

MATHEMATICAL MODELLING: ANALYSIS AND APPLICATION

Submitted in partial fulfilment of the required for the
award of

**Master of Science Degree in Bioinformatics and
Data Science**

By

J . Kowsalya (43739007)



DEPARTMENT OF BIOINFORMATICS AND DATA SCIENCE

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade “A++” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI,

CHENNAI – 600119

APRIL 2024



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

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DEPARTMENT OF BIOINFORMATICS AND
DATA SCIENCE

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of

J.KOWSALYA (43739007) who carried out the project entitled
“MATHEMATICAL MODELLING: ANALYSIS AND APPLICATION
” under my / our supervision from January 2024 to April 2024.

Internal Guide

External Guide

Head of the Department

Submitted for Viva voce Examination held on_____

DECLARATION

I **J .KOWSALYA (43739007)** hereby declare that the Project Report entitled
“MATHEMATICAL MODELLING: ANALYSIS AND APPLICATION” done
by me under the guidance of Dr. /Prof./ Mr./Ms._____(Internal)
and_____(External) at _____(Company name and
address) is submitted in partial fulfillment of the requirements for the award
of Bachelor of Engineering / Technology degree in _____.

DATE:

PLACE:

KOWSALYA J

SIGNATURE OF THE CANDIDATE

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to Dr. -----, Dean, School of ----- and Dr.-----, Head of the Department, Dept. of ----- for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide Dr./Mr./Ms-----for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of ----- who were helpful in many ways for the completion of the project.

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NPTEL (IIT CERTIFICATION COURSE)

MATHEMATICAL MODELLING: ANALYSIS AND APPLICATIONS

MATHEMATICAL MODELLING :

Mathematical modelling is the process of describing a real world problem in mathematical terms, usually in the form of equations, and then using these equations both to help understand the original problem, and also to discover new features about the problem. Modelling both lies at the heart of much of our understanding of the world, and it allows engineers to design the technology of the future. A dictionary meaning of a “model” is to represent something . Thus, modeling is a process or a way of representation. Now, what are we supposed to represent? The nature or behavior of the system and/or the activities involved in it !Again, what are the ways to represent? It may be done by a drawing or some verbal arguments or a physical structure or mathematical formulas Thus, the mathematical modelling is a process of representation of the system with help of mathematical formulas and the mathematical model is the structure obtained. A mathematical model plays a vital role in analysis of the system which other models like physical, chemical, linguistic etc. can't.

How?

- Simulation on models rather experiments on actual system.
- Best way to understand the physical behavior of the system.
- Economic way for measurements.
- Control on parameters.
- Allow us to predict the future nature which haven't been seen so far.

COURSE LAYOUT :

WEEK 1: Overview of mathematical modelling, types of mathematical models and methods to solve the same; Discrete time linear models – Fibonacci rabbit model, cell-growth model, prey-predator model; Analytical solution methods and stability analysis of system of linear difference equations; Graphical solution – cobweb diagrams; Discrete time age structured model – Leslie Model; Jury's stability test; Numerical methods to find eigen values – power method and LR method.

WEEK 2: Discrete time non-linear models- different cell division models, prey-predator model; Stability of non-linear discrete time models; Logistic difference equation; Bifurcation diagrams.

WEEK 3: Introduction to continuous time models – limitations & advantage of discrete time model, need of continuous time models; Ordinary differential equation (ODE) – order, degree, solution and geometrical significance; Solution of first order first degree ODE – method of separation of variables, homogeneous equation, Bernoulli equation; Continuous time models – model for growth of micro-organisms, chemostat; Stability and linearization methods for system of ODE's.

WEEK 4: Continuous time single species model – Allee effect; Qualitative solution of differential equations using phase diagrams; Continuous time models – Lotka Volterra competition model, prey-predator models.

SCOPE OF MATHEMATICAL MODELING IN BIOSCIENCES:

Specifically In Bio-Sciences, Mathematical Models Are Used To:

Diagnosis And Treatment Of Diseases (Biomedical):

This involves identifying diseases or conditions in patients. It can include various methods such as physical examination, laboratory tests (like blood tests or imaging tests such as X-rays or MRIs), and procedures like biopsies. Once a disease is diagnosed, treatment involves interventions to alleviate symptoms, cure the disease, or manage it effectively. Treatments can range from medications (like antibiotics for bacterial infections), surgery, physical therapy, and lifestyle changes.

Study Of The Growth And Shape Of Plants (Botany):

Botany is the scientific study of plants, including their physiology, structure, genetics, ecology, distribution, classification, and economic importance. Understanding plant growth and shape involves studying processes like photosynthesis, cell division, hormonal regulation, and environmental factors influencing plant development.

Designing Artificial Body Parts (Bioengineering):

Bioengineering combines principles from biology and engineering to design and create artificial body parts or improve existing biological systems. This can include prosthetic limbs, artificial organs (like hearts or kidneys), tissue engineering for regenerative medicine, and biomedical devices such as pacemakers or insulin pumps.

Enzyme Kinetics And Chemical Reactions In Living Bodies (Biochemistry):

Biochemistry focuses on the chemical processes and substances that occur within living organisms. Enzyme kinetics involves studying the rates at which enzymes catalyze chemical reactions, while chemical reactions in living bodies encompass various metabolic pathways like glycolysis, Krebs cycle, and protein synthesis.

