Syllabus
DCP4300/ URP6931 Artificial Intelligence in the Built Environment
2024 Fall

Instructor

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Director of Urban AI Lab @UFL
Email: shenhaowang@ufl.edu
Tuesday: 1:55pm – 4:55pm
Location: TBD

Course description

This course introduces how to investigate the built environment with artificial intelligence (AI). The course consists of three modules with Module 1 focused on computational basics, Module 2 on diverse data in built environment, and Module 3 on AI techniques. Specifically, Module 1 introduces Python, GitHub, Google Colab, among other computational tools. Module 2 presents diverse data sources, including conventional data, such as census and travel survey, and unconventional data, such as imagery, networks, and texts. Module 3 introduces four dominant AI models, including artificial neural networks (ANN) for numeric data, convolutional neural networks (CNN) for imagery, graph neural networks (GNN) for spatial networks, and LSTM and large language models (LLM) for texts. Students will learn the major Python packages, e.g., Pandas, GeoPandas, PyTorch, thus processing and analyzing the conventional and unconventional data structures. Through reading materials, students will learn AI as a general analytical framework for economic development, urban mobility, sustainability, energy consumption, design, and community development. This course focuses on enhancing students' hands-on experiences in AI for built environment, and empowering designers, planners, engineers, and data scientists to leverage AI to dissect cities and tackle enduring challenges in built environment.

Course prerequisites

No prerequisite course is needed. However, students need to take Practicum AI at UFL as a concurrent requirement. The prior Python coding skills are encouraged, and the prior knowledge in probability, statistics, and linear algebra can also facilitate your learning experiences. If you have questions, please contact the instructor to discuss your qualification. This course is the prerequisite for the Intermediate Urban Analytics in Spring 2025.

Coding

This course uses Python as the programing language. Students are expected to use Google Colab in the lab sessions. You don't need to install Python and other libraries on your laptop because Colab provides a standardized coding platform. The course will teach Python coding modules including Numpy, Pandas, Matplotlib, Statsmodels, GeoPandas, Scikit-Learn, and PyTorch.

Textbook

No textbook is required. The following textbooks are recommended as references.

1. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. O'Reilly Media, Inc. GitHub link here.
2. Bishop, C. M. (2006). Pattern recognition and machine learning. GitHub link here.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning: MIT press Cambridge.

Course schedule

Week	Dates	Lectures	Lab sessions	Project sessions	Psets	Project
1	Aug 27	Class overview				
Module 1: Computational basics						
2	Sep 03	Python, Colab, and data sources	Lab 02. Python in Colab			
3	Sep 10	Python, GitHub, and data processing	Lab 03. Data collection and processing			
Module 2: Diverse Data Sources						
4	Sep 17	Data description and visualization	Lab 04. Matplotlib, Seaborn, and Pandas			Idea guidance out;
5	Sep 24	Correlational analysis and urban application I: Gasoline consumption and cities	Lab 05. Gasoline consumption and cities		pset 1 out	
6	Oct 01	Spatial visualization and urban imagery	Lab 06. Visualizing property values; Google API; and	Project 01. Ovealeaf and Zotero		Submitting group members.
7	Oct 08	Graph and text data	Lab 07. OpenStreetMap in Python		pset 1 due	
8	Oct 15	Midterm presentation for project ideas	NA		pset 2 out	Idea due;
Module 3: AI Applications						
9	Oct 22	Modeling basics and artificial neural networks	Lab 09. Predicting property values			
10	Oct 29	Convolutional neural networks for prediction and semantic segmentation	Lab 10. Dissecting satellite imagery	Project 02. arXiv	pset 2 due pset 3 out	Proposal guideline out
11	Nov 05	Graph neural networks and language models	Lab 11. Graph-based prediction and language models			
Module 4: Final Project						
12	Nov 12	Proposal presentation	NA	Y	pset 3 due	Proposal presentation; proposal due
13	Nov 19	Everything everywhere all at once: a comprehensive review	NA	Y		
14	Nov 26	HOLIDAY				
15	Dec 03	Final Presentation				Final presentation and final report due

Note: This schedule is **subject to changes**.

