



Winter 2024

Course Number	ARCH 672. 32 L03	Classroom	CBDL
Course Name	Design with Deep Learning		
Pre/Co-Requisites			
Instructor	Jinmo Rhee	Office Hours/Location	By appointment
	Email: jinmo.rhee@ucalgary.ca	Phone: 412-628-2948	
Class Dates	Block Week (Mon-Fri), 13:00-17:00		
Instructor Email Policy	Please note that all course communications must occur through your @ucalgary email. See Communication Guidelines section for more details.		
Name and Email of Teaching Assistant(s)			

Course Description:

With the recent surge in generative artificial intelligence (AI), there has been a renewed interest in how these technologies can impact architecture and other creative practices. This course offers students an opportunity to understand how Generative Adversarial Networks (GAN), a deep learning-based generative AI model, operates, and to apply it in design work, exploring the role and limitations of AI models as design tools.

The course is structured into three main modules. In the first module, students will gain both theoretical and practical understanding of GANs through lectures and hands-on sessions, where they will generate random images.

In the second module, students will learn about Conditional GANs (C-GANs), a derivative model of GANs, and use them to create architectural façade images based on specific conditions.

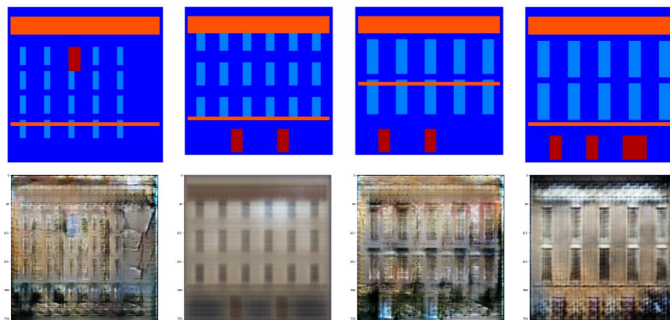


Figure 1. Generated Façade Images using C-GAN

The final module has students designing a unit of a rowhouse using C-GANs. To do this, they will train the C-GAN with data representing the relationship between rooms in a bubble diagram and corresponding architectural floor plans, and generate new plans that align with their design intentions.

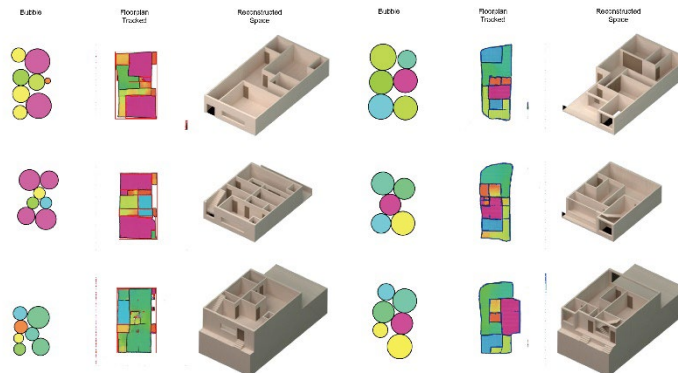


Figure 2. Design Examples of Rowhouse Unit Floor Plans using C-GAN with the Bubble2Floor Dataset

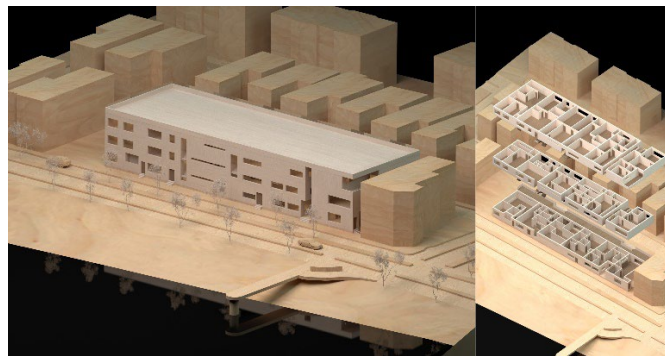


Figure 3. A Design Example of Rowhouse using C-GAN with the Bubble2Floor Dataset

Course Hours: 1.5 units;

