Param Pathak

Vadodara, Gujarat, India
param.pathak@fractal.ai, parampathak28@gmail.com parampathak.com Scholar

Education

Sardar Vallabhbhai Patel Institute of Technology **09.2021 – 06.2025**
B.E. in Computer Engineering [CGPA: 8.71 / 10.00] *Gujarat, India*

Experience

Fractal Analytics (Hybrid) **06.2025 –**
AI Research Associate (QuantumAI Group) *Mumbai, India*

- Currently working on developing Frequency Comb Neural Networks in collaboration with BITS Pilani, Dubai Campus.
- Also working on applying physics-informed neural networks (PINNs) to option pricing by extending variable splitting methods from linear to complex-linear stochastic volatility models for efficient derivatives valuation.

University of Oxford (Remote) **03.2025 – 06.2025**
Research Collaborator (Center for Human-inspired Artificial Intelligence) *Oxford, UK*

- Developed quantum circuit framework achieving 63× lower regret for 10-player Bayesian games using Holevo-informed encoding with $O(n)$ parameter scaling vs. classical $O(2^{2n})$.
- Accelerated convergence by 2× speed through curriculum learning and entropy regularization, enabling first tractable correlated equilibrium solver for games with 10+ players and incomplete information.

Birla Institute of Technology and Science (BITS) Pilani (Remote) **03.2025 – 06.2025**
Research Collaborator (Dept. of Electrical Engineering) *Dubai, UAE*

- Lead a group of junior undergrads in quantum research, contributing to two review papers on Qiskit's applications across various domains.

New York University Abu Dhabi (Hybrid) **08.2024 – 05.2025**
Research Collaborator (eBRAIN Lab, and Center for Quantum and Topological Systems) *Abu Dhabi, UAE*

- Developed regime-adaptive stock prediction framework achieving R^2 of 0.89 and Sharpe Ratio of 12.02 by implementing KANs with sparse spline activations and Gumbel-Softmax regime detection, outperforming LSTM baselines.
- Enhanced model interpretability and risk management with 83% win rate and -0.09% maximum drawdown through Monte Carlo Shapley-based feature attribution and orthogonality-constrained regime classification across bullish, bearish, and neutral market states. Work submitted to *TMLR*
- Worked on a chapter titled "*Quantum-Enhanced Decision-making in ACT-R*" which got published in *Elsevier* Book.

Fractal Analytics (Hybrid) **09.2024 – 03.2025**
Research Intern (Quantum-AI Group) *Mumbai, India*

- Developed 3 novel Quantum-Classical GAN architectures achieving 40% better molecular generation (Fréchet distance: 10.0 vs 21.8) using Wasserstein distance and gradient penalty on patched quantum circuits with PennyLane.
- Evaluated 16 quantum circuit variants on QM9 dataset (134K molecules) across 9 pharmaceutical metrics, achieving superior drug-likeness scores (NP: 0.792, QED: 0.486, 44% novelty) for accelerated drug discovery
- Submitted the work "Quantum-Classical Generative Models for Drug Design" to *Springer Nature's Quantum Machine Intelligence (QMI).*

Sardar Vallabhbhai Patel Institute of Technology (On-Site) **09.2024 – 12.2024**
Undergraduate Research Assistant *Anand, India*

- Developed a 3-layer CNN model for Alzheimer's detection achieving 96% accuracy on medical imaging data for robust binary classification.
- Built *DRiVE*, a Spiking Neural Network (SNN) model for vehicle detection achieving 94.8% accuracy and 0.99 AUC score using snnTorch framework with Leaky Integrate-and-Fire neurons, surrogate gradients, and batch normalization on 2K+ vehicle images.
- Outperformed existing SNN models (AMOS: 80.97%, CSNN-blurr9: 92.85%) through 3-layer feedforward architecture with AdamW optimizer and early stopping, demonstrating energy-efficient alternative to CNNs for autonomous vehicle applications. Work published by *IEEE ASSIC 2025*, India

Université Hassan II de Casablanca (Remote) **09.2023 – 12.2023**
Project Intern *Casablanca, Morocco*

- Optimized 5G network resource allocation using a Variational Quantum Regressor (VQR), achieving an MSE of 0.008 and outperforming classical models by 83%. Presented the paper at *IEEE QCNC 2024* in Kanazawa, Japan.