Survival Of Populations With Limited Resources (Ecology):

Ecology is the study of interactions between organisms and their environment. Examining the survival of populations with limited resources involves understanding how populations of organisms interact with each other and their environment when resources such as food, water, and habitat are scarce. This can involve studying concepts like competition, predation, adaptation, and carrying capacity within ecosystems.

WHAT I LEARNT ?

- Introduction to mathematical modelling and analysis in biological sciences
- Designed for students in applied mathematics and bio-medical/biological sciences
- Major content chosen from population dynamics
- Covers fundamentals of deterministic models in discrete and continuous time domains
- Includes linear and non-linear models with theoretical background
- Provides concepts and solution methods for different types of difference and differential equations
- Emphasizes graphical solutions for clear analysis of model nature

DURATION:

4 Weeks

COURSE PROGRESS :

100 %

Grade :

55%

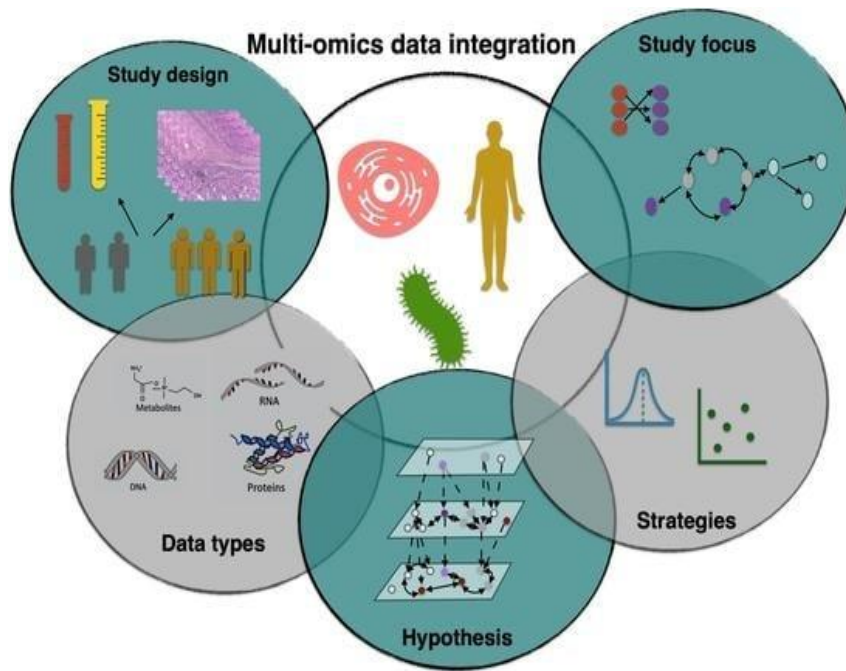
REVIEW ARTICLE

Harnessing Multi-omics Data: Approaches and Challenges in Integration and Analysis

INTRODUCTION

The utilization of multi-omics data has become essential in biomedical research due to the vast amount of available data. These approaches offer a holistic view of biological systems by capturing various molecular layers simultaneously, including genomics, transcriptomics, proteomics, metabolomics, and epigenomics. This integration holds promise for understanding complex biological processes, uncovering disease mechanisms, and advancing precision medicine. However, challenges such as data diversity, scalability, computational complexity, and interpretation hinder the integration and analysis.

This review provides an overview of methods and obstacles in leveraging multi-omics data, discussing integration strategies like correlation-based techniques, network-based methodologies, and machine learning approaches. It also highlights computational tools aiding multi-omics data analysis and addresses challenges related to data preprocessing, normalization, dimensionality reduction, and interpretation. Lastly, the review emphasizes the importance of interdisciplinary collaboration, standardization, and robust analytical frameworks for advancing biomedical research and clinical applications using multi-omics data.



DATA INTEGRATION TECHNIQUES FOR GENOMICS, TRANSCRIPTOMICS, AND EPIGENOMICS

Advancements in high-throughput technology have diversified omics applications in medicine, notably encompassing genomics, transcriptomics, and epigenomics. These omics disciplines find utility across various domains such as cellular molecular analysis, investigation of intestinal microbial ecosystems, and examination of pathological imaging, among other areas. With the goal of comprehending and measuring every gene in an organism as well as their connections, genomics is an essential field in medicine. High-throughput DNA sequencing and analysis are required for this. GWAS, which finds disease-related genetic variants like SNPs throughout the human genome, is one important application. Many found variants may not have direct biological relation to disease, despite its capacity to identify novel genes and pathways associated with the disease.

