

Dany Varghese ,B.Tech, M.Tech, P.hd., FHEA

<https://dvarghese.com>

varghese.dany@outlook.com



Research Interests

My principal research interests are in **Artificial Intelligence, Machine Learning**, particularly the theory, implementations and real-world applications of **Relational and Logic-based Machine Learning** (also known as **Inductive Logic Programming**). My current research interests also include **Computer Vision, Explainable AI, Robotics, Human-Like Computing, Explainable AI** (e.g. Comprehensible Machine Learning), **Data Science, Automated Scientific Discovery, Machine Learning of Biological Networks, Abductive ILP (Common-sense reasoning)**, and **Automatic Program Synthesis**.

Academic Employment

Research Fellow (Lecturer B)

Since July 2023

Explainable & Trustworthy Machine Learning for Autonomous Robots (EPSRC)

Dept. Computer Science, University of Surrey, Guildford, UK

- Design of Explainable machine learning algorithms using PyGol (an ILP approach)
- Development of human-centred robotic applications
- Leading research discussions with collaborators
- Mentoring Phd students and MSc students
- *Published - 3 Papers (3 IJCLR-2024), Under review - 2 Papers (IJCAI-2025, IEEE CAI 2025)*

Teaching Assistant

Since Feb 2020

Module : Machine Learning & Data mining (PG)

Dept. Computer Science, University of Surrey, Guildford, UK

- Design of lab materials and teaching materials
- Developed PyILP to bridge Prolog and Python for ILP approaches
- PyILP published in PIP package-management system (**6K downloads**)
- Assistance for coursework and lab exercises
- Developed tools to connect Python and Prolog
- Weekly assessment and final marking of coursework

Assistant Professor

Aug 2015 - Nov 2019

Department of Computer Science

Jyothi Engineering College, Thrissur, Kerala, India

- Curriculum design and lab module design
- Supervising UG and PG students (3 PG students, 30+ UG students)
- Funded research activities
- Academic mentoring and Department administration
- Various tools to improve student outcome
- Various classroom, out-reach and lab activities to encourage learning
- Start-up activities
- **Subjects taught:** Logic Programming, Algorithms, Theory of Computation, Compiler Design, Data Structure, Programming Paradigms, Machine Learning and NLP
- *Published - 3 Papers*

Lecturer

May 2013 - Nov 2014

Department of Computer Science

Government Engineering College, Thrissur, Kerala, India

- Curriculum design
- Academic mentoring and Department administration
- Various tools to improve student outcome
- Various classroom, out-reach and lab activities to encourage learning
- **Subjects taught:** Logic Programming, Theory of Computation

Education

Phd in Explainable Machine Learning

Jan 2020 - Dec 2023

- Fully Funded by **Vice-Chancellor's Fellowship - 125K**
- Dept. of Computer Science, University of Surrey, Guildford, UK
- Phd Thesis: *Explainable and Efficient Machine Learning using Meta Inverse Entailment*.
- Developed PyILP - A tool to integrate Prolog and Python for machine learning approaches.
<https://github.com/danyvarghese/PyILP>
<https://pypi.org/project/PyILP/>
- Developed PyGol - An efficient explainable machine learning approach
<https://github.com/danyvarghese/PyGol>
- 4 publication² in B conference (ILP), 2 publications in the scopus-index conferences, 1 journal publication (Advances in Ecological Research)
- One best paper award from B conference (ILP)

Master of Technology (M. Tech) in Computer Science & Engineering

Aug 2013 - June 2015

- Dept. of CSE, University of Calicut, Kerala, India
- First Class with Distinction, CGPA: **8.29/10**
- Gold Medalist for the Rank Holder
- 1 Journal and 1 Conference publication based on M.Tech thesis

Bachelor of Technology (B. Tech) in Computer Science & Engineering

Aug 2009 - May 2013

- Dept. of CSE, University of Calicut, Kerala, India
- First Class, CGPA: **7.86/10**
- Diamond-Ring winner for the best outgoing student

Grants & Awards

Travel Grant from EPSRC Network + Human-Like Computing, Grant amount £2.4K	2024
Best Paper Award , 2 nd International Joint Conference on Learning & Reasoning (IJCLR)	2022
Best Paper Award , 4 th International Joint Conference on Learning & Reasoning (IJCLR)	2024
Vice-Chancellors Fellowship - Phd , Grant amount £125K , University of Surrey, UK.	2020
Gold Medal for Outstanding Academic Performance , Jyothi Engineering, college, Kerala, India.	2015
Over all Academic Topper – M. Tech , Jyothi Engineering College, Kerala, India.	2015
Diamond Ring for Best Student - B.Tech , Jyothi Engineering College, Kerala, India.	2013

Professional Memberships

Chair (Workflow/Proceeding) for International Joint Conference on Learning & Reasoning 2025.