ChemicalQDevice (Remote) **11.2022 – 04.2023**
Quantum Machine Learning Research Intern *San Diego, USA*

- Led Quantum Machine Learning Neuroimaging projects integrating Quantum Computing and ML for medical imaging analysis.
- Used deep neural networks (DNNs) and quantum-enhanced algorithms like quantum support vector machine (Q-SVM) and variational quantum circuits for Alzheimer's and dementia diagnosis.
- Applied traditional ML techniques such as transfer learning and stacked denoising auto-encoders to enhance MRI-based Alzheimer's detection accuracy.

Publications (The ones which are available on the web are hyperlinked)

- **Quantum-Classical Generative Models for Drug Design (Under-Review)**
  Springer Nature's Quantum Machine Intelligence (QMI), 2025
  Authors:
  P. Jain, **P. Pathak**, K. Bhatia **D. Shalini**, **S. Ganguly**

- **Quantum Computing for Carbon Capture: A Qiskit-Based Framework and Perspective (Accepted)**
  International Conference on Computational Intelligence and Network Systems (IEEE CINS 2025 BITS Pilani, Dubai Campus)
  Authors: K. Tarakeshwar, S. Ali, **P. Pathak**, **D. Shalini**, **A. Ganesan**

- **Evolution of *QISKIT*: A Review of its Application**
  Elsevier: Computer Science Reviews, 2025
  Authors: **P. Pathak**, K. Tarakeshwar, S. Ali, **D. Shalini**, **A. Ganesan**

- ***KASPER*: Kolmogorov Arnold networks for Stock Predictions & Explainable Regimes (Under-Review)**
  Transactions for Machine Learning Research (TMLR), 2025
  Authors: **V. Oad***, **P. Pathak***, **N. Innan**, **D. Shalini**, **M. Shafique (*Equal Contribution)**

- **DRiVE: Dynamic Recognition in VEhicles using snnTorch**
  International Conference on Advancements in Smart, Secure & Intelligent Computing (IEEE ASSIC 2025 Bhubaneshwar, India)
  Authors: H. Vora, **P. Pathak**, **P. Bakaraniya**

- **Quantum-Enhanced Decision-making in ACT-R**
  Elsevier Book - Quantum Computational AI Algorithms, Systems and Applications, 2024
  Authors: **P. Pathak**, **N. Innan**, **A. Marchisio**, **M. Shafique**

- **Resource Allocation Optimization in 5G Networks using Variational Quantum Regressor**
  International Conference on Quantum Communication, Networking, and Computing (IEEE QCNC 2024 Kanazawa, Japan), 2024
  Authors: **P. Pathak**, **V. Oad**, A. Prajapati, **N. Innan**

Technical Skills

Languages: C, Python, SQL, Lisp, LaTeX (Scientific Writing), Mathematica
SDKs: Qiskit, Pennylane, Intel LAVA, PyACT-R
Machine Intelligence: Actor-Critic Method, Kolmogorov Arnold Networks, PyTorch, QAOA, Q-Learning, QUBO (DWave Quantum Annealer), Quantum Neural Networks, Quantum Supervised Learning, Spiking Neural Networks, Supervised Learning, Tensorflow, time series analysis, Unsupervised Learning

Relevant Certifications (Hyperlinked)

- **Qiskit Advocate** *: Issued by IBM* *[2025]*
- **OxML Summer School** *: Issued by Oxford Internet Institute* *[2025]*
- **IBM Certified Developer - Quantum Computation using Qiskit v0.2X** *: Issued by IBM* *[2025]*
- **Quantum Optimization (with IBM Quantum)** *: Issued by Hasso Plattner Institute* *[2023]*