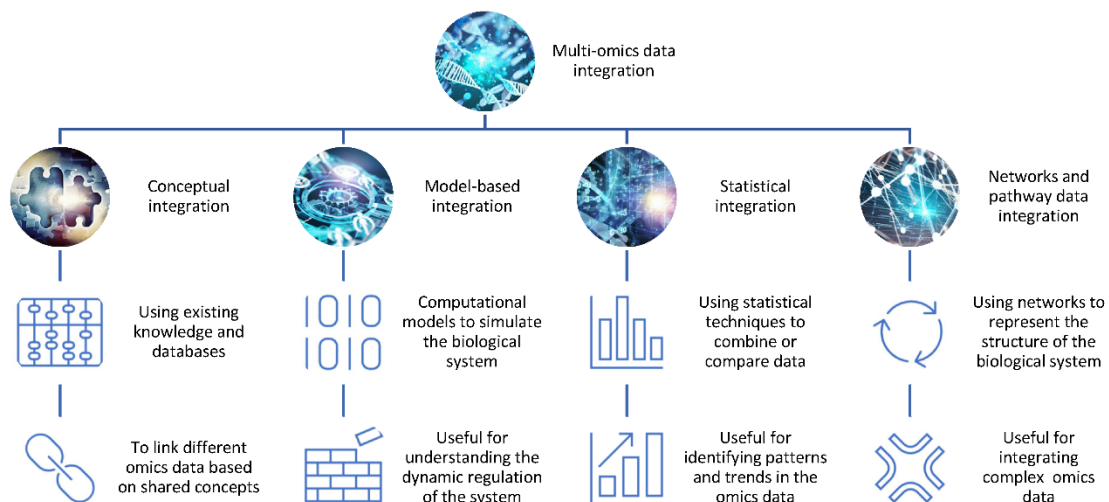
Transcriptomics, which involves looking at every RNA that is expressed in a group of cells, one can learn more about the molecular changes caused by environmental factors or viruses. It encompasses a range of RNA types, including protein-coding RNAs, circular RNAs, long and short noncoding RNAs, and others. Among the noncoding RNAs associated with various diseases, such as diabetes, cancer, heart disease, and neurological problems, are circular RNAs. Given that mRNA makes up

a minor portion of the transcriptome, it is becoming more and more important to look into how noncoding RNAs affect disease. A popular technique for transcriptomics is RNA-sequence, which can precisely measure RNA transcripts from tiny samples as well. The field of single-cell transcriptomics is gaining prominence as it allows for the identification of particular cell type transcripts in disorders like Alzheimer's and cancer.

The field of epigenomics studies how radiation properties and reversible changes to DNA or histones affect gene expression. Nonetheless, overfitting and class imbalances are common problems in radiomics. For instance, it is challenging to distinguish between impacted and unaffected lesion areas on PET scans due to the low prevalence of some diseases in the population.

ANALYSIS OF INTEGRATED MULTI-OMIC DATA BASED ON NETWORKS

The incorporation of network-based approaches has brought about a substantial transformation in the field of multi-omics analysis by providing an organized framework for the graphical representation of interactions among several omics layers. These networks may be able to capture the complex relationships between molecules inside of cells.



Network-based methods rely on networks built from these links to infer relationships between samples/patients or omics features. Patient Reliability Two types of networks constructed using omics data are networks and molecular networks, such as gene or protein networks. Network integration techniques such as Similarity Network Fusion are used to integrate many patient or molecular networks together. Machine learning models are then trained with the attributes of integrated networks to carry out tasks like prediction or grouping. Network-based techniques convert heterogeneous omics types into homogenous networks by utilizing network features that are much smaller in dimension than those of omics data.

BIOLOGICAL INSIGHTS GAINED FROM INTEGRATED MULTI-OMICS STUDIES

One may wonder if science will be ready to seize this chance to gain a deeper understanding of biology given the possibility of obtaining access to such a massive data resource—the genetic code for a significant fraction of the planet's eukaryotic biosphere. While there are other approaches to answering this question, the fundamental one is the capacity to recognize the composition and role of individual genes as they interact to preserve biological validity and viability.

Overcoming this obstacle with new, advanced instruments has made it possible to measure many molecular characteristics of biological systems in a high throughput fashion. This has made it possible to determine the global expression profile of the genome at the transcriptome, proteome, and metabolome levels. The acquisition of these extensive datasets is frequently rationalized as a means of gaining knowledge about gene function. However, in spite of this improved capacity to produce data across several platforms, it is unclear how these data inputs have improved the capacity to identify novel gene functions.

The primary focus in gaining practical understanding of cellular processes is now on the analysis of multi-omics data in conjunction with clinical information. Using multi-omics data to integrate information on biomolecules from several layers appears to hold promise for a systematic and comprehensive understanding of complicated biology. To comprehend how molecules interact, integrated techniques combine individual omics data in a sequential or simultaneous fashion. They aid in evaluating the information transfer between omics levels and, hence, aid in closing the gap

between genotype and phenotype. Integrative techniques can eventually contribute to better treatment and prevention since they can examine biological phenomena holistically, which can improve prognostics and the predictive accuracy of disease phenotypes.

ETHICAL ASPECTS IN THE INTEGRATION AND ANALYSIS OF MULTI-OMICS DATA

Numerous facets of biological science study have been profoundly impacted by recent developments in 'omics' technologies. These developments have supported research in molecular biology, physiology, biochemistry, and variety. They have also aided in the creation of novel goods and processes. They are essential in combating new diseases, the world's food shortage, environmental degradation, the creation of high-quality products with added value, and improving our understanding of host-pathogen interactions and stress tolerance in microorganisms and plants.

Three primary ethical and social concerns arise when integrating these modalities into the palliative care system: balancing the advantages and disadvantages, ensuring that underrepresented and marginalized groups are involved in the development and application of new technologies, and figuring out how cutting-edge modalities will impact the highly personalized and intimate nature of palliative care practice. Many of these techniques are still being developed, though, and careful integration of the generated data is necessary to draw meaningful findings. Though frequently manageable, biosafety and ethics concerns must nevertheless be addressed seriously.

