COLLEGE OF DESIGN, CONSTRUCTION AND PLANNING UNIVERSITY OF FLORIDA

AI IN THE BUILT ENVIRONMENT

COURSE NUMBER: DCP 4300

TERM: SPRING 2024

NUMBER OF CREDIT HOURS: 3

The planning, design, and construction of the built environment is on the verge of a fundamental transformation. A key element of this transformation is a radical shift in paradigm from planning and design representations of unconnected data to practices with an overwhelming amount of information-rich data. Artificial Intelligence (AI), in particular Machine Learning (ML), provides planners, designers, and constructors with new models and methods to engage in these data-heavy processes in order to synthesize meaningful information for all areas of their practice from planning to design to fabrication to erection. This course provides the College of Design, Construction and Planning (DCP) students an opportunity to learn about application of AI in their disciplines.

CLASS LOCATION: *RINKER HALL ROOM 210*

CLASS MEETING TIMES: *TH 10:00 – 12:55 PM*

INSTRUCTORS SPRING: Dr. Karla Saldana Ochoa and Dr. Charles Wang
INSTRUCTORS FALL: Dr. Shenhao Wang and Dr. Charles Wang

OFFICE HOURS: Thursday 2:50 - 3:50 PM (ARCH 252 / RINKER 342)

COURSE WEBSITE: http://elearning.ufl.edu

GitHub: https://github.com/charlesxwang/DCP-4300

COURSE DESCRIPTION:
An introduction to Artificial Intelligence (AI) and its applications to real-world problems in planning, design, and construction of the built environment. Includes application in professional practice in architecture, construction management, interior design, landscape architecture, sustainability and the built environment, and urban and regional planning.

PREREQUISITE KNOWLEDGE AND SKILLS:
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

COURSE OBJECTIVES:

- Understand how AI technologies can be used to guide planning, design, and construction of the built environment.
- Apply existing AI models in architecture, construction management, interior design, landscape architecture, sustainability and the built environment, and urban and regional planning disciplines.
- Build a simple Machine Learning model.
- Understand the current limitations of machine learning technologies.

INSTRUCTIONAL METHODS:

The class meets three lecture hours per week.

COURSE POLICIES:

ATTENDANCE POLICY:

Attendance and participation in the class activities are required. Attendance and participation grade will be computed in proportion to the number of presence on the days the rolls were taken and participation on a given topic in the class forum. Requirements for class attendance and make-up quizzes, assignments, and other work in this course are consistent with university policies that can be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

COURSE EVALUATION

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/

UF POLICIES:

UNIVERSITY POLICY ON ACCOMMODATING STUDENTS WITH DISABILITIES:

Students requesting accommodation for disabilities must first register with the Dean of Students Office (https://disability.ufl.edu/). The Dean of Students Office will provide documentation to the student who must then provide this documentation to the instructor when requesting accommodation. You must submit this documentation prior to submitting assignments or taking the quizzes or exams. Accommodations are not retroactive, therefore, students should contact the office as soon as possible in the term for which they are seeking accommodations.

UNIVERSITY POLICY ON ACADEMIC MISCONDUCT:

Academic honesty and integrity are fundamental values of the University community. Students should be sure that they understand the UF Student Honor Code at https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/ . Although joint work on assignments may be acceptable in some cases, duplication of an assignment, both manually or by computer will be considered an act of academic dishonesty and dealt with accordingly. On all work submitted for credit by students at the university, the following pledge is either required or implied: **"On my honor, I have neither given nor received unauthorized aid in doing this assignment."**

GETTING HELP:

For issues with technical difficulties for E-learning in Canvas, please contact the UF Help Desk:

- Learning-support@ufl.edu
- (352) 392-HELP - select option 2
- https://lss.at.ufl.edu/help.shtml

GRADING POLICIES:

Assignment	Percentage
Module Assignments (6 total@10% each)	60%
Final Group Project	30%
Attendance and Participation	10%
Total	100%

GRADING SCALE:

Grades will be computed according to the following scale:

A=93-100; A- =90-92.9; B+ =87-89.9; B=83-86.9; B- =80-82.9; C+ = 77-79.9; C=73-76.9; C- =70-72.9; D+ =67-69.9; D=63-66.9; D- =60-62.9; E<60.

