Martin Burke PhD

Quantitative Researcher | AI, Model Validation & Computational Science | PhD, Imperial College London

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PROFILE

Martin Burke is a quantitative researcher working at the intersection of AI and quantitative finance. Currently researching AI-safety debate frameworks for the UK AI Safety Institute — with broader interests across mechanistic interpretability and applied AI — he previously spent a decade validating derivatives and counterparty-credit-risk models at banks including Citi. He holds a PhD in Theoretical Chemistry from Imperial College London, where he pioneered the application of sum-of-squares optimisation — a technique from real algebraic geometry — to molecular energy minimisation.

EXPERIENCE

Contractor — AI Safety Research

Oct 2025 – Present

Deloitte LLP (client: AI Safety Institute (UK)) — London

Contracting through Deloitte on a research project for the UK AI Safety Institute, designing and stress-testing recursive debate frameworks for AI safety. Focus on the formal structure of honest vs. dishonest debaters, separation of ground truth from main claims, and the construction of high-difficulty obfuscated arguments to evaluate robustness against hidden flaws and verification intractability.

- Designed and stress-tested **recursive debate frameworks** for AI safety, formalising honest vs. dishonest debater structure, ground-truth separation from main claims, and construction of high-difficulty **obfuscated arguments** to probe robustness against hidden flaws and verification intractability.
- Developed programmatic pipelines using multiple **LLM APIs** to generate and analyse structured debate artefacts (multi-level claims, LaTeX exports, PDF generation).
- Empirically investigated whether elevated reasoning modes improve detection of subtly false sub-claims, exploring implications for **scalable oversight** and **alignment**.

Model Validation Quantitative Analyst (VP)

Nov 2021 – Feb 2025

Citi — London

Independent model validation of equity and equity-rates-hybrid base and product models, covering first-time validations, re-validations and model-change workflows. Owned the end-to-end validation lifecycle from materiality assessment through independent testing to validation report and ongoing performance monitoring.

- For model-change submissions, completed initial **materiality assessment** based on Front Office (FO) Quant submissions.
- Performed **Model Eligibility Assessment** of submitted Model Developer Documents and worked with FO Quants to achieve compliance with validation policies.
- Performed independent testing including **calibration assessment, model benchmarking, PAA, stress testing and risks-not-in-model** assessment.
- Authored **Model Validation Reports** assessing model inputs, appropriateness of upstream models, validity of assumptions and theoretical foundations, correctness of implementation, limitations and compensating controls, outputs, and suitability for approved downstream usage.
- Worked with FO Quants to manage limitations and implement compensating controls.
- Contributed to quarterly **Objective Performance Assessment (OPA)** of validated models.
- Conducted **peer-review** assessments of colleagues' validation reports prior to release.

Quantitative Analyst (Manager → Senior Manager)

Feb 2017 – Nov 2021

Deloitte LLP — London

Quantitative consulting across multiple investment-bank clients, progressing from Manager to Senior Man-

ager. Engagements spanned front-office equity-derivatives model validation, counterparty credit risk internal-model review, regulatory stress-testing validation, and a Libor-transition library upgrade.

- **Libor Transition upgrade — Citi (EQTG / QLX front-office equity & equity-IR hybrid library) — 10 months**
  - Updated Equity-IR hybrid model classes and code in the QLX library to accommodate the projection index and new risk-free rates ahead of IBOR transition / Libor decommissioning (**C++**).
  - Conducted testing in the Front Office library testing framework (**C#**) and prepared Model Developer Documentation (**LaTeX**).
  - Refactored yield-curve objects in QLX to better manage multiple market-data sources.
- **CCAR stress-testing framework validation — Deutsche Bank — 3 months**
  - Validated CCAR stress tests applied to the bank's Equity, FX, Credit and Rates portfolios and prepared asset-class-specific reports for regulatory submission.
- **Front-office exotic equity-IR hybrid model validation — Citi (GSST programme) — 2 years**
  - Validated product models: exotic swaps with equity and Libor / CMS-spread underlyings, and range accruals with callable or TARN trade-level features, priced and risk-managed with Monte Carlo and PDE base models.
  - IR components of base models included **Linear Gaussian Markov 1 & 2 Factor** and **Quadratic Gaussian Markov 1 Factor**.
  - Performed independent testing (calibration, benchmarking, PAA, stress testing, risks-not-in-model) and proposed model limitations / valuation adjustments.
- **Front-office equity-derivatives product model validation — JP Morgan**
  - Initial risk assessment, evaluation of FO Quant testing, and independent testing of a European equity / equity-basket model with forward-start and delayed-settlement features (smile-implied pricing).
  - Tests: convergence, stress testing, PAA, missing risks.
- **Counterparty credit risk (CCR) — Credit Suisse (IMM application to the PRA)**
  - Led internal model review covering **IR, FX, Wrong Way Risk and Advanced CVA** against the Capital Requirements Regulation.
  - Reviewed and enhanced the development, validation and governance of the Credit Analytics framework.