Precision health is the future we are heading towards as a result of the evolution of digital health, systems biology, artificial intelligence, and environmental monitoring. Precision health goes beyond treating illnesses and attempts to maintain good health throughout a person's life. Investigating how precision health methods might impact those with terminal or life-limiting illnesses is vital, though.

MATLAB

MATLAB ONRAMP

The MATLAB Onramp course offers participants a comprehensive introduction to the MATLAB programming language and its versatile applications. Throughout the course, participants are guided through the essential components of the MATLAB environment, becoming familiar with its user interface elements like the Command Window, Workspace, and Editor. They delve into the core syntax and data types of MATLAB, gaining proficiency in numeric arrays, matrices, variables, and strings, while also mastering fundamental mathematical operations and utilizing MATLAB's extensive library of mathematical functions for various computations.

WHAT I LEARNT ?

- Completing the MATLAB Onramp course has yielded a comprehensive outcome, shaping a strong foundation in MATLAB programming and data analysis.
- computational skills have seen significant improvement, thanks to the practice in mathematical operations, data manipulation, and programming within the MATLAB environment.
- proficiency instills a sense of confidence, allowing you to approach various tasks with assurance and competence.
- MATLAB Onramp course is transformative, equipping you with the knowledge and skills to excel in academic, professional, or personal endeavors requiring MATLAB expertise.

COURSE DURATION :

2 Hours

COURSE GRADE:

100 %

MATLAB FUNDAMENTALS

The course has also introduced you to the power of visualization, enabling you to create compelling plots and graphs to analyze and interpret data effectively. Through hands-on exercises and projects, you've sharpened your programming prowess, mastering concepts such as loops, conditional statements, and functions. As you move forward, the skills and knowledge you've acquired in the MATLAB Fundamentals course will serve as a solid foundation for advanced study and real-world applications. Whether you're pursuing further education, conducting research, or embarking on a professional career, MATLAB will continue to be a valuable tool in your toolkit, enabling you to tackle complex challenges with confidence and proficiency.

WHAT I LEARNT ?

- Participants become proficient in performing various mathematical operations, numerical analyses, and algorithm implementations using MATLAB's extensive library of functions and tools.
- participants gain proficiency in data analysis and visualization, learning how to import, manipulate, and analyze data, as well as create informative visualizations such as plots and graphs
- The course also focuses on building strong programming skills, including scripting, loop structures, conditional statements, and function definitions. Participants learn to write clean, efficient code, enabling them to automate tasks and solve complex problems with ease.

COURSE DURATION :

2 Hours

COURSE GRADE:

100 %

SIMULINK ONRAMP

Completing the Simulink Onramp course is a significant milestone in mastering Simulink, a powerful tool for modeling, simulating, and analyzing dynamic systems. Throughout the course, participants embark on a journey to understand Simulink's core principles, interface, and practical applications. One of the central outcomes of the course is gaining proficiency in modeling dynamic systems using Simulink's intuitive block diagram environment. Participants learn to represent complex systems with ease, leveraging Simulink's extensive library of pre-built blocks and components. Moreover, the course equips participants with essential skills in simulating dynamic systems, allowing them to analyze system behavior and performance under various conditions. By setting up simulations and running them within Simulink, participants gain valuable insights into system dynamics and response characteristics.

WHAT I LEARNT ?

- Completing the Simulink Onramp course has yielded significant outcomes, providing a solid foundation in Simulink and its practical applications.
- The course, participants have gained comprehensive knowledge of Simulink's interface, tools, and functionalities.
- Completing the Simulink Onramp course has empowered participants with the knowledge, skills, and confidence to leverage Simulink effectively for modeling and simulating dynamic systems.
- well-equipped to tackle complex problems and pursue advanced topics in Simulink with a strong foundation in place.

COURSE DURATION :

2 Hours

COURSE GRADE:

100 %

SIGNAL PROCESSING WITH MATLAB

The Signal Processing with MATLAB course offers participants a comprehensive exploration of signal processing fundamentals and their implementation using MATLAB. Throughout the course, participants delve into a wide range of topics, including time-domain and frequency-domain analysis, filtering techniques, convolution, and spectral analysis. They gain a deep understanding of how signals are processed and analyzed in various domains, from audio and speech processing to image and biomedical signal processing. Hands-on exercises and projects provide participants with opportunities to reinforce their learning and apply signal processing techniques to real-world problems.

WHAT I LEARNT ?

- Completing the Signal Processing with MATLAB course empowers participants with a comprehensive understanding of signal processing principles and practical skills in MATLAB implementation.
- Throughout the course, participants delve into fundamental concepts such as time-domain and frequency-domain analysis, filtering, convolution, and spectral analysis. They gain proficiency in MATLAB, mastering the tools and functions necessary for effective signal processing.
- Hands-on exercises and projects provide participants with valuable practical experience, allowing them to apply their newfound knowledge to real-world scenarios.

COURSE DURATION :

7.5 hours

COURSE GRADE:

100 %

IMAGE PROCESSING WITH MATLAB

Completing the Image Processing with MATLAB course offers participants a comprehensive understanding of image processing principles and practical skills in MATLAB implementation. Throughout the course, participants explore a wide range of topics, including image enhancement, filtering, segmentation, feature extraction, and object detection. Participants gain proficiency in MATLAB, mastering the tools and functions necessary for effective image processing. They learn how to manipulate and analyze images using MATLAB's built-in functions and toolboxes, such as the Image Processing Toolbox. Hands-on exercises and projects provide participants with valuable practical experience, allowing them to apply their newfound knowledge to real-world scenarios. Through these activities, participants develop the ability to enhance image quality, remove noise, segment objects, extract features, and detect objects of interest within images. Furthermore, participants learn to visualize image processing results using MATLAB's plotting and visualization capabilities. This skill enhances their ability to analyze and communicate findings effectively, enabling them to interpret and present image processing results with clarity.