Reading List

1. Week 5 (Required). Newman, P. W., & Kenworthy, J. R. (1989). Gasoline consumption and cities: a comparison of US cities with a global survey. Journal of the American Planning Association, 55(1), 24-37.
2. Week 9 (Required). Wang, S., Mo, B., Hess, S., & Zhao, J. (2021). Comparing hundreds of machine learning classifiers and discrete choice models in predicting travel behavior: an empirical benchmark. arXiv preprint arXiv:2102.01130.
3. Week 9 (Optional). Hinton, G., Vinyals, O., & Dean, J. (2015). Distilling the knowledge in a neural network. arXiv preprint arXiv:1503.02531.
4. Week 10 (Required). Jean, N., Burke, M., Xie, M., Davis, W. M., Lobell, D. B., & Ermon, S. (2016). Combining satellite imagery and machine learning to predict poverty. science, 353(6301), 790-794.
5. Week 10 (Optional). Wang, Q., Wang, S., Zheng, Y., Lin, H., Zhang, X., Zhao, J., & Walker, J. (2024). Deep hybrid model with satellite imagery: How to combine demand modeling and computer vision for travel behavior analysis? Transportation Research Part B: Methodological, 179, 102869.
6. Week 10 (Optional). Gebru, T., Krause, J., Wang, Y., Chen, D., Deng, J., Aiden, E. L., & Fei-Fei, L. (2017). Using deep learning and Google Street View to estimate the demographic makeup of neighborhoods across the United States. Proceedings of the national academy of sciences, 114(50), 13108-13113.
7. Week 11 (Required). Xue, J., Jiang, N., Liang, S., Pang, Q., Yabe, T., Ukkusuri, S. V., & Ma, J. (2022). Quantifying the spatial homogeneity of urban road networks via graph neural networks. Nature Machine Intelligence, 4(3), 246-257.
8. Week 11 (Optional). Zheng, Y., Lin, Y., Zhao, L., Wu, T., Jin, D., & Li, Y. (2023). Spatial planning of urban communities via deep reinforcement learning. Nature Computational Science, 3(9), 748-762.

Course communication

The instructor can be reached through Canvas inbox or by email. Expect a response within 48 hours, excluding holidays and weekends. General questions can be posted to the Canvas class website discussion board.

Details in Course Schedule

Practicum AI provides a wonderful overview for using Python, Colab, GitHub, and other tools in computation. It is highly recommended for the students to read the materials.

- Link to Practicum AI: https://practicumai.org/
- GitHub repository: https://github.com/PracticumAI

Module 1. Computational basics

- Google Colab: Google Tutorial about Colab features
  - https://colab.research.google.com/notebooks/basic_features_overview.ipynb
- GitHub: Getting started with GitHub
  - https://docs.github.com/en/get-started/quickstart/hello-world
- Python basics.
  - 30-min crash course: https://github.com/srebalaji/python-crash-course
  - 4-hour crash course: https://github.com/Python-Crash-Course/Python101
  - MIT Open Course for Python Programming: https://ocw.mit.edu/courses/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/
- Zotero.
  - Website: https://www.zotero.org/
- Overleaf

- Tutorials: https://www.overleaf.com/learn/latex/Tutorials

Module 2: Diverse Data Sources

- Python statsmodels for regressions
  - Getting started: https://www.statsmodels.org/stable/gettingstarted.html
  - Linear regression example: https://www.statsmodels.org/stable/regression.html
- Python Pandas and Matplotlib for data description and visualization
  - Pandas and Matplotlib: Chapters 3 and 4 in VanderPlas, J. (2016) Python data science handbook: Essential tools for working with data.
  - Python tutorials: Chapters 3 and 4 in the GitHub repository: https://github.com/jakevdp/PythonDataScienceHandbook/tree/master/notebooks
- Data Sources.
  - American Community Survey: https://www.census.gov/programs-surveys/acs
  - Census Geography and TIGER Lines: https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html
- Readings
  - (Required) Newman, P. W., & Kenworthy, J. R. (1989). Gasoline consumption and cities: a comparison of US cities with a global survey. Journal of the American Planning Association, 55(1), 24-37.

Module 3: AI Applications

- Python Scikit-learn for machine learning.
  - Scikit learn tutorial: https://scikit-learn.org/stable/
  - Supervised learning tutorial in Scikit-learn: https://scikit-learn.org/stable/supervised_learning.html#supervised-learning
  - Unsupervised learning tutorial in Scikit-learn: https://scikit-learn.org/stable/unsupervised_learning.html
  - GitHub tutorials for Chapters 4, 5, and 7 for Bishop, C. M. (2006): https://github.com/gerdm/prml
- Python PyTorch for deep learning.
  - Official webpage: https://pytorch.org/
  - PyTorch examples: https://pytorch.org/tutorials/beginner/pytorch_with_examples.html
- Readings
  - (Required) Wang, S., Mo, B., Hess, S., & Zhao, J. (2021). Comparing hundreds of machine learning classifiers and discrete choice models in predicting travel behavior: an empirical benchmark. ArXiv:2102.01130.
  - (Required). Xue, J., Jiang, N., Liang, S., Pang, Q., Yabe, T., Ukkusuri, S. V., & Ma, J. (2022). Quantifying the spatial homogeneity of urban road networks via graph neural networks. Nature Machine Intelligence, 4(3), 246-257.
  - (Required). Jean, N., Burke, M., Xie, M., Davis, W. M., Lobell, D. B., & Ermon, S. (2016). Combining satellite imagery and machine learning to predict poverty. science, 353(6301), 790-794.
  - (Optional). Hinton, G., Vinyals, O., & Dean, J. (2015). Distilling the knowledge in a neural network. arXiv preprint arXiv:1503.02531.
  - (Optional). Wang, Q., Wang, S., Zheng, Y., Lin, H., Zhang, X., Zhao, J., & Walker, J. (2024). Deep hybrid model with satellite imagery: How to combine demand modeling and computer vision for travel behavior analysis? Transportation Research Part B: Methodological, 179, 102869.
  - (Optional). Gebru, T., Krause, J., Wang, Y., Chen, D., Deng, J., Aiden, E. L., & Fei-Fei, L. (2017). Using deep learning and Google Street View to estimate the demographic makeup