- Attendance grade will be computed in proportion to the number of presence on the days the rolls were taken and participation grade is based on responding to a given discussion topic in the class forum.

- At the end of each module an individual assignment will be given that covers topics that were discussed in that module. Specific evaluation criteria will be provided with each assignment.

- A final group project will be assigned that requires implementing existing AI algorithms in a project in the built environment, to facilitate planning, design and construction strategies.

COURSE CONTENT:

The course is organized to showcase the predominant branches of research in artificial intelligence and how those have been used in the different disciplines in the built environment. The following paragraphs briefly describe how AI has been used to facilitate the design, construction, and planning for each particular discipline.

Architecture (ARC):

Architecture sits at the crossroads of concerns of both design and construction, but also of art, function, technique, culture, community, place, politics, history, etc. Architects draw influence from these sources and respond to integrate a wide variety of competing factors and criteria that can be simultaneously precise and vague, qualitative and quantitative, measurable and immeasurable. The application of cutting-edge technology has long impacted the design and production of architecture on many levels, be it theoretical, cultural, or technical. These advances have deep influences on the design process and the resultant architectural artifact. Therefore, in this course we will ask the following question: What happens when an architect no longer draws explicitly, but works in collaboration with AI? Moreover, it is important to discuss the implication of AI technologies for the discourse of the discipline and theFoundational technical know-how in the emerging ecology of AI applications.

Construction Management (CM):

AI has been implemented in several domains, and the construction industry has also seen the value of using AI-driven solution methods to increase efficiency and decrease risk. Construction researchers and professionals have been exploring different Machine Learning, Computer Vision, Natural Language Processing methods for various applications such as design optimization, scheduling, estimating, project documentation, safety inspection, and construction project monitoring. In this course we will discuss AI abilities in the construction together with misconceptions around its capabilities, and its limitations.

Interior Design (IND):

The use of intelligent and assistive technologies to guide the design of the environments in which we live, learn, and work is growing at an increasing rate. Interior Design involves the creation of data driven, well-conceived, and adaptive spaces by expert practitioners that support and foster human resilience. Using AI-based approaches such as Human in the Loop (HITL) Machine Learning leverages both numerical data as well as the opinions and viewpoints of people occupying a space to optimize both design functionality and human experience. This approach to AI-guided Interior Design offers a vehicle for applying both human and machine intelligence to forecast a design’s ability to meet expected and evolving performance outcomes. Examples of how AI can be used to inform space programming and environmental planning will be reviewed in this course. For example, how Machine Learning can be used as an evidence basis to guide the design of spaces in safety critical environments.

Landscape Architecture (LAE):

The application of Artificial Intelligence and Machine Learning in Landscape Architecture is emerging. AI and ML could efficiently collect, analyze and digest information from the built environment for Landscape Architects. AI provides Landscape Architects great tools for innovative design and creation. The lifestyle that AI changes, provides opportunities and challenges for

Landscape Architects to create a desirable built environment. Moreover, AI can help us understand, monitor and conserve nature, which is a topic that will be discussed in this course.

Sustainability in the Built Environment

Within the Geodesign Specialization, Sustainability and the Built Environment students focus on the science and applications fusing design thinking with geospatial data analytics and decision-support to solve problems related to land use change and human habitation. Computer vision, crowdsourced geospatial data, digital twins, procedural models, and related decision support technologies like building information modeling (BIM) and geographic information systems (GIS) are increasingly moving toward cross-scale interoperability and revolutionizing how we sense, make sense, and solve problems of sustainability as we cope with change and facilitate adaptive capacity and community resilience in the face of uncertainty. In this course we will explore how AI and machine learning empower geospatial problem solving and may improve the monitoring, measuring, and modeling of natural resource conservation and social-ecological system management, may have the capacity to predict poverty from remote sensing data, may empower the supply and demand side infrastructure and information management of the emerging smart grid, and may cultivate community resilience and emergency response.