WHAT I LEARNT ?

- Comprehensive understanding of fundamental concepts in image processing, including image enhancement, filtering, segmentation, feature extraction, and object detection.
- Image processing algorithms and techniques using MATLAB's built-in functions and toolboxes, such as the Image Processing Toolbox.
- Image processing techniques to a variety of domains, including medical imaging, remote sensing, computer vision, digital photography, and more.

COURSE DURATION :

11 hours

COURSE GRADE:

100 %

SIGNAL PROCESSING ONRAMP

Completing the Signal Processing Onramp course is an essential step towards mastering signal processing techniques using MATLAB. Throughout the course, participants delve into fundamental concepts such as time-domain and frequency-domain analysis, filtering, convolution, and spectral analysis. They gain a comprehensive understanding of how signals are processed and analyzed across various domains, including audio, speech, image, and biomedical signal processing. Participants also acquire practical skills in MATLAB, learning how to implement signal processing algorithms and techniques using MATLAB's built-in functions and tools. They explore methods for filtering signals, performing Fourier analysis, and conducting digital signal processing (DSP), enabling them to manipulate and analyze signals effectively. Hands-on exercises and projects provide participants with opportunities to reinforce their learning and apply signal processing techniques to real-world problems.

WHAT I LEARNT ?

- Participants gain a strong foundational understanding of signal processing concepts and techniques, including time-domain and frequency-domain analysis, filtering, convolution, and spectral analysis.
- Implementing signal processing algorithms and techniques using MATLAB's tools and functions. They learn how to manipulate and analyze signals effectively, perform filtering operations, and conduct spectral analysis.
- Hands-on exercises and projects, participants gain practical experience in using MATLAB for signal processing tasks.

COURSE DURATION :

1.5 hours

COURSE GRADE:

100 %

SOLVING NONLINEAR EQUATIONS WITH MATLAB

Completing the "Solving Nonlinear Equations with MATLAB" course equips participants with a comprehensive understanding of methods and techniques for solving nonlinear equations using MATLAB. Throughout the course, participants delve into various numerical methods, optimization techniques, and root-finding algorithms commonly employed in solving nonlinear equations. Participants gain proficiency in implementing these methods and algorithms using MATLAB's built-in functions and tools. They learn how to formulate nonlinear equations, apply appropriate numerical techniques, and interpret results effectively using MATLAB's programming environment. Hands-on exercises and projects provide participants with practical experience in solving a wide range of nonlinear equations encountered in engineering, science, finance, and other domains. Through these activities, participants develop problem-solving skills and gain confidence in applying MATLAB to tackle real-world nonlinear equation problems.

WHAT I LEARNT ?

- Participants become proficient in using a variety of numerical methods and algorithms for solving nonlinear equations, such as iterative methods, optimization techniques, and root-finding algorithms.
- advanced MATLAB programming skills, learning how to implement and apply numerical methods to solve nonlinear equations efficiently.
- participants acquire practical experience in solving a diverse range of nonlinear equation problems encountered in various fields, such as engineering, science, finance, and economics.

COURSE DURATION :

3 hours

COURSE GRADE:

100 %

STATISTICS ONRAMP

The "Statistics Onramp" course offers participants a comprehensive introduction to statistics concepts and their practical applications using MATLAB. Throughout the course, participants delve into fundamental statistical principles, methods, and techniques, gaining a solid foundation in statistical analysis and interpretation. Key topics covered in the course include descriptive statistics, probability distributions, hypothesis testing, confidence intervals, regression analysis, and ANOVA (analysis of variance). Participants learn how to use MATLAB's statistical functions and tools to perform various statistical analyses and visualize data effectively. Hands-on exercises and projects provide participants with practical experience in applying statistical methods to real-world datasets. Through these activities, participants develop proficiency in data analysis, interpretation, and decision-making, enhancing their problem-solving skills and critical thinking abilities.

WHAT I LEARNT ?

- Participants gain a strong foundational understanding of statistical concepts, including descriptive statistics, probability distributions, hypothesis testing, and regression analysis.
- practical skills in using MATLAB for statistical analysis, learning how to perform various statistical tests, calculations, and visualizations efficiently.
- interpreting data using statistical methods, enabling them to draw meaningful conclusions and make informed decisions based on data insights.
- The course lays the groundwork for further study or exploration of advanced statistical topics and techniques, providing participants with a solid foundation for continued learning and growth in the field of statistics.

COURSE DURATION :

1.5 hours

COURSE GRADE:

100 %

MACHINE LEARNING ONRAMP

The Machine Learning Onramp course is a comprehensive introductory program designed to familiarize participants with the fundamental concepts and techniques of machine learning. The course begins with an overview of what machine learning is, its applications, and its importance in various industries. An introduction to neural networks and deep learning is provided, covering topics such as feedforward neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).

WHAT I LEARNT?

