pun disambiguation required handling semantic and phonetic ambiguity, making it ideal for comparing statistical methods against neural approaches in capturing subjective linguistic phenomena.

- Compared three model architectures on SemEval 2017 dataset: Logistic regression off semantics – TF-IDF, Doc2Vec, syntactic – POS n-grams, dependencies, and lexical ambiguity – word-sense disambiguation, polysemy; T5 transformer model fine-tuned for text-to-text classification; and multinomial naive bayes baseline.
- Implemented word-sense disambiguation as explicit feature engineering, quantifying semantic ambiguity through entropy and distribution flatness of WordNet synset mappings
- Demonstrated that word-sense disambiguation features significantly improve statistical model performance – logistic regression achieves 82.6% accuracy (88.2% F1). T5 outperformed overall, confirming embedding superiority in contextual understanding, but statistical approach provided interpretable feature importance.

Tools: Python, scikit-learn, SimpleT5/Hugging Face Transformers, NLTK (WordNet), spaCy, gensim

ADDITIONAL TECHNICAL EXPERIENCE

- Spearheaded development of web-scrapes supporting Open Source Intelligence (OSINT) collection and analysis at The Network Group – implementing IP rotation, secure credential management for operational security and built ETL processes to clean and transform large-scale raw datasets for integration into production databases.
- Productize research prototypes for work at *Two Six Technologies* into broader systems through refactoring, documentation, system design specifications, and Git-based development workflows.
- Architected security layer for IoT router firmware implementing OAuth 2.0 / JWT authentication, API key rotation, and role-based access control with encrypted channel communication.
- Implemented MERN stack (MongoDB, Express, React, Node.js) with FastAPI model serving layer, orchestrating data flow from user queries through embedding generation, vector similarity search, and LLM synthesis.

RESEARCH FUNDING

Network Analysis of Illicit Marketplaces - $8,000
The Network Group, 2022-2023

Secured funding from organizational board and private donors for computational analysis of underground marketplace dynamics. Authored research proposal and presented at donor events to non-technical audiences, communicating research objectives and societal impact.

LEADERSHIP & SERVICE

Speaker Series Organizer……..……...*October 2025 - Present*

Curate and coordinate invited speaker series featuring researchers across interpretable AI, formal methods, quantum computing, network analysis, and neuroscience

- Identify emerging research directions and facilitate knowledge exchange between industry and academic researchers
- Coordinate with university faculty and research scientists from institutions – such as MIT, Y Combinator, and Dartmouth College – to present cutting-edge work
- Lead technical discussions aiming for cross-disciplinary collaboration between research teams

CONFERENCES

Presentations

- *"Computational Analysis of Illicit Marketplace Networks",* Human Trafficking National Convening, Washington D.C., May 2023

Attended

- NVIDIA GTC 2025 – GPU Technology Conference (AI and high-performance computing)
- HCSS 2025 – High Confidence Software Systems Conference (Formal verification and high-assurance systems)

ADDITIONAL COURSES

IBM Data Science Professional Certification……..……..November 2023

IBM AI Engineering Professional Certification……...……...……...…….……February 2025

REFERENCES

Dr. Susama Agarwala……Associate Research Director, Two Six Technologies……...…….susama@alum.mit.edu
David Lewis……Researcher at Oxford e-Research and Goldsmiths……..…… david.lewis@oerc.ox.ac.uk
Ian Hassell……CEO of The Network Group, Inc. ……...… ian@thenetworkteam.org