10835-Artificial Neural Networks

General Objectives:

1. Fundamentals of Coding
    - Data type, Function/Algorithms, Dynamics
    - Introduction to Python
2. Fundamentals of Python Programming
    - Values and variables
    - Expressions and arithmetic
    - Functions
    - Classes
3. Data Handling and Analytics
    - Data sets and structures
    - Data sorting
    - Getting and cleaning data
    - Creating usable data
4. Machine Learning and Artificial Intelligence in RoboticsİEnergy, and Health.
    - Why AI is important, future applications, overall picture of AI in industry and medicine.
    - High level flow
        i. Localization, Probability, Sense Functions, Move, and Motion
        ii. Probability of events
        iii. Control theory, Control of robots, Implementatio
        iv. Neural network establishment
        v. Datasets and Training
5.
    - AI and Medical applications
        i. Applications
        ii. Widespread adoption of AI and ML in the medical field.
        iii. The science of creating intelligent computer programs
        iv. Orientation/Algorithms and Implementation
        v. Data observation and Control
        vi. Clustering events and Optimization
        vii. Noise
    - Building an identification and data retrieval system
        viii. Neural network establishment
        ix. Datasets and Training
        x. Tuning
        xi. Evaluation results

6. Final Project Demonstration
    - Demonstration and Discussion
    - Summarizing, intense Q&A session

Specific Objectives and Schedule:

Time	Topic	Details	
Part I	Modeling & Numerical Methods	• Stochastic & Deterministic Models • The Capabilities of Machine Learning on Models • First Principal Models: Advantages and Challenges • Algebraic Equations: Solution Methods and Applications	• successive_substitution.ipynb • GoldenSectionSearch.ipynb • NewtonRaphson_SISO.ipynb • NewtonRaphson_MIMO.ipynb
		• ODEs: Solution Methods and Applications • DDEs: Solution Methods and Applications • PDEs: Solution Methods and Applications • Integro-PDEs: Solution Methods and Applications • Discretization Methods • Empirical Models • Sensitivity Analysis • Input and Output Multiplicity • Model Validation Considerations	• ExplicitEuler.ipynb • ImplicitEuler.ipynb • CentralizedDiscretization.ipynb • ODE_stability.ipynb • ODE_stiffness.ipynb • ODE_FCCreactor.ipynb • PDE_2D_heat_equation.ipynb • Jacobian.ipynb • • ODE_simulationCSTR.ipynb • ODE_canonical_transformation.ipynb • IntegroDifferentialEquation.ipynb • InputMultiplicity.ipynb
Part II	Optimization	• Basic Theory on the Solution of Optimization Problems • Linear Programming: Theory and Applications • Sensitivity Analysis in Linear Programming	• linear_programming.ipynb • Pyomo_LinearOpt.ipynb • MultivariableOptimizaiton_Constrained.ipynb
		• Nonlinear Optimization: Challenges and Applications • Single Variable Optimization: Line search Algorithms • Multivariable Optimization: Jacobian and Hessian Concepts • Integer Programming: Branch and Bound • Global Optimization Methods	• successive_substitution.ipynb • GoldenSectionSearch.ipynb • TransferFuncParEst.ipynb • Jacobian.ipynb • NewtonRaphson_SISO.ipynb • NewtonRaphson_MIMO.ipynb • Newton_MultivariableOptimizaiton.ipynb • MidacoOptimization.ipynb • MINLP_GEKKO.ipynb • MINLP_GOOGLE.ipynb • IP.ipynb • IntegerProgrammingGoogle.ipynb • GlobalOptimization.ipynb • parallel_processing.ipynb • octave_run.ipynb
Part III	Process Control	• System Identification • Optimal PID Tuning • Model Predictive Control	• MPC_SISO.ipynb • MPC_MIMO.ipynb • Optimization_PI_Control.ipynb
		• Nonlinear Model Predictive Control	• NMPC_MIMO.ipynb

Part IV	Statistics and Regression	• Economic Model Predictive Control • • Statistical Concepts: Covariance and Uncertainty • PCA and PLS • Data Projection • Nonlinear PCA, • Outlier Detection • Process Monitoring and Fault Detection Statistics	• nonlinear_MPC.ipynb • hawk.ipynb • Casadi_DynamicMINLP_control.ipynb • Confidence_region.ipynb • ParEst_ODE.ipynb • **TransferFuncParEst.ipynb** • MIMO_TF_parest.ipynb • • TuprasData_TF_ParEst.ipynb
		• Data Elimination Methods • Linear Regression • Nonlinear Regression • Parameter Uncertainty • Model Uncertainty Considerations • Importance Sampling • Big data Management Tools	• PCA_tutorial.ipynb • PCA_handwritten.ipynb • ParameterConfRegion_identifiability.ipynb • overfitting_example.ipynb • overfitting_example2.ipynb
Part V	Machine Learning and AI	• Unsupervised Learning Algorithms • Hierarchical Clustering Algorithms • Time series models • Causality • Supervised Learning Algorithms	• UnsupervisedLearning_KMEANS.ipynb • NN_intro.ipynb
		• Supervised Regression • Supervised Classification • Optimal Decision Making under Empirical Models • Machine Learning • Deep Learning • AI • Markov Chains	• keras.ipynb
Part VI	Project	• A group based project assignment	
		• Presentation of the projects	