Quantitative Developer

Jun 2015 – Feb 2017

SunGard (now FIS) — Oxfordshire, U.K.

Quantitative developer on SunGard / FIS's Adaptiv counterparty-credit-risk product suite, consulting to bank clients on regulatory CCR implementations.

- **Mediobanca — SA-CCR implementation in Adaptiv Risk™**
  - Implemented (coding and testing) changes to **Adaptiv Risk™** to apply **SA-CCR** (Standardised Approach to Counterparty Credit Risk) methodologies to the client's customised solution and product portfolio.
- **Standard Chartered Bank — Adaptiv Credit Risk / Adaptiv Analytics**
  - Implemented (coding and testing) changes to **Adaptiv Credit Risk / Adaptiv Analytics** to meet *"Margin requirements for non-centrally cleared derivatives"* (Basel Committee, IOSCO / BIS, 2015). Coding in **C#** and **SQL**.

Assistant Quantitative Analyst

Dec 2014 – Jun 2015

VTB Capital PLC — 14 Cornhill, London

Counterparty-credit-risk quant in the Quantitative Risk Management Group, calibrating risk-factor models and supporting UAT of the bank's PFE simulation platform.

- Calibrated risk-factor model parameters for **equity, fixed income and FX** for use in daily **Potential Future Exposure (PFE)** simulations in Adaptiv Credit Risk / Adaptiv Analytics.
- Built test portfolios and ran test-case PFE simulations in FIS' Adaptiv Analytics across a variety of products during **UAT**.
- Developed an **Excel / VBA / SQL** tool to track and monitor mark-to-market differences between Adaptiv

Analytics and the bank's front-office pricing system.

Research & Development Director
May 2007 – Jun 2014

Veryan Medical Ltd. — Galway, Ireland

First full-time employee of Veryan Medical, a venture-capital-backed medical-device start-up spun out of Imperial College London on the pioneering work of Professor Colin Caro. Built out the company in Galway, Ireland — leveraging the region's world-class MedTech hub — to develop a highly novel **helical peripheral artery stent**, the first of its kind for the treatment of superficial femoral artery disease. Under the guidance of serial MedTech entrepreneurs Paul Gilson and Chas Taylor, built up the R&D team and took the flagship **BioMimics** stent through to CE Mark approval. The company now employs over 200 people and was subsequently acquired by Otsuka Medical (Japan).

- Joined as the **first full-time employee** and built up the R&D organisation from the ground up; the company now employs **200+ people**.
- Assembled and led a team of **seven R&D engineers** (Masters and PhD level), applying state-of-the-art **finite element analysis** and **computational fluid dynamics** to stent design.
- Helped the company achieve **CE Mark** for its flagship product, the **BioMimics** helical peripheral artery stent — the first of its kind for superficial femoral artery disease.
- Responsible for **IP portfolio management** and **manufacturing** up to CE Mark approval.
- Devised a **novel IP strategy** to secure freedom to operate: rather than competing on incremental tweaks to curve radii (as competitors did), reframed the problem and leveraged **expired prior-art IP** — a solution no one else in the field had conceived.
- Contributed to building the company to the point of acquisition by **Otsuka Medical** (Japanese medical-device company).

Research & Development Engineer
Oct 1999 – Sep 2001

Biocompatibles Cardiovascular Ltd. — U.K.

