

Indicative list of topics for short term training programmes:

1. Data Science & Predictive analytics

- a. Data pre-processing
- b. Data visualisation
- c. Descriptive Statistics
- d. Dimensionality Reduction
- e. Data Mining
 - i. Association Analysis
 - ii. Classification
 - iii. Time Series Analysis
 - iv. Text Mining
 - v. Cluster Analysis
 - vi. Anomaly Detection

Sub-themes:

- Industrial Data Collection - Arduino and Raspberry Pi
- Open Source Programming Techniques – Python, MATLAB and R Programming
- Introduction to Data Analytics – ML Algorithms
- Build predictive models using ML Techniques
- Image Processing – Introduction and Neural Networks
- Deep Learning with MATLAB - Learn the theory and practice of building deep neural networks with real-life image and sequence data
- Optimization Techniques – Python & Mat lab Tool box

Suggested reference Books:

- Predictive Analytics and Data Mining: Concepts and Practice with Rapid Miner by Vijay Kotu, Bala Deshpande
- Data Science and Predictive Analytics: Biomedical and Health Applications using R by Ivo D. Dinov
- Data Mining and Predictive Analytics by Daniel T. Larose

2. Internet of Things (IoT)

- a. Information Theory and Computation
- b. M2M communications
- c. Sensors
- d. Actuators
- e. Cloud and Data platforms
- f. IoT architectures
- g. Embedded Systems
- h. Communication Models
- i. Network Protocols

- j. Data Analytics
- k. Security

Suggested reference Books:

- The Technical Foundations of IoT by Boris Adryan, Dominik Obermaier, Paul Fremantle
- IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry

3. Machine Learning (ML)

- a. Lazy Learning
- b. Probabilistic Learning
- c. Decision trees and random forests
- d. Regression Analysis
- e. Neural Networks
- f. Support Vector Machines
- g. Clustering
- h. Optimization

Suggested reference Books:

- Pattern Recognition and Machine Learning by Christopher M. Bishop
- Machine Learning by Tom Mitchell

4. Deep Learning (DL)

- a. Perceptrons
- b. Deep Feedforward Networks
- c. Convolutional Networks
- d. Recursive Networks
- e. Recurrent networks
- f. Autoencoders
- g. Representation Learning
- h. Pre-trained models
 - i. LeNet
 - ii. AlexNet
 - iii. ImageNet
 - iv. GoogleNet
 - v. ResNet

Suggested reference Books:

- Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville
- Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms by Nikhil Buduma, Nicholas Locascio

5. Big Data Analytics

Data Science basics

- a) Data Preparations and processing
- b) Introduction to R and visualization

- c) Basics of Matrices and Linear Algebra
- d) Basics of Probability and Statistics

Basic data models

- a) Linear regression modelling and diagnostics
- b) Multiple linear regression modelling
- c) Logistic regression and binary classification
- d) Decision tree modelling

Advanced data models

- a) Model evaluation and improvement
- b) Nonlinear classification methods
- c) Dimensionality reduction methods
- d) Matrix decomposition methods

Finding structures in data

- a) Clustering methods
- b) Outlier analysis
- c) Association analysis
- d) Network analysis and optimization

MapReduce and Hadoop

- a) MapReduce basics
- b) Hadoop MapReduce
- c) HDFS basics
- d) Hadoop Ecosystem

Distributed and parallel computing using R

- a) Integrating R and Hadoop
- b) RHIPE and RHadoop
- c) Applications on large data
- d) High-Performance and Parallel R

Analyzing data in motion

- a) Real time data streams
- b) Stream data basics
- c) Data Stream analysis platforms
- d) R based stream analysis

Databases and operationalizing Big Data

- a) Relational and Non-relational databases
- b) R interface to databases
- c) Managing data security and variety
- d) Cloud in the context of Big Data

Big Data case studies

(practical lessons)

Theme areas:

- a. Challenges in Big Data
- b. Paradigm Shifts
- c. Big Data Storage and Retrieval
- d. Applications of Big Data
- e. MapReduce
- f. Apache Hadoop
 - i. Pig
 - ii. Hive
 - iii. HBase
 - iv. HDFS

- g. Cloud Computing
- h. Spark
- i. Data Analytics

Suggested reference Books:

- Big Data Analytics: Tools and Technology for Effective Planning edited by Arun K. Somani, Ganesh Chandra Deka
- Handbook of Big Data Analytics edited by Wolfgang Karl Härdle, Henry Horng-Shing Lu, Xiaotong Shen

6. Robotics

- a. Perception
- b. Mechanics and Planning
- c. Assembly and Control
 - i. Kinematics and Dynamics
 - ii. The whole Iguana
- d. Actuation Design