Course Learning Outcomes:

Upon successful completion of this course, students will have acquired the knowledge and competencies to:

1. Understand the Fundamentals of Generative AI: Gain a comprehensive understanding of generative artificial intelligence, particularly focusing on Generative Adversarial Networks (GANs) and their operational principles.
2. Apply Generative AI in Creative Practices: Develop the ability to apply generative AI models, like GANs, in the context of design and architecture, enhancing creative processes with cutting-edge technology.
3. Hands-On Experience with GANs: Acquire practical skills by engaging in hands-on sessions to generate images using GANs, facilitating a deeper grasp of the theoretical concepts learned.

4. Explore Conditional Image Generation: Learn about and implement Conditional GANs (C-GANs) for generating images based on specific conditions, with a focus on architectural applications.
5. Design with AI-Generated Architectural Elements: Utilize C-GANs to design specific architectural elements, such as façades and rowhouse units, integrating AI tools into conventional design methodologies.
6. Data Integration in AI Models for Design: Learn to train generative AI models using specific types of data, such as bubble diagrams and architectural floor plans, to produce design outcomes that align with predefined intentions.
7. Critical Analysis of AI in Design: Develop the ability to critically analyze the role and limitations of AI models as tools in the design process, fostering a balanced and informed approach to technology integration in creative fields.

These learning outcomes contribute towards equipping students with a multifaceted understanding of both theoretical concepts and practical applications at the intersection of architectural design and artificial intelligence.

Learning Resources:

There is no textbook for this course but reading material will be provided.

The following are useful resources.

- Chollet, Francois. 2021. Deep Learning with Python, Second Edition. 2 edition. Shelter Island: Manning.
- Manaswi, Navin K. 2020. Generative Adversarial Networks with Industrial Use Cases: Learning How to Build GAN Applications for Retail, Healthcare, Telecom, Media, Education, and HRTech. BPB Publications.
- Mishra, Pradeepta. 2019. PyTorch Recipes: A Problem-Solution Approach. 1st ed. edition. Apress.
- Veloso, Pedro, Jinmo Rhee, Ardavan Bidgoli, and Manuel Rodriguez Ladron de Guevara. 2022. "Bubble2Floor: A Pedagogical Experience With Deep Learning for Floor Plan Generation." In POST-CARBON - Proceedings of the 27th CAADRIA Conference, edited by Jeroen van Ameijde, Nicole Gardner, Kyung Hoon Hyun, Dan Luo, and Urvi Sheth, 1:373–82. Sydney: The Association for Computer Aided Architectural Design Research in Asia (CAADRIA). http://papers.cumincad.org/cgi-bin/works/paper/caadria2022_90.
- Wani, M. Arif. 2021. Deep Learning Applications, Volume 3. Edited by Bhiksha Raj, Feng Luo, and Dejing Dou. 1st ed. 2022 edition. Springer Nature.

Other readings will be added to this list.

Technology Requirements (D2L etc.):

To ensure a productive and enriching learning experience at the University of Calgary, students enrolled in online, remote, and blended courses must have reliable access to the following technology:

- A computer with a supported operating system, equipped with the latest security and malware updates.

- A current and updated web browser to access course materials and online resources.
- A webcam, either built-in or external, to actively participate in virtual sessions and collaborative activities.
- A microphone and speaker (built-in or external) or a headset with a microphone for effective communication during online interactions.
- Current antivirus and/or firewall software enabled to safeguard against potential security threats.
- A broadband internet connection to ensure seamless access to online content and virtual classrooms.

Additionally, this course will utilize specific software tools, namely Grasshopper in Rhinoceros. Students are required to have Rhinoceros version 6.0 or higher (preferably 7.0) and Grasshopper installed on their laptops to fully engage in the course activities.

