Instructors

The course instructors are experts in the field of machine learning, theoretical and experimental quantum computing, and optimization.

Prof. Shalabh Bhatnagar

Professor,
Dept. of Computer Science and Automation,
Indian Institute of Science, Bangalore

Dr. Shalabh was the chairman of CSA, IISc. Currently he is a Professor in the Department of Computer Science and Automation at IISc, Bangalore. His major research interests lie at the intersection of reinforcement learning and simulation optimization. Autonomous systems, vehicular traffic control, smart grids and wireless networks are among the different domains where Prof. Shalabh has applied his research.

Dr. Nagendra Nagaraja

CEO & Founder,
QpiAI India
PhD, Coventry University UK

Dr. Nagendra is a Ph.D. in Wireless, ML and AI from Coventry University, UK, has Masters in ECE from Illinois Institute of Technology. He has over 20+ years of Industry experience. He has 25+ granted patents in the areas of AI/ML, Security, wireless and multimedia and many pending patents. He is the Founder and CEO of QpiAI.

Prof. Ujjwal Sen

Professor,
Quantum Information & Computation Group,
Harish-Chandra Research Institute, Allahabad

Dr. Ujjwal Sen is a Professor in Physics (Quantum Information and Computation Group) at the Harish-Chandra Research Institute (HRI), Allahabad. He completed his PhD from the University of Gdansk, Poland in 2003 and subsequently was the Alexander von Humboldt Fellow at Leibniz University of Hannover, Germany and the Ramon-y-Cajal Fellow at ICFO Barcelona, Spain. His 12+ years of teaching experience includes IIT-Delhi and HRI. He has 250+ research papers and is an editor in several international scientific journals and boards. His group at HRI Allahabad is the largest group in India working in theoretical quantum information.

Dr. Amlan Mukherjee

Director Quantum Hardware Research,
QpiAI India
PhD, TIFR India

Dr. Amlan Mukherjee completed his Ph.D. on Quantum nanostructures from TIFR, Mumbai in 2015 and subsequently was postdoctoral researcher in Germany for more than 6 years before returning to India to join the Quantum team at QpiAI. He is an expert on a wide range of quantum systems and their control. He has written several research articles, patents and presented in international conferences. His research interests include quantum computation, quantum hardware and high frequency Cryo-CMOS IC design.

Dr. Arun Sehrawat

Quantum Research Scientist,
QpiAI India
PhD, National University of Singapore

Dr. Arun completed his Ph.D. in Hybrid Quantum Computation from the Centre for Quantum Technologies, NUS, Singapore after completing his Masters in Physics from IIT-Roorkee. He has 10+ years of research experience in quantum computation and information, simulation & optimization. He has written ten research articles, including five single-author and four first-author papers, and has presented papers in 14 international conferences plus 6 invited talks. His teaching experience includes PhD students in NUS Singapore, IQOQI Innsbruck Austria, University of Guadalajara Mexico, IISER Mohali, and HRI Allahabad.

Pinakin Padalia

Director Quantum Circuits,
QpiAI India
MS, TU Delft Netherlands

Pinakin did his MSc from TU Delft, Netherlands in Electrical Engineering with specialization in Microelectronic Design focussed on Analog and Quantum Computing Circuit Design. Working with QuTech, one of the leading places for quantum computing, he has successfully designed and taped out at two technology nodes: 40nm Bulk and 22nm Finfet with cryogenic circuit modules that form part of qubit readout and control at 4 Kelvin temperatures. He proposed a novel reference circuit that works for an extreme wide range of temperatures: 4 K to 400 K. Currently he has 3 patents under review and a publication in the field of circuit design.

Lakshya Priyadarshi

Software and Algorithms Researcher,
QpiAI India
B.Tech, Institute of Engineering & Technology

Lakshya completed his B.Tech in Computer Science from Institute of Engineering and Technology, Lucknow, India during which he was a Visiting Research Scholar at QuIC Group, HRI Allahabad and Research Intern at CHEP, IISc Bangalore. He co-developed the density-matrix simulator Qiskit Aakash. His works were selected for Young Researchers Forum at CALDAM 2020, Best Paper Award at IEEE-CICT 2019, and poster presentation at QIP 2020. At QpiAI he is currently working on quantum-inspired optimization algorithms, autoML, and NAS. He has published 2 research articles and has 1 patent under review.

Aswanth Krishnan

Director Quantum Research,
QpiAI India
MSc, NIT Karnataka

Aswanth did his MSc in Physics from National Institute of Technology Karnataka. At QpiAI he is working on Quantum Inspired Algorithms for optimization and machine Learning. He has 1 patent under review.

Sachin Kumar

Senior Data Scientist,
QpiAI India
B.Tech, NIT Trichy

Sachin completed his B.Tech in Instrumentation and Control Engineering from NIT, Trichy. He worked at FICO as an Analytic Scientist, delivering AI solutions and products across Retail (4.5 billion+ annual transaction volume), Cyber Security (alerting the possibility of data breach based on security posture) and Finance domains (stagewise explainable and interpretable model which outperformed state-of-the-art black-box model). Prior to FICO, while at Fidelity Investments, he was one of the youngest engineers to qualify and finish Fidelity's flagship program in Quantitative Finance with top honours.