Suggested reference Books:

- Robotics Science edited by Michael Brady
- Handbook of Industrial Robotics edited by Shimon Y. Nof

7. Self-Monitoring, Analysis & Reporting Technology (SMART)

- a. SMART technology
- b. SMART attributes
- c. Self-tests

8. Advanced materials

- a. Polymer Composites
- b. Ceramic materials
- c. Nickel and Nickel Alloy
- d. Titanium Alloys
- e. Aluminium and Aluminium Alloys
- f. Functionally Graded Materials

Suggested reference Books:

- Handbook of advanced materials enabling new designs by James K. Wessel

9. Sensor Networks

- a. Sensing and sensors
- b. Architectures
 - i. Single Node
 - ii. Network architecture
- c. Communication Protocols
 - i. MAC protocols
 - ii. Link layer protocols
 - iii. Routing protocols
- d. Node and network management
- e. Security

Suggested reference Books:

- Protocols and Architectures for Wireless Sensor Networks by Holger Karl and Andreas Willig
- Fundamentals of Wireless Sensor Networks: Theory and Practice by Waltenegeus Dargie, Christian Poellabauer

10. Quantum Computing

- a. Quantum Computation
- b. Quantum Mechanics
- c. Devices for computation
 - i. Classical models
 - ii. Quantum information
 - iii. Circuits
- d. Fast Factorization
 - i. Quantum Fourier transform
 - ii. Shor's algorithm
- e. Finding hidden subgroup
 - i. Generalized Simon's algorithm
- f. Grover's Search algorithm

Suggested reference Books:

- Quantum Computing by Mika Hirvensalo
- An Introduction to Quantum Computing by Phillip Kaye, Raymond Laflamme, Michele Mosca

11. Quantum Communication

- a. Fundamentals
 - i. Vector and Hilbert spaces
 - ii. Quantum mechanics
- b. Classical and Quantum communication systems
- c. Poisson processes
- d. Quantum Decision Theory
 - i. Analysis and Optimization
 - ii. Sub-optimization
- e. Quantum Communication systems
- f. Quantum Information

Suggested reference Books:

- Quantum Communications by Gianfranco Cariolaro
- An Introduction to Quantum Communication by Vinod K. Mishra

12. Quantum encryption (Quantum Key Distribution)

- a. Classical Cryptography
- b. Information Theory
 - i. Source coding
 - ii. Channel coding
- c. Quantum Information Theory
 - i. Qubits

- ii. Entropies and coding
- iii. Quantum optics
- d. Quantum key distribution
- e. Secret key distillation
- f. Privacy amplification
- g. Reconciliation

Suggested reference Books:

- Quantum Cryptography and Secret-Key Distillation by Gilles van Assche

13. Cyber Security and security for physical infrastructure

- a. History and Impact
- b. Fundamentals rights in cyber security
- c. Ethical issues
- d. Cyber security technology
 - i. Clustering-Based Protocol Classification
 - ii. Timing and Side Channel Attacks
- e. Cyber Security and Automation
 - i. Protection of ICS Systems

Suggested reference Books:

- Cyber Security: Analytics, Technology and Automation by Martti Lehto • Pekka Neittaanmäki

Blockchain Technology

- f. Blockchain basics
- g. Blockchain client
- h. Regulator
- i. Blockchain developer
- j. Blockchain network administrator
- k. Blockchain creation
- l. Blockchain validation
- m. Block chaining
- n. Understanding cryptocurrency

Suggested reference Books:

- Blockchain, A guide to understanding blockchain by Sean Benett
- Blockchain Technology by Stephen Fleming

14. Artificial Intelligence (AI)

- a. State space search
- b. Uninformed Search techniques
 - i. Breadth first search
 - ii. Depth first search
 - iii. Depth Limited Search
 - iv. Iterative Deepening Search
 - v. Iterative Broadening Search
 - vi. Uniform Cost Search

- c. Informed Search Techniques
 - i. Heuristics
 - ii. Types of Heuristics
- d. Heuristic Search Techniques
 - i. Generate-and-Test
 - ii. Greedy Search
 - iii. Best First Search
- e. Heuristic Search Strategies
 - i. Iterative Improvement Search
 - Hill Climbing
 - Simulated annealing
 - ii. A* Search
 - iii. Iterative Deepening A*
 - iv. AO* Search
- f. Adversarial Search
- g. Iterative Improvement Search
 - i. Beam search
- h. Branch and Bound
- i. Adversarial Search

Suggested reference Books:

- Artificial Intelligence by Christopher Thornton
- Artificial Intelligence, A Modern Approach by Stuart J. Russell and Peter Norvig