- Participants will gain a solid understanding of the fundamental concepts, techniques, and algorithms used in machine learning. This includes supervised and unsupervised learning methods, data preprocessing techniques, model evaluation, and more.
- With a comprehensive understanding of core concepts such as supervised and unsupervised learning, coupled with proficiency in data preprocessing techniques and model evaluation, individuals gain the confidence to tackle real-world data challenges.
- Through hands-on projects and exercises, We develop the ability to apply machine learning algorithms using popular tools and libraries like scikit-learn, TensorFlow, or PyTorch. Moreover, the course fosters a problem-solving mindset, enabling participants to analyze data effectively, identify patterns, and make informed decisions.

COURSE DURATION:

2 hours

COURSE GRADE:

100%

APP BUILDING ONRAMP

An App Building Onramp course is designed to provide individuals with the foundational knowledge and skills needed to develop mobile applications. Understanding how to create user-friendly interfaces is crucial in app development. Many apps require interaction with a server or database for data storage and retrieval. The course may cover basics of backend development, including APIs, databases, and server-side scripting. Participants are introduced to best practices in app development, including optimizing app performance, security considerations, and adhering to platform-specific guidelines.

WHAT I LEARNT?

- Many App Building Onramp courses emphasize collaboration and version control using tools like Git. We will learn how to work effectively in a team environment and manage code changes using version control systems.
- The course serves as a stepping stone for individuals who wish to pursue further learning and specialization in specific areas of app development, such as iOS or Android development, game development, or mobile app security
- By completing hands-on projects and assignments throughout the course, students will develop the skills necessary to build their own mobile applications, ranging from simple utility apps to more complex projects with database integration and server communication.

COURSE DURATION :

1 hour

COURSE GRADE:

100%

OBJECT - ORIENTED PROGRAMMING

Through a combination of theoretical concepts and hands-on practical exercises, we delve into the principles and practices of OOP, learning to design, implement, and maintain robust and scalable software systems. The course typically covers key OOP concepts such as encapsulation, inheritance, and polymorphism, empowering students to organize code efficiently, enhance reusability, and facilitate easier maintenance. Moreover, students often explore advanced topics like design patterns, abstraction, and object relationships, gaining the skills necessary to develop complex applications and navigate real-world software development challenges

WHAT I LEARNT?

- The Object-Oriented Programming (OOP) course equips with a robust skill set and a deep understanding of software development principles.
- Upon completion, students emerge with the ability to design, implement, and maintain complex software systems using OOP concepts such as encapsulation, inheritance, and polymorphism. They gain proficiency in organizing code efficiently, enhancing reusability, and ensuring scalability.
- Developing problem-solving skills and learn to navigate real-world software development challenges by applying design patterns and leveraging abstraction

COURSE DURATION :

2 HOURS

COURSE GRADE :

100%

COMPUTER VISION ONRAMP

The Computer Vision Onramp course is an introductory program designed to provide learners with a comprehensive understanding of computer vision concepts and techniques. The course usually starts with an overview of what computer vision is, its applications, and its significance in various fields such as healthcare, autonomous vehicles, robotics, etc. Learners are introduced to fundamental concepts such as image representation, color spaces, image filtering, and feature extraction. These concepts lay the groundwork for understanding more advanced topics. The course covers various image processing techniques like edge detection, image segmentation, and morphological operations. These techniques are essential for preprocessing images before applying more advanced computer vision algorithms.

WHAT I LEARNT?

- Upon completing the Computer Vision Onramp course, participants emerge with a robust understanding of the fundamental principles and techniques underlying computer vision.
- Armed with this knowledge, we gain the ability to process and analyze images effectively, extracting meaningful information and insights.
- To become proficient in employing various image processing techniques, feature extraction methods, and object detection algorithms to tackle real-world challenges.

COURSE DURATION

2 HOURS

COURSE GRADE

100%

REINFORCEMENT LEARNING ONRAMP

The Reinforcement Learning Onramp is a structured learning pathway designed to introduce individuals to the fundamentals of reinforcement learning (RL). It serves as a starting point for beginners who want to understand the principles, algorithms, and applications of RL in various fields such as artificial intelligence, robotics, game playing, and more. MDPs form the mathematical framework for modeling RL problems. The course covers MDPs, including states, actions, transition probabilities, and rewards. Deep RL integrates neural networks with RL algorithms to handle high-dimensional state spaces. The course introduces deep Q-networks (DQN), policy gradients, and actor-critic methods.

WHAT I LEARNT?

- Acquiring a comprehensive understanding of the fundamental concepts, principles, and terminology of reinforcement learning, including Markov Decision Processes (MDPs), value functions, policies, and exploration-exploitation trade-offs.
- Help us to develop problem-solving skills necessary to tackle real-world reinforcement learning problems across diverse domains such as robotics, gaming, finance, healthcare, and more. learnt how to formulate RL problems, choose appropriate algorithms, and evaluate their performance.
- The course will enhance learners' critical thinking abilities as they analyze and evaluate the performance of different RL algorithms in various scenarios.

COURSE DURATION

2 .5 HOURS

COURSE GRADE

100%

MACHINE LEARNING WITH MATLAB

The "Machine Learning with MATLAB" course is an immersive educational experience designed to equip participants with the knowledge and skills necessary to excel in the dynamic field of machine learning. Through a combination of theoretical foundations and hands-on practical exercises, this course delves into various aspects of machine learning, from fundamental concepts to advanced techniques. This course covers the topics such as data preprocessing, feature selection, model evaluation, and algorithm implementation using MATLAB, a powerful computational tool widely used in the field of data science and machine learning

WHAT I LEARNT?