Urban and Regional Planning (URP):

The world is becoming more urban while large quantities of data are being generated by humans about the built environment on an unprecedented scale. Urban data are pervasive, and computing is ubiquitous that creates a great opportunity for reinvigorating and revamping traditional urban planning. According to the National Science Foundation, "Knowledge of computer science and computer programming is becoming a necessary skill... in marketing, advertising, journalism, and the creative arts." Urban planning is no exception. Both the pervasiveness of ubiquitous sensor technology and the growth of information technology produce large quantities of data and making sense of these gathered data requires computer and data science skills. Examples of technologies that are already highly concentrated in the built environment include, but not limited to autonomous vehicles, embedded environmental sensors, distributed intelligence and control in infrastructure, the sharing economy, and social networks. To understand and take advantage of these vast amounts of new data, the traditional data analysis methods in the urban planning field is insufficient, and thus requires advanced data analysis skills for large data such as machine learning, and deep learning, subjects that will be discussed during this course.

Reading Materials:

Mario Carpo, The Second Digital Turn – Design Beyond Intelligence, Cambridge, MIT Press, 2017
AI & Architecture: An Experimental Perspective

Stanislas Chaillou, Harvard Graduate School of Design | Feb. 24th, 2019
https://towardsdatascience.com/ai-architecture-f9d78c6958e0

Rajagopal, A., & Tetrick, C. (2017). The rise of AI and machine learning in construction. Autodesk University
https://www.autodesk.com/autodesk-university/article/Rise-AI-and-Machine-Learning-Construction-2018

Blanco, J. L., Fuchs, S., Parsons, M., & Ribeirinho, M. J. (2018). Artificial intelligence: Construction technology's next frontier| McKinsey.
https://www.mckinsey.com/business-functions/operations/our-insights/artificial-intelligence-construction-technologys-next-frontier#

Tan, P. N., Steinbach, M., & Kumar, V. (2016). ***Introduction to Data Mining.*** Pearson Education India, Chapter 2: "Data" and Chapter 3 "Exploring Data."

Book: Bradley E Cantrell, Justine Holzman; Responsive Landscapes: Strategies for Responsive Technologies in Landscape Architecture; Routledge, 2016
https://www.routledge.com/Responsive-Landscapes-Strategies-for-Responsive-Technologies-in-Landscape/Cantrell-Holzman/p/book/9781138796652

Article: Mimi Zeiger; "Live and Learn"; Landscape Architecture Magazine, vol. 109, Iss.2, Feb 2019, pp. 78-89

Nishant, R., Kennedy, M., & Corbett, J. (2020). Artificial intelligence for sustainability: Challenges, opportunities, and a research agenda. International Journal of Information Management, 53, 102104. https://doi.org/10.1016/j.ijinfomgt.2020.102104

Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M., & Fuso Nerini, F. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. Nature Communications, 11(1), 233.
https://doi.org/10.1038/s41467-019-14108-y

Urban Analytics (Spatial Analytics and GIS) First Edition
https://www.amazon.com/Urban-Analytics-Spatial-Gis/dp/1473958636/ref=asc_df_1473958636/?tag=hyprod-20&linkCode=df0&hvadid=312446862670&hvpos=&hvnetw=g&hvrand=5187003182187135649&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9011703&hvtargid=pla-415427782747&psc=1

Software / Language:
Python, Jupyter Notebooks

COURSE SCHEDULE:

The following is a simplified version of the course schedule. The full table can be found here: https://github.com/charlesxwang/DCP-4300

Week	Disciplines	Applications in DCP	Classes	Assignments
Week 01	AI/ML	-	Introduction to AI and Machine Learning,	-
Week 02	Data Collection & Visualization	-	Collecting data and urban imagery for visualization	
Week 03	Computer Vision	Image analysis, Remote sensing, SLAM, Point cloud …	Computer vision and CNNs: overview and theory	
Week 04			application lecture	A2 for 15 points
Week 05	Generative Models	Generative design	GANs: overview and theory	
Week 06			application lecture	A3 for 15 points
Week 07	NLP	Text mining Sentiment analysis …	Transformers: overview and theory	
Week 08			application lecture	A4 for 15 points
Week 09	Robotics	Robots Human-Machine interaction	Reinforcement Learning and Robotics	
Week 10			application lecture	A5 for 15 points
Week 11	Special Topics	Special Topics	Special Topics	
Week 12	-	-	Final Project and Presentations	Final project for 30 points
Week 13				
Week 14				
Week 15				

Disclaimer: This syllabus represents the current plans and objectives. As we go through the semester, those plans may need to change to enhance the class learning opportunity. Such changes, communicated clearly, are not unusual and should be expected.