Program Committee Member

- 4th International Joint Conference on Learning & Reasoning (IJCLR)
- 4th International Conference On Intelligent Perception And Computer Vision (CIPCV)
- 3rd International Conference On Intelligent Perception And Computer Vision (CIPCV)

Editorial Board Member

- Revista Review Index Journal of Multidisciplinary ISSN 2583-0031
- Techno Review Journal of Technology and Management ISSN 2583-0716
- Research Review International Journal of Multidisciplinary ISSN 2455-3085

Ethics Committee Member (Since 2020), University of Surrey, Guildford, UK.

Supervision

Rudra Someshwar, M.Sc Thesis , University of Surrey	2023
○ Developed ILP approach in robot navigation	
Uzma Patel, M.Sc Thesis , University of Surrey	2021
○ Developed ILP approach in plant disease detection	
○ Published a paper based on the thesis	
Nicy Anto, M.Tech Thesis , University of Calicut, India	2019
○ <i>Thesis: A Novel Approach for Diagnosing Plant Diseases</i>	
Krishna Thulasi NP, M.Tech Thesis , University of Calicut, India	2018
○ <i>Thesis: A Novel Approach for Diagnosing Alzheimer's Disease Using SVM</i>	
○ Published a paper based on the thesis	
Neethu K S, M.Tech Thesis , University of Calicut, India	2017
○ <i>Thesis: An incremental semi-supervised approach for visual domain adaptation</i>	
○ Published a paper based on the thesis	
B.Tech Thesis , University of Calicut, India	2015-2019
○ Supervised 50+ students to complete undergraduate dissertations	

Leaderships & Management Experiences

Reviewer

- **Journal** - Medical Image Analysis (Elsevier) Impact Factor: 10.7
- **Journal** - Internet of Things (Elsevier) Impact Factor: 6
- **Journal** Machine Learning (Springer) Impact Factor: 5.8
- **Journal** - Computer Vision and Image Understanding (Elsevier) Impact Factor: 4.3
- **Conference** - International Conference on Machine Learning and Intelligent Systems (MLIS 2021)

Program Support Member, 25th European Symposium on Research in Computer Security (ESORICS) 2020, University of Surrey, Guildford, UK.

Mentor, STARS Mentoring Scheme, University of Surrey, Guildford, UK.

Admission Officer (2015-2018), Jyothi Engineering College, Kerala, India

Secretary of Institution of Engineers, Student Chapter.

Head of Entrepreneurs Development Cell, Jyothi Engineering College, Thrissur, Kerala.

Scientific Contribution

Explainable AI: My contributions to Explainable AI (XAI) encompass research, development, mentorship, and industry applications. I have concentrated on improving the transparency and interpretability of AI systems, with a particular emphasis on healthcare and autonomous systems. I developed hybrid models that combine statistical learning with rule-based reasoning to facilitate human-like decision-making. In healthcare, my work included analyzing large datasets, such as those used for Alzheimer's diagnosis, ensuring that the insights generated were comprehensible and actionable for practitioners. I have also mentored PhD students conducting XAI research, guiding them toward successful publications, and initiated an entrepreneurial venture focused on bringing explainable AI solutions to the finance sector. Furthermore, I designed logic-based frameworks for autonomous systems and XAI, ensuring adherence to legal requirements and building trust in AI-driven decisions.

Meta Inverse Entailment (MIE) within Inductive Logic Programming (ILP) stands out for its capacity to leverage domain expertise and produce human-readable, logically sound rules that incorporate common sense reasoning. This approach is efficient, capable of generalizing from limited examples, and particularly adept at learning recursive rules and inventing new predicates and facts from data. MIE's methodological design allows for the extraction and formulation of structured rules directly from sparse datasets, making it invaluable in fields requiring interpretability and rigorous theoretical backing. Its ability to synthesize new knowledge and identify patterns beyond initial observations offers extensive applications across various specialized domains, enhancing both the depth and breadth of potential discoveries and insights.

