URP 6931-DCP 4300 AI in the Built Environment

START HERE:

Read and familiarize yourself with all the information in the syllabus below at the start of the semester, then during the semester we will work through the modules in the order specified by Dr Flood. This will largely be the order presented below and within the modules.

INSTRUCTOR:

Dr. Ian Flood, room RNK 316, Rinker School, College of Design, Construction and Planning, University of Florida, Gainesville, FL 32601, USA. Email: flood@ufl.edu

SCHEDULE AND OFFICE HOURS:

For class times and office hours please see my schedule. If you have a question or need an appointment, we can either meet in my office, via a private Zoom meeting, by phone, or by email, whichever you prefer. To arrange a meeting, please either send me an email (flood@ufl.edu) or ask me at the end of class.

PREREQUISITES:

Students who are interested in the UF AI Fundamentals and Applications Certificate must complete the following two courses prior to or in conjunction with DCP 4300:

- EEL 3872: Artificial Intelligence Fundamentals
- PHI 3681: Ethics, Data, and Technology

SUBJECT:

The understanding and application of artificial intelligence techniques (*in particular machine learning and artificial neural networks – ML/ANN*) to the built environment.

OBJECTIVES:

The main objectives of the course are to provide the student with:

- understanding of the areas of application, current limitations and future potential of ML/ANN technologies in the built environment;
- broad knowledge of the available ML/ANN models and development algorithms used in built environment applications;
- in-depth understanding of the different ways of representing a problem and interpreting a solution using ML/ANN systems;
- understanding of the suitability of different ML/ANN systems for different applications, and knowledge of how to decompose a problem into a form suitable for solution using these technologies;
- understanding and experience in following the basic steps required to develop a valid ML/ANN model;
- knowledge and experience in the application of state-of-the-art ML/ANN tools, in particular deep learning, transfer learning and reinforcement learning.

Course materials will make extensive use of examples and case studies from built environment applications.

COURSE CONTENT:

Read and familiarize yourself with all the information in the syllabus below at the start of the semester, then during the semester we will work through the modules in the order specified by Dr. Flood.

Module 1: **Introduction to AI in the Built Environment:**

- What are Artificial Intelligence (AI), Machine Learning, and Artificial Neural Networks (ANNs)?
- ANN Fundamentals
- Some Illustrative Example Applications of ANNs in Construction and Civil Engineering
- Challenges with Current Applied ANNs
- Introduction to ANN Systems
- ANN Development and Training Techniques
- Introduction to Deep Learning ANNs

Module 2: **Developing Machine Learning Models: *Designing, Training, and Testing:***

- Overview of the Machine Learning Development Method
- Assignments: Case Studies from the Built Environment
- Group Project: Development and Analysis of a Machine Learning Model for the Built Environment

Module 3: **AI Methods and their Applications in the Built Environment:**

- Regression
- Artificial Neural Networks
- Deep Learning
- Reinforcement Learning
- Large Language Models (LLMs)
- Generative Adversarial Networks (GANs)
- Transfer Learning

Group Term Project: **Group Term Project.**

Assignments: **Assignments 1 to 3.**

Exam: **Example and Actual Exam.**

REFERENCES:

There are no books that you are expected to purchase for this course, however, the first in the following list (Deep Learning) is freely available as an online book, and you will be recommended to access it at relevant sections in this course. All other course material will either be provided or will be available within the UF library system.

Online access to the following book is free via the UF library system:

- "Deep Learning" by I Goodfellow and Y Bengio and A Courville. MIT Press. 2016. This is freely available online: http://www.deeplearningbook.org/

The following books are also recommended for general reference:

- "Introduction to Machine Learning" by E Alpaydin. MIT Press. 3rd Edition. 2014.
- "Deep Learning with Python" by F Chollet. Manning Publications Co. 2018.
- "Introduction to Machine Learning with Python: A Guide for Data Scientists" by AC Muller and S Guido. O'Reilly Media Inc. 2017.
- "Machine Learning: An Artificial Intelligence Approach" Eds: RS Michalski, JG Carbonell and TM Mitchell. Morgan Kaufmann Publishers Inc.

INSTRUCTIONS ON SUBMITTING ASSIGNMENTS:

Online submission of assignments requires files to be in either MS Word, Excel or PDF format - each assignment identifies the file type(s) that it permits. All answers to an assignment must be put in the correct order with the question clearly identified, and submitted within just **one** file. Placing all parts of a question in one file can be achieved by several means, for example: (a) in MS Word you can type-in answers, draw pictures, and cut&paste or import images and other objects; (b) Windows provides an easy to use Snipping Tool that allows you to gather images from any part of the screen and then paste them into the file to be submitted; and (c) you can use a scanner to create a single pdf file for submission.

GRADING:

Item	Grade
Exams	
• End-of-Semester Exam:	10
Group Term Project	
• **Step I:** Development and Analysis of a Machine Learning Solution: A Case Study from Construction and its Related Fields *(Data Collection, Analysis and Formatting)*	15
• **Step II:** Development and Analysis of a Machine Learning Solution: A Case Study from Construction and its Related Fields, using PyTorch *(Model Development, Verification and Validation)*	15
• **Step III:** Improving Model Predictions using and Ensemble of ANNs: A Case Study from Construction and its Related Fields, using PyTorch *(Model Development, Verification and Validation)*	15
Assignments	
• **Assignment 1:** Linear Regression as an Introduction to the Machine Learning Development Strategy: *Building energy consumption case study*	15
• **Assignment 2:** Artificial Neural Networks: *The building energy consumption case study revisited using PyTorch*	15
• **Assignment 3:** To be determined.	15
TOTAL	**100 %**

Letter Grade	% Grade
A	>= 93.3
A-	>= 90
B+	>= 86.7
B	>= 83.3
B-	>= 80
C+	>= 76.7
C	>= 73.3
C-	>= 70
D+	>= 67.7
D	>= 63.3
D-	>= 60
E	< 60

Homework that is submitted late will usually be penalized at a rate of 10% per day.

HARDWARE AND SOFTWARE REQUIREMENTS:

To follow this course you will need:

- Internet access (required throughout the course).
- Microsoft Office including, Word, Excel and PowerPoint (required throughout the course).
- Adobe Acrobat Reader (required throughout the course - click here to download a copy).
- A Windows environment able to run the latest **free** versions of (*installation done in class*):
  - Microsoft's Visual Studio Code
  - Python programming language
  - PyTorch
  - Pandas
- Other s/w will be provided by Dr. Flood.

GENERAL:

- Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.
- Students must respect all copyright laws.
- The university honor code will be enforced.
- It is recommended that you KEEP REGULAR BACKUPS OF ALL YOUR FILES IN CASE OF A SYSTEM FAILURE!