- Help us to Gain proficiency in utilizing MATLAB, a versatile computational tool, to develop, train, and deploy machine learning models for various real-world applications.
- With hands-on experience in data preprocessing, feature selection, model evaluation, and algorithm implementation, participants are equipped to tackle complex problems and make informed decisions in data-driven environments.
- Furthermore, acquiring the ability to interpret and communicate the results of machine learning models effectively, empowering them to contribute meaningfully to projects and initiatives across diverse industries

COURSE DURATION

12 HOURS

COURSE GRADE

100%

MATLAB FOR DATA PROCESSING AND VISUALIZATION

The "MATLAB for Data Processing and Visualization" course is designed to provide participants with a comprehensive understanding of how to utilize MATLAB, a powerful programming language and computing environment, for handling, analyzing, and visualizing data. The course begins with an overview of MATLAB's interface, basic syntax, and fundamental operations. Participants learn how to navigate the MATLAB environment, work with variables, and execute basic commands. The course covers a range of data analysis techniques available in MATLAB, including descriptive statistics, hypothesis testing, regression analysis, and clustering. Participants learn how to apply these techniques to extract meaningful insights from their data. The course also covers best practices for writing efficient and maintainable MATLAB code, as well as tips and tricks for optimizing performance and overcoming common challenges.

WHAT I LEARNT?

- This help us to learn how to create insightful visualizations of their data using MATLAB's plotting functions, including 2D and 3D plots, histograms, scatter plots, and more. They will also learn how to customize the appearance of their plots to effectively communicate their findings.
- Many courses include hands-on projects or assignments where participants apply their MATLAB skills to analyze real-world datasets and create meaningful visualizations.
- how to perform basic and advanced data analysis tasks using MATLAB, such as statistical analysis, curve fitting, signal processing, image processing, and machine learning.

COURSE DURATION

8 HOURS

COURSE GRADE

100%

DEEP LEARNING WITH MATLAB

Deep learning is a branch of machine learning that teaches computers to do what comes naturally to humans: learn from experience. Deep learning uses neural networks to learn useful representations of features directly from data. The Deep Learning with MATLAB course provides a comprehensive introduction to deep learning concepts and techniques using MATLAB. With "Deep Learning with MATLAB," users can leverage a vast array of built-in algorithms and tools, including convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative adversarial networks (GANs).

WHAT I LEARNT?

- By harnessing deep learning algorithms within MATLAB's framework, researchers and practitioners have achieved remarkable outcomes. One notable area of impact is in image recognition and classification, where convolutional neural network (CNNs) have demonstrated unprecedented accuracy in identifying objects within complex visual scenes
- deep learning with MATLAB has revolutionized medical image analysis, facilitating the detection of anomalies in MRI scans, X-rays, and histopathology slides. Researchers can leverage MATLAB's deep learning tools to create customized architectures tailored to specific medical imaging tasks, ultimately enhancing diagnostic accuracy and patient care.
- MATLAB's integration with specialized hardware platforms, such as GPUs and FPGAs, empowers researchers to accelerate deep learning computations and deploy models on embedded systems, opening new frontiers in edgecomputing and Internet of Things (IoT) applications.

COURSE DURATION

7 hours

COURSE GRADE

100%

DEEP LEARNING ONRAMP

The Deep Learning Onramp course is designed to provide participants with a comprehensive introduction to deep learning, a subset of machine learning focused on neural networks and their applications. The course starts with an overview of what deep learning is, its applications, and its significance in modern AI. The course teaches how to build and train neural networks using popular frameworks like TensorFlow or PyTorch. Participants learn about different types of neural networks, including feedforward, convolutional, and recurrent networks. Deep learning models require large amounts of data for training. Therefore, the course covers techniques for data preparation, cleaning, and preprocessing to ensure that the data is suitable for training.

WHAT I LEARNT?

- Many deep learning courses involve hands-on projects where students apply what they've learned to solve real-world problems. Completing these projects helps reinforce concepts and build a portfolio of work to showcase to potential employers.
- Completing a Deep Learning Onramp course can serve as a solid foundation for further study or employment in the field of deep learning and artificial intelligence. It can provide a starting point for more advanced courses or projects, or even entry-level positions in industries where deep learning expertise is valued.
- acquiring practical skills in implementing deep learning models using popular frameworks like TensorFlow or PyTorch. This may include tasks such as data preprocessing, model building, training, evaluation, and deployment.

COURSE DURATION

2 hours

COURSE GRADE

100%

MATLAB PROGRAMMING TECHNIQUES

The MATLAB Programming Techniques course is designed to provide participants with a comprehensive understanding of MATLAB programming concepts and techniques. Throughout the course, students will learn how to efficiently utilize MATLAB for various computational tasks, data analysis, and visualization. Matlab fundamental section covers fundamental concepts such as variables, arrays, data types, operators, and basic MATLAB syntax. Using MATLAB's powerful plotting functions to create various types of plots including 2D and 3D plots, histograms, and scatter plots for data visualization. Techniques for integrating MATLAB with other programming languages (e.g., C/C++, Python) and tools for collaborative development.

WHAT I LEARNT?