Curriculum

AI Certification - Beginner

1.Prerequisites for Artificial Intelligence

- 1.1 Linear Algebra
- 1.2 Probability Theory
- 1.3 Bayes Theorem and Statistics
- 1.4 Calculus and Optimization

2. Supervised Machine Learning

- 2.1 Linear Regression
- 2.2 Multiple Linear Regression
- 2.3 Regression Performance Metrics
- 2.4 Classification Models
- 2.5 KNN, Logistic Regression
- 2.6 Support Vector Machines
- 2.7 Confusion Matrix, ROC Curves
- 2.8 Decision Tree, Bagging, Boosting and Ensembling

3. Unsupervised Machine Learning

- 3.1 Dimensionality Reduction: PCA
- 3.2 Clustering: K-Means Clustering

3. Deep Learning

- 4.1 Activation Functions, Feedforward Network
- 4.2 Back Propagation, Loss Functions, Hyperparameters
- 4.3 Convolutional Neural Networks
- 4.4 CNN Architectures for Image Classification
- 4.5 Recurrent Neural Networks
- 4.6 Long Short-Term Memory Models
- 4.7 Autoencoders

4. Reinforcement Learning

- 4.1 Introduction to RL and Finite Markov Decision Processes

- 4.2 Value and Policy Iteration (Dynamic Programming)
- 4.3 Monte-Carlo Methods
- 4.4 On-policy and Off-Policy Algorithms

AI Certification - Advanced

1.Prerequisites for Artificial Intelligence

- 1.1 Linear Algebra
- 1.2 Probability Theory
- 1.3 Bayes Theorem and Statistics
- 1.4 Calculus and Optimization

2. Supervised Machine Learning

- 2.1 Linear Regression
- 2.2 Multiple Linear Regression
- 2.3 Regression Performance Metrics
- 2.4 Classification Models
- 2.5 KNN, Logistic Regression
- 2.6 Support Vector Machines
- 2.7 Confusion Matrix, ROC Curves
- 2.8 Decision Tree, Bagging, Boosting and Ensembling

3. Unsupervised Machine Learning

- 3.1 Dimensionality Reduction: PCA
- 3.2 Clustering: K-Means Clustering
- 3.3 t-SNE
- 3.4 Kernel PCA
- 3.5 Spectral Clustering

4. Deep Learning

- 4.1 Activation Functions, Feedforward Network
- 4.2 Back Propagation, Loss Functions, Hyperparameters
- 4.3 Convolutional Neural Networks
- 4.4 CNN Architectures for Image Classification
- 4.5 Recurrent Neural Networks
- 4.6 Long Short-Term Memory Models
- 4.7 Autoencoders

5. **Practical Machine Learning**

  - 5.1 Exploratory Data Analysis
  - 5.2 Feature Engineering
  - 5.3 Hyperparameter Tuning
  - 5.4 Model Selection
  - 5.5 End-to-end Machine Learning

6. **Bayesian Methods in Machine Learning**

  - 6.1 Bayesian Inference
  - 6.2 Bayesian Optimization
  - 6.3 Variational Methods
  - 6.4 Gaussian Process Regression

7. **Advanced Topics in Deep Learning**

  - 7.1 Object Detection
  - 7.2 Semantic Segmentation
  - 7.3 Action Recognition
  - 7.4 Generative Adversarial Networks
  - 7.5 Variational Autoencoders

8. **Reinforcement Learning and Deep Reinforcement Learning**

  - 8.1 Finite Markov Decision Processes
  - 8.2 Value and Policy Iteration (Dynamic Programming)
  - 8.3 Monte-Carlo Methods
  - 8.4 On-policy and Off-Policy Algorithms
  - 8.5 Deep Reinforcement Learning
  - 8.6 Value-based methods and Q-learning
  - 8.7 Function Approximation, DQN
  - 8.8 Policy Gradient Methods, Actor Critic Methods

Joint Certification in AI and Quantum Computing

1. Prerequisites for Quantum Computing

- 1.1 Essential Linear Algebra
- 1.2 Essential Computer Science
- 1.3 Basics of Quantum Mechanics

2. Quantum States, Evolution, and Measurements

- 2.1 Single-qubit states and superposition
- 2.2 Single-qubit gates and measurements
- 2.3 Two-qubit states, entanglement, and Bell’s inequality
- 2.4 Two-qubit gates and observable
- 2.5 Multi-Qubit states (GHZ and W states)
- 2.6 Universal gates and quantum circuit model
- 2.7 Quantum adiabatic computation and the Ising model for NP-hard problems

3. Quantum Algorithms

- 3.1 Quantum Circuits
- 3.2 Deutsch-Jozsa Algorithm
- 3.3 Bernstein-Vazirani Algorithm
- 3.4 Quantum Fourier Transform
- 3.7 Quantum Factoring: Shor’s Algorithm
- 3.8 Quantum Database Search: Grover's Algorithm
- 3.9 Circuit Simulations on QpiAI Explorer Software

4. Quantum Protocols

- 4.1 Quantum Teleportation
- 4.2 Superdense Coding
- 4.3 Simulation on QpiAI Explorer Software
- 4.4 Quantum Cryptography and Key Distribution
- 4.5 Quantum Communication and Networks

5. NISQ Devices

- 1.1 Noise Models
- 1.2 Quantum Error Mitigation
- 1.3 Quantum Volume and Performance Metrics

- 1.4 Hybrid Quantum-Classical Computing

6. Quantum Algorithms for Applications

- 2.1 Quantum Inspired Computing
- 2.2 Variational Quantum Algorithms
- 2.3 Variational Quantum Eigensolver
- 2.4 Quantum Approximate Optimization Algorithm
- 2.5 Quantum Machine Learning: QNNs
- 2.6 HHL Algorithm for Solving Linear Systems

7. Quantum Hardware: Superconducting Qubits

- 3.1 Introduction to physical qubits
- 3.2 Circuit Quantum Electrodynamics
- 3.3 Transmon and Coupled Qubits
- 3.4 Control and Readout

8. Quantum Hardware: Semiconducting Qubits

- 4.1 Introduction to physical qubits
- 4.2 Spin Physics and Quantum Dots
- 4.3 Control and Readout
- 4.4 Scalability