Joined Biocompatibles Cardiovascular to deepen specialisation in finite element analysis, arriving as the company prepared an **IDE submission to the FDA** for its flagship coronary stent. Identified and corrected a fundamental flaw in the company's externally produced fatigue analysis that had stalled the submission for nearly a year, then proved the design safe through physical testing — directly enabling Biocompatibles to become the **first European company to receive PMA clearance to market a coronary stent in the USA**.

- On joining, reviewed externally generated FEA data and **identified that the consultant had used Von Mises stresses rather than principal stresses** for the fatigue analysis — the root cause of the flagship stent appearing to fail both FEA and fatigue tests, which had delayed the IDE submission by nearly 12 months.
- Reproduced the analysis and **re-plotted the S–N diagram using principal stresses**, demonstrating the design was in fact robust; **validated the approach with Prof. David Taylor (Trinity College Dublin)**, an internationally respected mechanical-fatigue expert.
- Persuaded management to bring testing in-house: procured a **stent fatigue tester** and proved the design safe through physical testing to **200 million pulsatile cycles**.
- As a direct result, Biocompatibles proceeded with the IDE submission and became the **first European-based company to receive FDA PMA clearance** to market a coronary stent in the USA.
- Exposure to the Oxford-educated PhD scientists working on the stent-coating technology sparked a fascination with biology that led to a Masters offer at Imperial College London — which **Biocompatibles part-funded** in recognition of his contribution.
- On the strength of this work, serial MedTech entrepreneur **Paul Gilson** asked him to join **Mednova** (Gilson's first start-up, later acquired by Abbott Laboratories); respectfully declined, having already committed to the Imperial Masters and rented out his house.

Research & Development Engineer
Jun 1995 – Sep 1999

Medtronic Inc. — Ireland

First role after graduating in Mechanical Engineering from the University of Limerick. Began at **C.R. Bard Ltd.** as a co-op student — returning for summer work and completing the final-year project there — and was offered and accepted a full-time R&D position on graduation. Shortly afterwards C.R. Bard was acquired

by **Arterial Vascular Engineering (AVE) Inc.**, and subsequently by **Medtronic Inc.** After two years moved into specialising in **finite element analysis (FEA) of implantable devices**, specifically **coronary stents**.

- Joined as a co-op student, was re-hired for summer work, completed the final-year project at C.R. Bard, and converted to a full-time R&D engineer on graduation.
- Continued through the C.R. Bard → AVE → Medtronic acquisitions.
- After two years, **specialised in finite-element analysis of implantable devices**, focusing on **coronary stents** — the start of the FEA expertise that defined the next decade of his medical-device career.

EDUCATION

Certificate in Quantitative Finance (CQF)

May 2012

Fitch Learning — U.K.

Professional qualification in quantitative finance, marking the transition from a computational-science / medical-device career into quantitative finance.

PhD, Theoretical Chemistry

Mar 2007

Imperial College London — London, U.K.

PhD applying a newly developed **sum-of-squares (SOS) optimisation** methodology to potential-energy minimisation for small chemical systems, supervised by Prof. Sophia N. Yaliraki.

External examiner. Prof. Pablo A. Parrilo (MIT)

Awards. 1st Prize (Physical Chemistry), Imperial College Postgraduate Symposium — oral, 2005; 1st Prize (Physical Chemistry), Imperial College Postgraduate Symposium — poster, 2004

Funded by. US Office of Naval Research (ONR)

Master of Research (MRes), Biomolecular Science (Distinction)

Sep 2002

Imperial College London — London, U.K.

MRes (Distinction) modelling protein-fragment aggregation in Huntington's disease using **dissipative particle dynamics** (an off-lattice mesoscopic simulation method based on numerical integration of a stochastic differential equation). The project produced a **PNAS paper** and led directly to a PhD offer.

Bachelor of Engineering (BEng), Mechanical Engineering (2.1 Honours)

Jun 1995

University of Limerick — Limerick, Ireland

Bachelor of Mechanical Engineering (2.1 Honours) at the University of Limerick, including co-operative-education placements. Co-op work and the final-year project were completed at **C.R. Bard Ltd.**, leading to a full-time R&D position on graduation.