- Gaining a solid understanding of the MATLAB programming language, its syntax, and its various features.
- This course help us to develop algorithms and implement them in MATLAB for various applications, such as signal processing, image processing, control systems, and more.
- understanding the importance of documenting their code and results effectively, including writing clear comments and generating reports or presentations.
- learning techniques for optimizing MATLAB code to improve performance and efficiency, including vectorization, preallocation, and parallel computing.

COURSE DURATION:

16 hours

COURSE GRADE

100%

IMAGE PROCESSING ONRAMP

The Image Processing Onramp course is a comprehensive introduction to the fundamentals of image processing. Designed for beginners and those seeking to enhance their understanding of digital image manipulation, this course covers a wide range of topics including image acquisition, preprocessing techniques, filtering, segmentation, feature extraction, and image enhancement. Participants will gain hands-on experience through practical exercises using industry-standard software tools and programming languages commonly employed in image processing applications. professional in fields such as computer vision, medical imaging, or remote sensing, this course provides a solid starting point for further exploration and application of image processing techniques.

WHAT I LEARNT?

- Completing the Image Processing Onramp course can have numerous outcomes, depending on your goals and aspirations. To gain a solid understanding of the fundamental concepts and techniques used in image processing, equipping you with valuable knowledge applicable across various industries, from healthcare to robotics.
- This course can serve as a stepping stone for further exploration and specialization in fields like computer vision, machine learning, and artificial intelligence.
- Additionally, mastering image processing techniques can enhance your problem-solving skills, allowing you to tackle real-world challenges more effectively.

COURSE DURATION:

2 hours

COURSE GRADE

100%



NPTEL Online Certification

(Funded by the MoE, Govt. of India)



This certificate is awarded to

KOWSALYA J

for successfully completing the course

Mathematical Modelling: Analysis and Applications

with a consolidated score of **55** %

Online Assignments	21.67/25	Proctored Exam	33.68/75
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Total number of candidates certified in this course: **36**

Prof. Kaushik Ghosh,
Professor (Chemistry)
Coordinator CEC

Jan-Feb 2024

(4 week course)

Prof. Ranjana Pathania,
Professor (BSBE)
Coordinator (NPTEL)



Indian Institute of Technology Roorkee



Roll No: NPTEL24MA32S553403733

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No. of credits recommended: 1 or 2

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1 Submitted to Staffordshire University 6%
Student Paper

2 Conghao Wang, Wu Lue, Rama Kaalia, Parvin Kumar, Jagath C. Rajapakse. "Network-based integration of multi-omics data for clinical outcome prediction in neuroblastoma", Scientific Reports, 2022 3%
Publication

3 ebin.pub 2%
Internet Source

4 Indhupriya Subramanian, Srikant Verma, Shiva Kumar, Abhay Jere, Krishanpal Anamika. "Multi-omics Data Integration, Interpretation, and Its Application", Bioinformatics and Biology Insights, 2020 1%
Publication



Course Completion Certificate

Kowsalya J

has successfully completed **100%** of the self-paced training course

MATLAB Onramp



DIRECTOR, TRAINING SERVICES

8 November 2023



Course Completion Certificate

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MATLAB Fundamentals



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Machine Learning Onramp



DIRECTOR, TRAINING SERVICES

15 November 2023



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Simulink Onramp



DIRECTOR, TRAINING SERVICES

27 March 2024



Course Completion Certificate

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Signal Processing with MATLAB


DIRECTOR, TRAINING SERVICES

20 March 2024



Course Completion Certificate

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Image Processing with MATLAB


DIRECTOR, TRAINING SERVICES

16 March 2024



Course Completion Certificate

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Signal Processing Onramp



Craig L. Santos
DIRECTOR, TRAINING SERVICES

7 March 2024



Course Completion Certificate

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Solving Nonlinear Equations with MATLAB



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Image Processing Onramp



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5 March 2024



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Deep Learning Onramp



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3 December 2023



Course Completion Certificate

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Computer Vision Onramp


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1 December 2023



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MATLAB for Data Processing and Visualization


DIRECTOR, TRAINING SERVICES

6 December 2023



Course Completion Certificate

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MATLAB Programming Techniques



A handwritten signature in black ink, appearing to read 'Craig L. Santos', is positioned above a horizontal line. Below the line, the text 'DIRECTOR, TRAINING SERVICES' is printed in a small, black, sans-serif font.

DIRECTOR, TRAINING SERVICES

25 March 2024



Course Completion Certificate

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Machine Learning with MATLAB



Craig T. Santos

DIRECTOR, TRAINING SERVICES

7 December 2023



Course Completion Certificate

Kowsalya J

has successfully completed **100%** of the self-paced training course

Deep Learning with MATLAB



Craig T. Santos

DIRECTOR, TRAINING SERVICES

3 December 2023



Course Completion Certificate

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Statistics Onramp



DIRECTOR, TRAINING SERVICES

15 November 2023



Course Completion Certificate

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Reinforcement Learning Onramp



Craig L. Santos
DIRECTOR, TRAINING SERVICES

2 December 2023



Course Completion Certificate

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Object-Oriented Programming Onramp



Craig L. Santos
DIRECTOR, TRAINING SERVICES

1 December 2023



Course Completion Certificate

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App Building Onramp



Craig L. Santos
DIRECTOR, TRAINING SERVICES

17 November 2023

