

Profile

AI researcher and technical lead building inspectable, uncertainty-aware world models for embodied agents. I lead the CPNS Lab at the University of Exeter, translating more than a decade of Bayesian computational neuroscience into semantic planning, partially observed control and adaptive systems. I have built working systems in Habitat-Sim, ReplicaCAD and PyBullet spanning multi-object search, hidden-state tracking, dependency-aware task planning and belief-state drone control. Experienced in prototype architecture, open-source scientific software, interdisciplinary R&D and academic-industry collaboration.

Technical Focus

AI & robotics	World models, embodied AI, active inference, Bayesian state estimation, partial observability, semantic planning, task graphs, adaptive control and epistemic action selection
Modelling & inference	Generative models, variational inference, Variational Laplace, expected-free-energy-style policy evaluation, hierarchical empirical Bayes, dynamical systems and optimisation
Engineering	Python, MATLAB and Julia; Habitat-Sim, ReplicaCAD and PyBullet; simulation, scientific computing, data pipelines, visual diagnostics and reproducible research software
Leadership	Technical R&D strategy, feasibility assessment, prototype scoping, programme leadership, industry collaboration and scientific communication

- Selected AI & Robotics Projects
- Active Inference World Models: Search, State Inference and Tea-Making

Habitat-Sim / ReplicaCAD

 - Built an embodied semantic world model that reasons jointly over mug, kettle and teabag locations, learns from negative evidence and completes an 18-action dependency graph from uncertain search to serving tea.
 - Exposes posterior beliefs, information gain, candidate policy scores, task eligibility and hidden states such as water present, water hot, tea brewed and tea served; separates semantic active-inference planning from local navigation and simulator-level manipulation.
- Polyphonic Active Inference Drone

Python / PyBullet

 - Developed a continuous 3D drone controller that acts from noisy self-observations, egocentric target cues and ray-based obstacle sensing rather than privileged simulator truth.
 - Integrated Bayesian filtering, behavioural-mode inference and latent scene interpretation with concurrent pressures for goal pursuit, safety, stability, epistemic value and future-scene quality; the demonstration reached within 0.26 m of the target across 1,152 control steps.
- Hierarchical Polyphonic Gridworld

Partially observed control

 - Built a belief-guided agent using hierarchical context inference and short-horizon rollouts to balance safety, goal pursuit, uncertainty reduction, energy preservation and habit under hidden hazards and battery constraints.
- Active Inference Agents and Embodied Robotics

3D physics prototypes

 - Developed collect-and-return and navigation agents integrating perception, online transition learning, action correction, obstacle avoidance and recovery through a generative model rather than a fixed reward policy.

- Experience
- Independent AI & World Models Consultant

Independent

2026–Present

 - Advise on uncertainty-aware world models, physical AI, robotics, adaptive decision systems and mechanistic modelling; support early-stage R&D, technical architecture, feasibility reviews, prototype design and research strategy.
- Senior Lecturer (Research), previously Lecturer; PI and CPNS Lab Director

University of Exeter

2021–Present

 - Lead research at the intersection of active inference, computational neuroscience, Bayesian modelling and intelligent systems, including a portfolio spanning embodied AI, generative architectures, neurotechnology and mechanistic machine learning.
 - Lead or co-supervise one postdoctoral researcher and seven PhD projects across AI, mathematical modelling, computational ethics, neuropharmacology and multimodal data science.
 - Develop open-source tools and reusable computational methods for variational inference, neural dynamics, model calibration and agent-based learning in Python, MATLAB and Julia.
 - Director of Business Engagement and Innovation for Psychology and member of the departmental Senior Leadership Team, translating research capabilities into partnerships, prototypes and industry-facing programmes.
 - PI, Co-I or collaborator on funded programmes exceeding £5m across EPSRC, Wellcome, MRC and industry, including work with GABA Labs and Awakn Life Sciences.

Earlier Experience

Research Fellow

2017–2021

Cardiff University

- Developed and applied generative models of neural systems, Bayesian inversion methods and multimodal data pipelines across M/EEG, MRI and PET; translated latent-state estimates into mechanistic explanations of behaviour, disease and pharmacological intervention.

Research Associate

2015–2017

University of Cambridge

- Built computational assays linking neurophysiology, pharmacology and latent circuit dynamics in dementia and neurological disease, working across experimental, clinical and modelling teams.

Postdoctoral Research Associate

2014–2015

Cardiff University

- Modelled thalamo-cortical dynamics and pharmacological perturbations using human neuroimaging, dynamical systems and Bayesian generative models.

Selected R&D Programmes and Industry Partnerships

- **Wellcome Sleep Detectives** (£1m, Co-I): large-scale longitudinal neurophysiology and cross-species generative modelling programme, integrating human data, mechanistic models and translational experimentation.
- **MRC Convergent Endophenotypes in Psychiatric Genetics** (£3.5m, collaborator): multi-institution programme combining genomics, neuroimaging and computational phenotyping.
- **Awakn Life Sciences** (£441k, Co-I): industry-linked mechanistic study of ketamine therapy and adaptive behaviour.
- **GABA Labs**: PI on EEG assay development and co-funded doctoral research translating neurophysiology and computational modelling into scalable product evaluation.
- **EPSRC Neural Mass Model Calibration** (£98k, PI): mathematical and computational methods for reliable calibration of nonlinear generative models.

Open-Source Software

- **SourceMesh** (MATLAB): M/EEG visualisation toolkit for source overlays, network rendering, volumetric-to-surface projection and 3D export.
- **atcm** (MATLAB) and **tcn_py** (Python): extended thalamo-cortical generative models for simulation, spectral prediction and Variational Laplace inversion.
- **VariationalLaplace.jl** (Julia): nonlinear variational-Laplace inference with thermodynamic integration, low-rank covariance and heteroscedastic noise modelling.
- **VariationalInferenceLab** (MATLAB): research platform for developing variational and Bayesian inference methods.

Selected Technical and AI Publications

- **Active Inference World Models: From Embodied Control to General-Purpose Adaptive Intelligence.** Zenodo preprint, 2026.
- **Coordination Without Command: Active Inference and the Route to Embodied Intelligence.** Preprint, 2026.
- **Dynamics-Informed Priors for Neural Mass Modelling.** *Imaging Neuroscience*, 2026.
- **Predictive Coding and Neurocomputational Psychiatry: A Mechanistic Framework for Understanding Mental Disorders.** *Frontiers in Psychiatry*, 2026.
- **Toward a Reusable Architecture for Intelligent Agents.** OSF, 2025.

Education

PhD Medicine (Neuroscience), Cardiff University, 2014 (MRC-funded)

MSc Psychology & Education, University of Bristol, 2010

Additional qualifications: PGCert Academic Practice, University of Exeter, 2024; BA (Hons) Music, Rolle College of Music & Drama, 2009.