## BCN 6905: AI & Machine Learning in Construction



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**START HERE:**[**Accessibility score: Perfect Click to improve**](https://ufl.instructure.com/courses/395964)

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](https://ufl.instructure.com/courses/395964/pages/about-dr-ian-flood), room RNK 302, 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](https://ufl.instructure.com/courses/395964/pages/schedule-us-eastern-standard-time). To arrange an appointment either see me or send me an email (flood@ufl.edu).

**PREREQUISITES:**

Graduate Standing

**SUBJECT:**

The understanding and application of empirically based artificial intelligence techniques (specifically machine learning and artificial neural networks – ML/ANN) to the field of construction science, technology and management.

**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;
* broad knowledge of the available ML/ANN models and development algorithms;
* 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 construction and its related disciplines.

**COURSE CONTENT:**

The course material (including lecture notes, presentations, interactive media and assignments) should be followed in the order specified by Dr Flood, which will largely follow the order given below.

[**Module 1:**](https://ufl.instructure.com/courses/395964/pages/module-1-introduction)**Introduction:**

* 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 Deep Learning ANNs
* Next Generation of ANNs

[**Module 2:**](https://ufl.instructure.com/courses/395964/pages/module-2-systems-overview-and-classification)**Systems Overview and Classification**

* Operational Modes
* Architectures
* Development and Training Techniques
* Problem Types
* Input and Output Data Structures and Interpretations
* Application Areas (with reference to construction and its related fields)
* Implementation Tools

[**Module 3:**](https://ufl.instructure.com/courses/395964/pages/module-3-design-development-and-validation-steps-for-machine-learning-solvers)**Design, Development and Validation Steps for Machine Learning Solvers**

* Overview of the Machine Learning Development Methodology
* Development Case Studies from Construction using Supervised Learning

[**Module 4:**](https://ufl.instructure.com/courses/395964/pages/module-4-foundational-systems)**Foundational Systems**

* Regression
* Artificial Neural Networks
* Support Vector Machines
* Clustering Methods

[**Module 5:**](https://ufl.instructure.com/courses/395964/pages/module-5-advanced-systems)**Advanced Systems**

* Deep Learning:
	+ Convolutional Artificial Neural Networks
	+ Recurrent Artificial Neural Networks
* Reinforcement Learning
* Generative Adversarial Networks (GANs)
* Transfer Learning
* Emerging Techniques

[**Exams:**](https://ufl.instructure.com/courses/395964/pages/exams)**Sample exam questions and model answers for midterm and end-of-semester exams**

[**Assignments and Group Project:**](https://ufl.instructure.com/courses/395964/pages/assignments-and-group-project) **Assignments and Group Project**

**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 expected to access it throughout 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 required:

* “Deep Learning” by I Goodfellow and Y Bengio and A Courville. MIT Press. 2016. This is freely available online: [http://www.deeplearningbook.org/ (Links to an external site.)](http://www.deeplearningbook.org/)

The following books are recommended for general reference:

* “Introduction to Machine Learning” by E Alpaydin. MIT Press. 3rd 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:**

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| **Item** | **Grade** |
| **Exams** |
| * Exam 1 Mid Semester
 | 10 |
| * Exam 2 End of Semester
 | 10 |
| **Term Project:** |
| * Part I: Development and Analysis of a Machine Learning Solution: A Case Study from Construction and its Related Fields  (Data Collection, Analysis and Formatting)
 | 15 |
| * Part II: Development and Analysis of a Machine Learning Solution: A Case Study from Construction and its Related Fields  (Model Development, Verification and Validation)
 | 15 |
| **Assignment 1** |
| * Linear Regression as an Introduction to the Machine Learning Development Strategy: Building energy consumption case study
 | 10 |
| **Assignment 2** |
| * Artificial Neural Networks:  The building energy consumption case study revisited using JustNN
 | 10 |
| **Assignment 3** |
| * TBD
 | 10 |
| **TOTAL** | **80/80 =****100 %** |

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| **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+ | >= 66.7 |
| 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 (Links to an external site.)](https://get.adobe.com/reader/)).

**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!

## Course Summary:

| **Date** | **Details** |
| --- | --- |
|  | Assignment [Assignment 1](https://ufl.instructure.com/courses/395964/assignments/4146717) | due by 11:59pm |
|  | Assignment [Assignment 2](https://ufl.instructure.com/courses/395964/assignments/4146718) | due by 11:59pm |
|  | Assignment [Exam 1](https://ufl.instructure.com/courses/395964/assignments/4146720) | due by 7:15pm |
|  | Assignment [Group Project Part 1](https://ufl.instructure.com/courses/395964/assignments/4146722) | due by 4:30pm |
|  | Assignment [Group Project Part 2](https://ufl.instructure.com/courses/395964/assignments/4146723) | due by 11:59pm |
|  | Assignment [Assignment 3](https://ufl.instructure.com/courses/395964/assignments/4146719) |   |
| Assignment [Exam 2](https://ufl.instructure.com/courses/395964/assignments/4146721) |   |