PyGol is an advanced ILP system designed around the Meta Inverse Entailment (MIE) framework, which significantly enhances the speed and accuracy of learning compared to traditional ILP methods. As a Python-based implementation, PyGol seamlessly integrates with other systems, making it a flexible tool for developing complex reasoning applications. One of its standout features is the ability to perform both abduction (common sense reasoning) and induction within the same framework, facilitating a comprehensive approach to learning from data. This dual capability ensures that PyGol can handle a variety of data types and reasoning tasks efficiently. Additionally, PyGol's data efficiency makes it particularly effective in environments where data is sparse but learning requirements are demanding, providing reliable results even from limited examples.

PyLog: Engineered a system capable of executing logic operations similar to Prolog within a Python environment. This project highlights my skills in integrating complex logic programming paradigms with versatile, high-level programming languages to expand the applications of machine reasoning.

InfIntE: The functional diversity of microbial communities emerges from a combination of many species and the many interaction types, such as competition, mutualism, predation or parasitism, in microbial ecological networks. Understanding the relationship between microbial networks and the functions delivered by the microbial communities is a key challenge for microbial ecology, particularly as so many of these interactions are difficult to observe and characterise. We believe that this 'Dark Web' of interactions could be unravelled using an explainable machine learning approach, called Abductive/Inductive Logic Programming (A/ILP) in the R package InfIntE, which uses mechanistic rules (interaction hypotheses) to infer directly the network structure and interaction types.

One-Shot Hypothesis Derivation (OSHD): Developed a novel theoretical framework utilising Inductive Logic Programming (ILP) to facilitate one-shot learning. This approach leverages the strength of ILP in learning from minimal data to efficiently tackle challenges in machine learning with limited examples.

PyILP: I designed and implemented a Python tool that combines various cutting-edge Inductive Logic Programming (ILP) algorithms, demonstrating my proficiency in developing versatile tools that enhance the utility and reach of advanced machine learning algorithms within the Python ecosystem. This tool not only simplifies the integration of ILP systems with other machine learning approaches but also facilitates the creation of robust pipelines, enabling more comprehensive data analysis and model development strategies.

Projects & Collaborations (Major)

Abductive Reasoning using MIE & PyGol

- **Domain :** Ecology, common sense reasoning and explainable AI
- **Collaborators :** David Bohan (Director of Research, INARe, France)

- **Abstract** : We leveraged the explainable machine learning approach of Abductive/Inductive Logic Programming (A/ILP) through the R package InfIntE to elucidate the complex interaction networks within the grapevine foliar microbiome using metabarcoding data. By employing synthetic data, we demonstrated the effective reconstruction of microbial networks, aligning with known interaction types from literature. This methodology not only enhances our understanding of microbial ecological processes but also facilitates the identification of potential biological control agents within the microbiome. Our findings underscore the potential of A/ILP in uncovering the 'Dark Web' of microbial interactions, paving the way for targeted ecological interventions. This research advances the application of explainable AI in microbial ecology, providing a novel tool for ecosystem management.

Alzheimer's detection using explainable AI

- **Domain** : Neurology, disease detection and explainable AI
- **Collaborators** : Roman Bauer (School of Computing, Newcastle University, UK), Stephen Muggleton (Department of Computing, Imperial College London, London, UK)
- **Abstract** : This work introduces a rule-based machine learning method, One-Shot Hypothesis Derivation (OSHD), that leverages Inductive Logic Programming (ILP) to incorporate domain-specific background knowledge, enabling human-like one-shot learning from minimal data. We apply OSHD to complex computer vision tasks like Malayalam character recognition and neurological diagnosis through retinal images. Unlike traditional deep learning models, such as the Siamese Network, which require extensive data, OSHD excels in scenarios with limited data availability. Our results demonstrate that OSHD not only generates rules that are understandable to humans but also achieves superior predictive accuracy compared to deep learning alternatives. This approach underscores the potential of ILP in advancing areas where data is scarce but the need for accurate, interpretable models is critical.

Learning compact language models

- **Abstract**: Recent advancements in language modelling have led to the development of models that significantly enhance performance across various natural language processing applications. However, these improvements often come at the cost of huge computational resources and very large models. This paper attempts to learn a compact language model that employs Meta Interpretive Learning (MIL) from minimal training data. Unique to our approach is the integration of negative examples that refine and correct the output strings, thereby improving the model's accuracy and reliability. We employ a novel MIL framework called Meta Inverse Entailment to learn a compact language model, implemented using the system PyGol. We evaluated our approach using randomly generated regular and context-free languages and a simplified natural language. We also compare the data efficiency and accuracy of the proposed approach with ChatGPT. By covering a range of language complexities, from formal grammar to natural language constructs, we demonstrate the robustness and versatility of our method for learning compact language models from minimal training data.