As the primary platforms for online learning, D2L and Zoom will play essential roles in delivering course materials, conducting virtual lectures, and facilitating interactive discussions. Prioritize ensuring that you have access to D2L and Zoom to make the most of the online learning opportunities provided.

Additional Classroom Conduct and Related Information

Q&A Sessions and Office Hours

D2L has a section for Discussion which will be used for Q&A sessions. Students can post questions about concepts and assignments. Other students can reply to the post to share their experience or ideas and logic about a problem. However, the D2L Discussion is not a place to catch up on missed classes. In necessary circumstances where you are unable to attend class, please make sure to inform us via email and the instructor will address the situation accordingly.

Digital Works and Back-up Requirements

In this computation course, the majority of the materials and assignments will be in digital format. Therefore, it is imperative for all students to take responsibility for maintaining back-up files of their digital works and productions. Regardless of the nature of the issue, such as data loss due to electrical problems or the misplacement of storage devices, these circumstances cannot serve as excuses for missed assignments or late submissions.

To ensure the safety and accessibility of your work, it is highly recommended to utilize OneDrive, the cloud storage service provided by the University of Calgary. OneDrive offers a reliable platform with no size limitations, making it an ideal solution for safeguarding your files. By diligently backing up your work, you can confidently approach the course knowing that your progress and efforts are secure and protected from unexpected data loss incidents.

Plagiarism Policy

Copying any materials without citation is considered plagiarism and is strictly prohibited in this course. Code plagiarism refers to using code from external sources without proper attribution to the original authors. Any instance of code plagiarism will be treated as a breach of academic

integrity, leading to severe consequences as per University policies. Please ensure all code submissions are your own, properly cited, and demonstrate your understanding of the material. If you have questions about using external code or proper citation, seek clarification from the instructor.

Communication Guidelines

Please reserve email communication for crucial queries and important concerns. For software-related questions or inquiries about the course content, it is recommended to ask the instructor during office/lab sessions or use the D2L Discussion section. By following these communication guidelines, we can ensure a more efficient and effective means of addressing your inquiries and fostering a collaborative learning environment.

Guidelines for Zoom Sessions in Online Classes

Students are expected to participate actively in all Zoom sessions and to turn on their webcam. Please join our class in a quiet space that will allow you to be fully present and engaged in the Zoom sessions. Students must behave in a professional manner during the session. Students, employees, and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment.

Assessment Components:

Assessment Method	Description	Weight	Aligned Course Learning Outcome
Module 1	Generating Image with GAN	20	1, and 3
Module 2	Designing a Building Façade with GAN	30	1, 2, and 4
Module 3	Designing a Unit of a Rowhouse using GAN	40	2, 4, 5, 6 and 7
Participation	Class attendance and active engagement.	10	1, and 7

Assessment and Evaluation Information

Attendance and Participation Expectations:

For in-person classes, punctuality is essential, and it is expected that students attend all sessions on time. The course will feature small group discussions as well as lecture and hands-on, and your active engagement in these activities, including asking and answering questions, will be considered as part of your participation.

Guidelines for Submitting Assignments:

Every assignment will include specific submission instructions provided in the assignment handouts and template files. Please ensure that you read and follow these instructions carefully

when submitting your work. Following the specified guidelines for submission is crucial for the successful evaluation of your assignments.

Final Examinations: There will be no final exam for this course. Instead, we will have a comprehensive review session dedicated to the results of Module 3. During this review, students will have the opportunity to present and discuss their design results in detail. The review will serve as a culmination of your efforts and provide a platform for showcasing your achievements throughout the course.

Expectations for Writing:

Expect collegial-level writing. Follow [university guidelines](#).

Late Assignments:

A 5%-point deduction will be applied *for each day* an assignment is submitted late. For instance, if a student submits an assignment (15 points max.) *two days late*, the highest achievable score for that assignment will be *90%* (13.5 points). Please ensure timely submission to avoid any deduction in your scores.