SKILLS

AI & machine learning

- **AI safety & scalable oversight:** recursive debate protocols (honest vs. dishonest debaters), construction and analysis of obfuscated arguments, detection of subtly false sub-claims, adversarial / red-team evaluation.
- **LLMs & applied AI:** LLM-API pipelines; programmatic generation and analysis of structured artefacts; prompt design; automated LaTeX / PDF generation.
- **Foundations underpinning ML:** convex & non-convex optimisation, semidefinite programming, sum-of-squares / convex relaxations, advanced linear algebra — the mathematics behind much of modern machine learning.
- **Active interests:** mechanistic interpretability; trustworthy and verifiable AI.

Optimisation & applied mathematics

- Convex optimisation; relaxation of non-convex / NP-hard problems; semidefinite and second-order cone programming; sum-of-squares decompositions; interior-point methods.
- Numerical methods: Monte Carlo, finite-difference methods; stochastic differential equations.
- Probability, statistics and stochastic calculus.

Programming & software

- **Languages:** Python, C++, C#, SQL, VBA.
- **Environments & tooling:** Visual Studio, VS Code; Git, GitHub, Bitbucket, JIRA; LaTeX; Linux, macOS, Windows.

Quantitative finance

- **Model validation:** first-time validations, re-validations and model-change workflows; calibration, benchmarking, PAA, stress testing, risks-not-in-model.
- **Pricing & models:** stochastic & local volatility (Gyöngy), Linear/Quadratic Gaussian Markov rate models, Monte Carlo & PDE methods; equity & equity-rates hybrids; exotics.
- **Counterparty credit risk:** SA-CCR, IMM, PFE simulation, CVA; CCAR stress testing; regulatory frameworks (CRR, Basel/IOSCO).

Scientific & computational modelling

- Molecular dynamics; dissipative particle dynamics; coarse-grained simulation.
- Finite element analysis (FEA) and computational fluid dynamics (CFD).

Earlier domain & leadership

- Medical-device R&D and regulatory pathways (FDA IDE/PMA, CE Mark); IP / freedom-to-operate strategy.
- Building and leading R&D teams from the ground up (start-up first employee); project management of complex technical programmes; strong written and oral communication.

PUBLICATIONS

1. Paramonov, L., Burke, M.G., & Yaliraki, S.N. (2009). *Coarse-Grained Dynamics of Anisotropic Systems.* In G.A. Voth (Ed.), *Coarse-Graining of Condensed Phase and Biomolecular Systems* (Ch. 5, pp. 59–68). CRC Press.
2. Burke, M.G., & Yaliraki, S.N. (2006). *Exploring model energy and geometry surfaces using sum of squares decompositions.* J. Chem. Theory Comput., 2(3), 575–587.
3. Burke, M.G., Woscholski, R., & Yaliraki, S.N. (2003). *Differential hydrophobicity drives self-assembly in Huntington's disease.* PNAS, 100(24), 13928–13933.

PATENTS

- **US11065029B2** — *Expandable balloon*, Veryan Medical Ltd (2021)
- **US9907679B2** — *Stent apparatus and treatment methods*, Veryan Medical Ltd (2018)
- **EP2349123B1; US9597214B2; US10966847B2** — *A Medical Device*, Veryan Medical Ltd (2015)

SELECTED PRESENTATIONS

- *Application of Sum of Squares Optimisation to Energy Surfaces*. American Conference of Theoretical Chemistry (ACTC) — Los Angeles, U.S.A. (Jul 2005, Poster)
- *Sum of Squares Optimisation and Potential Energy Surfaces*. Chemistry Postgraduate Symposium (oral presentations) — London, U.K. (Jun 2005, Oral)
- *A New Approach to Predicting Equilibrium Dynamical Properties of Complex Systems*. Chemistry Postgraduate Symposium (poster presentations) — London, U.K. (Jun 2004, Poster)
- *Efficient Strategies for the Design of Coronary Stents using the Finite Element Method*. Medical Device Technologies Conference — Galway, Ireland. (Sep 2001, Oral)