of neighborhoods across the United States. Proceedings of the national academy of sciences, 114(50), 13108-13113.
- (Optional). Zheng, Y., Lin, Y., Zhao, L., Wu, T., Jin, D., & Li, Y. (2023). Spatial planning of urban communities via deep reinforcement learning. Nature Computational Science, 3(9), 748-762.

Grading

Your grade consists of the follow three components.

Components	Total points	Percentage of final grade
Course participation	100	10%
Problem sets (3)	100 each	45%
Project	100	45%

Course participation (10 pts)
Attendance and participation in the class are required. Attendance and participation grade will be computed in proportion to the number of presences. Students are also highly encouraged to get engaged in the class discussions. The university policy can be found here.

Problem sets (45 pts)
Problem sets are designed to help you learn how to apply the analytical tools to cities. Students are allowed to work in groups, as long as each group is comprised of no more than three people and each member submits their own written answers.

1. Pset 1 (15 pts) – Data description and visualization.
2. Pset 2 (15 pts) – Diverse data structures.
3. Pset 3 (15 pts) – AI applications.

Project: three stages (45 pts)

1. Idea (5 pt). Limit to 1 page.
2. Proposal (10 pt). Limit to 3 pages.
3. Final paper (30 pt). Limit to 8 pages.

Grading scale
The following table is used as **an example only**.

	Percent Grade	4.0 Scale		Percent Grade	4.0 Scale
A	94-100	4.0	C	73-76	2.0
A-	90-93	3.67	C-	70-72	1.67
B+	87-89	3.33	D+	67-69	1.33
B	83-86	3.0	D	65-66	1.0
B-	80-82	2.67	E/F	Below 65	0.0
C+	77-79	2.33			

The grading follows the university policy here.

Late Submission

It is important to meet deadlines. All work must be completed and submitted by the designated date and time on Canvas. However, life is sometimes uncertain. Therefore, you are allowed to submit your assignments late, but with **3 points deducted for every 24 hours**. For example, if an assignment is submitted 1 hour after the deadline, its full grade will automatically drop from 15 points to 12 points. This policy applies to both Psets and the milestones of the project.

Other UF policies and resources

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.

Academic integrity and UF honor code

Academic honesty and integrity are fundamental values of the University community. UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

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 here. 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, or via this link. Summaries of course evaluation results are available here.

Other academic resources

- For On-Campus URP Students: Graduate Coordinator contact information: Laura Dedenbach, laurajd@ufl.edu, 352-294-1493.
- Career Connections Center: Reitz Union Suite 1300, 352-392-1601. Career assistance and counseling services career.ufl.edu/.
- Library Support: various ways to receive assistance with respect to using the libraries or finding resources. cms.uflib.ufl.edu/ask
- Teaching Center: Broward Hall, 352-392-2010 or to make an appointment 352- 392-6420. General study skills and tutoring. teachingcenter.ufl.edu/
- Writing Studio: 2215 Turlington Hall, 352-846-1138. Help brainstorming, formatting, and writing papers. writing.ufl.edu/writing-studio/
- For issues with technical difficulties for E-learning in Canvas, please contact the UF Computing Help Desk at 352-392-4357 or via e-mail at helpdesk@ufl.edu
- Student Complaints: sccr.dso.ufl.edu/policies/student-honor- code- student-conduct-code/

Health and wellness

- U Matter, We Care: If you or someone you know is in distress, please contact umatter@ufl.edu, 352-392-1575, or visit umatter.ufl.edu/ to refer or report a concern and a team member will reach out to the student in distress.
- Counseling and Wellness Center: Visit counseling.ufl.edu/ or call 352-392-1575 for information on crisis services as well as non-crisis services.

- Student Health Care Center: Call 352-392-1161 for 24/7 information to help you find the care you need or visit shcc.ufl.edu/.
- University Police Department: Visit police.ufl.edu/ or call 352-392-1111 (or 9-1-1 for emergencies).
- UF Health Shands Emergency Room / Trauma Center: For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; ufhealth.org/emergency-room-trauma-center