Criteria that must be met to pass:

Successful completion of assignments is a vital requirement for passing this course. Each assignment should not take more than 2 hours at most to complete. It is strongly recommended to aim for a score of over 70% on each assignment to ensure satisfactory progress.

In the event that you do not meet the desired scores in the assignments, the Final Project presents an additional opportunity to compensate for any low grades. Make the most of this chance to improve your overall grade in the course.

Grading Scale:

Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - evaluated by instructor
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing comprehensive understanding of the subject matter
A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies
C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.

C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript

The School of Architecture, Planning and Landscape will not permit the Flexible Grade Option (CG Grade) for any course offered by the School.

<https://www.ucalgary.ca/pubs/calendar/current/f-1-3.html>

CACB Student Performance Criteria (for Architecture courses only)

The following CACB Student Performance Criteria will be covered in this course at a primary level (other criteria will be covered at a secondary level): A2: Design Skills; A3: Design Tools; B1: Critical Thinking and Communication; B3: Architectural Theory.

Topic Areas & Detailed Class Schedule

	Topic	Assignments / Due Dates
Day 01	Introduction to GAN <i>Concept of GAN, Colab Logistics</i>	Preparation for Training GAN Due: 12:00 pm of Day 02
Day 02	Module 1 <i>Generating Images using GAN</i>	Training WGAN and Generating Images Due: 12:00 pm of Day 03
Day 03	Module 2 <i>Generating Building Façade Images using CGAN</i>	Training CGAN and Generating Façade Images Due: 12:00 pm of Day 04
Day 04	Module 3 <i>A Unit of Rowhouse Design using CGAN</i>	A Unit of Rowhouse Design using CGAN Due: 12:00 pm of Day 05
Day 05	Review <i>Role of Generative AI in Design</i>	

University of Calgary Policies and Supports

ACADEMIC ACCOMMODATION

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/university-policies-procedures/student-accommodation-policy>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities->

[Procedure.pdf](#). Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to their instructor (contact information on first page above).

SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/.

ACADEMIC MISCONDUCT

Academic Misconduct refers to student behavior which compromises proper assessment of a student's academic activities and includes: cheating; fabrication; falsification; plagiarism; unauthorized assistance; failure to comply with an instructor's expectations regarding conduct required of students completing academic assessments in their courses; and failure to comply with exam regulations applied by the Registrar.

For information on the Student Academic Misconduct Policy and Procedure please visit: <https://www.ucalgary.ca/legal-services/university-policies-procedures/student-academic-misconduct-policy>

Additional information is available on the Academic Integrity Website at <https://ucalgary.ca/student-services/student-success/learning/academic-integrity>.

COPYRIGHT LEGISLATION:

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (<https://www.ucalgary.ca/legal-services/university-policies-procedures/acceptable-use-material-protected-copyright-policy>) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy (<https://www.ucalgary.ca/pubs/calendar/current/k.html>).

INSTRUCTOR INTELLECTUAL PROPERTY

Course materials created by instructors (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. These materials may NOT be reproduced, redistributed or copied without the explicit consent of the instructor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private

information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

SEXUAL AND GENDER-BASED VIOLENCE POLICY

The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at <https://www.ucalgary.ca/legal-services/university-policies-procedures/sexual-and-gender-based-violence-policy> .

UNIVERSITY STUDENT APPEALS OFFICE

If a student has a concern about a grade that they have received, they should refer to Section I of the Undergraduate Calendar (<https://www.ucalgary.ca/pubs/calendar/current/i-3.html>) which describes how to have a grade reappraised. In addition, the student should refer to the SAPL's Procedure for reappraisal of grades

OTHER IMPORTANT INFORMATION

Please visit the Registrar's website at: <https://www.ucalgary.ca/registrar/registration/course-outlines> for additional important information on the following:

- Wellness and Mental Health Resources
- Student Success
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk