Instructional Lesson Plan

Machine Learning in Data Analysis

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LESSON DETAILS

Subject Area: Engineering Problem Solving and Design (MC-FALL-2022-ECE-103-30514)

Focus Grade Level: Freshman Engineering

Grade Level Range: Freshman Engineering

RESEARCH BACKGROUND

The use of computational tools in engineering-problem solving courses at the freshman level is a challenging learning and teaching endeavor. Exposing students during their first year will help to: (1) adapt in understanding how Machine Learning Algorithms (MLA) may help improve engineering problem solving skillset, using their prior mathematical knowledge acquired from a College Algebra Class, (2) stimulate students in machine learning, modeling and simulation for engineering problem solving in the evolving age of Artificial Intelligence, and (3) enumerate concepts in (i) Environments of Artificial Intelligence, (ii) Supervised Machine Learning, (iii) Regression and Classification, (iv) Digital Signal Processing and (v) Wireless Communication.

Wide-Band Orthogonal Frequency-Division Multiplexing (W-OFDM) is a widely used scheme for wireless networks. We assume a single mobile transmitter and two receivers at fixed designated positions. We would like to estimate the wideband channel of the second receiver from the first using machine learning algorithm (MLA). Linear Regression (LR) is used to implement MLA in predictive reduction modeling of W-OFDM channel estimation. The performance of second received signal in relation to the first receiver based on frequency coefficients are to be investigated.

LESSON SUMMARY

The objective of the lesson is to introduce the concepts of Loops in MATLAB programming software and how it is used in the implementation of Algorithms in Machine Learning. In computer programming, a *loop* is used to execute a group of instructions or a block of code multiple times, without writing it repeatedly [1]. Loops are control structures of a program. There are two types of loops: first, '*for*' statements-, loop a specific number of times-, and keep track of each iteration with an incrementing index variable; second, '*while*' statements-, loop as long as condition remains true. Both *loops* require the *end* keyword [2]. The application of loop in the implementation of Machine Learning Algorithm in MATLAB is discussed [3].

MATERIALS AND EQUIPMENT

A Computer with installed MATLAB software program from MathWorks Inc.

ATTACHMENTS

An example of Wireless Communication: Relationship between Transmitter (Tx) and Receivers (Rx). Explain the "Digital Signal Processing" concepts along with MLA are being used in the analysis of the signals between Tx/Rx. The Figure is attached in the power point file.

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EDUCATIONAL STANDARDS

MARICOPA COUNTY COMMUNITY COLLEGE

Maricopa County Community College District Official Course Competency:

5. Develop algorithms for implementation as computer code (III).

6. Apply computer code to analyze data, develop models, and/or operate equipment (III).

LEARNING OBJECTIVES

1. Students will be able to develop algorithms for implementation as computer code.
2. Students will be able to apply computer code to analyze data.

VOCABULARY

word	definition
loop	Composed of control statement and a sequence of logical statements.
algorithm	A set of instructions that are followed to solve a problem.
numeric	A number or a system of numbers, a numeric code, a numeric sign.
logical	Programming paradigm based on formal logic.
character	Is a single visual object used to represent text, numbers or symbols.
conditional	Programming language commands for handling decisions.
pseudocode	Is a simplified representation of an algorithm that uses language to describe coding logic.
flowchart	Is a graphical representation of the structure of process or system, algorithms or the step-by-step visual guide for solution of the problem.
arrays	Is a data structure that can store a fixed-size collection of elements of the same data type.

LESSON PROCEDURE

An introduction to MATLAB programming environment will be given. The program will implement Linear Regression Algorithm in MATLAB using '*fitlm*'. Some of these are:

(1) Declaration of Variables
(2) Declaration of Arrays
(3) Defining a Matrix as an array of rows and columns
(4) How to '*NULL*' a row and / or column within a Matrix
(5) Use of MATLAB built-in function in the implementation of Machine Learning Algorithms and Classification such as: '*fitlm*', '*fitrsvm*', '*predict*', '*mse*', '*mnrfit*', '*fitcnb*'
(6) Use of '*for*' loop
(7) Concept of '*Mean Square Error* (MSE)' and how to generate for the given dataset
(8) Use of linear regression function and the concept of '*trained*' versus '*predicted*' variable in the program
(9) How to construct and generate graphs in MATLAB
Correlate the following CONCEPT-MAP in the LESSON PLAN

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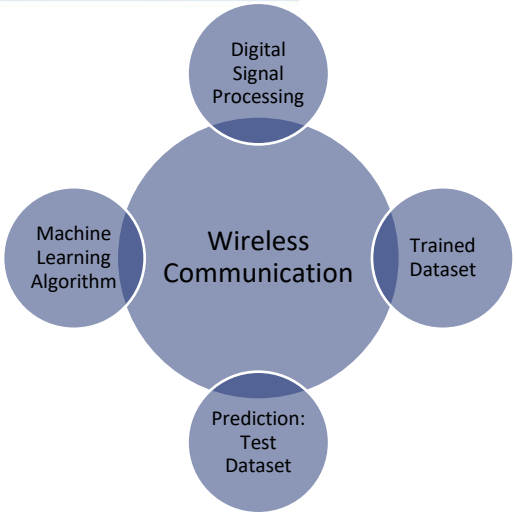
Instructional Lesson Plan



INTRODUCTION/MOTIVATION

(1) Share "Microsoft Azure Machine Learning Demo" video.
Motivation: How to construct a simple program in MATLAB to incorporate '*prediction*' using built-in Machine Learning Algorithms.
(2) An engineering application: Analysis of collected Excel dataset for "*channel estimation*" in Wireless Communication.

LEARNING ACTIVITIES/STRATEGIES

(1) Work with the students coding a program in MATLAB, in-class, as we discuss the concepts, debugging and running the program, analyze and understand the program in the context of '*channel estimation*'.
(2) Explain algebraically the concept of simple linear regression model (using the ***prior*** mathematical knowledge acquired form previous College Algebra Classes).

CLOSURE

Develop conceptual foundation on '*mathematical programming*' and allow students to work as a group of two- or, three-, discuss and critique the program implementation, help adopt new ideas / thoughts in the implementation of the solution and if possible, come up with a better solution.

ASSESSMENT

(1) Identify mastery of concepts and techniques of documentation in a MATLAB program.
(2) Run, Debug and Analyze the MATLAB program output.

FORMATIVE ASSESSMENT

(1) Implementation of '*for*' loop in analyzing a Matrix (Matrices in Linear Algebra):
    a. Identification of conceptual implementation of a MATLAB program
    b. Implementation of conceptual understanding of '*iteration*'
(2) Declaration of Matrix as an Array in the MATLAB program:

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a. Ability to define variables in a program and declaring arrays of rows and columns within a Matrix
b. Ability to NULL certain rows and/or columns of a Matrix
c. Matrix Linear Algebraic implementation of a given dataset

(3) Generate output of Linear Model and the corresponding Graph in MATLAB:
a. Check to see if student is able to use the following commands in MATLAB to generate plot/graph. These are: *plot*, *figure*, *xlabel*, *ylabel*, *title, grid* etc.

SUMMATIVE ASSESSMENT AND GRADING RUBRICS

Review the proposed solutions with the students and encourage close attention from the students to details, accuracies and documentation of logical flow in the program.

1. Explain the type of MLA analysis and test was conducted on the data collected.
2. Summarize the results / outputs based on the results of the data analyzed.
3. Include the MATLAB analysis as part of the report summary.
4. Grade students on a 1 to 5 scale as given below:

   Excellent (5): Analysis and test are clearly explained and include extensive details.

   Good (4): Analysis and test are complete and include relevant details.

   Satisfactory (3): Analysis and test are included but lack details.

   Less Than Satisfactory (2): Analysis and test are incomplete or incorrect.

   Unsatisfactory (1): Analysis and test are not included.

CONTRIBUTORS

INDIVIDUALS

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REFERENCES

[1] "What are Loops? Coding for Kids" Vedantu.com.

[2] "Loop Control Statements" MATLAB from MathWorks.

[3] "Machine Learning Algorithm" Computational Intelligence and Its Applications in Healthcare, 2020.

SUPPORTING PROGRAM

RET Site: Sensor, Signal and Information Processing Algorithms and Software

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