Enhancing the efficiency of LLM's

- **Abstract**: Large Language Models (LLMs) have achieved remarkable success in various natural language processing tasks. However, their ability to perform tasks requiring formal representation and reasoning remains limited. This paper explores the integration of Meta-Interpretive Learning (MIL) with LLMs to enhance their reasoning capabilities. Specifically, we employ a novel MIL framework called Meta Inverse Entailment to efficiently learn grammar from example sentences. In our experiments, we examine a hybrid GPT-MIL model on a simplified natural language grammar. The results suggest that the accuracy of GPT is significantly improved when it incorporates the grammar learned using MIL. This hybrid approach demonstrates the potential of combining LLMs' linguistic proficiency with MIL's rigorous formalism, leading to better performance in tasks demanding logical representation and reasoning.

Publications

- [1] Dany Varghese Alireza Tamaddoni-Nezhad. "Meta Inverse Entailment PyGol". In: *New Generation Computing - 2024*. Springer. in prep.

- [2] Dany Varghese Alireza Tamaddoni-Nezhad. “Towards enhancing LLMs with logic-based reasoning: A Meta Interpretive Learning approach”. In: *International Joint Conference on Learning and Reasoning 2024*. Springer. (in-press).
- [3] Daniel Cyrus, Dany Varghese, and Alireza Tamaddoni-Nezhad. “An Inductive Logic Programming approach for feature-range discovery”. In: *International Joint Conference on Learning and Reasoning 2024*. Springer. (accepted).
- [4] Dany Varghese et al. “One-Shot Learning of Autonomous Behavior: A Meta interpretive Learning approach”. In: *International Joint Conference on Learning and Reasoning 2024*. Springer. (accepted).
- [5] Dany Varghese, Roman Bauer, and Alireza Tamaddoni-Nezhad. “Few-Shot Learning of Diagnostic Rules for Neurodegenerative Diseases Using Inductive Logic Programming”. In: *International Conference on Inductive Logic Programming*. Springer. 2023, pp. 109–123.
- [6] Didac Barroso-Bergada et al. “Unravelling the web of dark interactions: Explainable inference of the diversity of microbial interactions”. In: *Advances in Ecological Research* 68 (2023), pp. 155–183.
- [7] Dany Varghese et al. “Few-Shot Learning for Plant Disease Classification Using ILP”. In: *Advanced Computing*. Ed. by Deepak Garg et al. Cham: Springer Nature Switzerland, 2023, pp. 321–336.
- [8] Dany Varghese et al. “Efficient abductive learning of microbial interactions using meta inverse entailment”. In: *International Conference on Inductive Logic Programming*. Springer. 2022, pp. 127–141.
- [9] Dany Varghese et al. “Human-Like Rule Learning from Images Using One-Shot Hypothesis Derivation”. In: *Inductive Logic Programming*. Cham: Springer International Publishing, 2022, pp. 234–250.
- [10] Dany Varghese and Alireza Tamaddoni-Nezhad. “One-Shot Rule Learning for Challenging Character Recognition”. In: *In Proceedings of the 14th International Rule Challenge, Oslo, Norway* 2644 (Aug. 2020), pp. 10–27.
- [11] Krishna Thulasi NP and Dany Varghese. “A novel approach for diagnosing Alzheimer’s disease using SVM”. In: *2018 2nd International Conference on Trends in Electronics and Informatics (ICOEI)*. IEEE. 2018, pp. 895–898.
- [12] KS Neethu and Dany Varghese. “An incremental semi-supervised approach for visual domain adaptation”. In: *2017 International Conference on Communication and Signal Processing (ICCSP)*. IEEE. 2017, pp. 1343–1346.
- [13] Dany Varghese and Viju Shanakr. “A Novel Approach for Single Image Super Resolution using Statistical Mathematical Model”. In: *International Journal of Applied Engineering Research* 10.44 (2015), pp. 31594–31597.
- [14] Dany Varghese and Viju Shankar. “Cognitive computing simulator-COMPASS”. In: *2014 International Conference on Contemporary Computing and Informatics (IC3I)*. IEEE. 2014, pp. 682–687.