4.S00 / 4.S12: Special Subject: Design Intelligence
Spring 2022

Studio Overview

Design Intelligence is a new subject that introduces students to a practical, hands-on approach to machine learning and artificial intelligence. Providing a new lens through which to engage machine learning through aesthetic, form-finding and interaction, the course introduces students to neural networks, CNNs, RNNs, GANs, and reinforcement learning, as well as how to collect and prepare data for training their own models. Situated within a graphic, product and interaction design context, students will learn to develop a new kind of creative practice that not only actively engages in shaping the future of artificial intelligence, but is also instrumental in addressing its biases and failures.

The course is divided into two parts. In the first half, students will progress through a series of 4 short warm-up exercises that will give exposure and hands-on experience to different neural network architectures and techniques. In the second half, students will develop an independent project, further exploring ideas uncovered during the exercises or pursuing their own interests.

Exercise 1 - From Parametric to GANs
Students will create parametric drawings in p5js that will act as input for pix2pix generative adversarial networks, experimenting with and comparing the trade offs of both generative methods.

Exercise 2 - Interactive Drawing Machine
Students will develop an interactive drawing machine by creating a unique dataset, training a classifier, and using its output as a source of dynamic input for visual composition and design.

Exercise 3 - Neural Designer and Fabricator
Students will generate synthetic 3D data in Grasshopper in order to train their own 3D GAN. Outputs from their neural network will be 3D printed and physically tested.

Exercise 4 - Music Video
In the last exercise, students will create a music video by combining VQGAN + CLIP and a recursive neural network (RNN) for audio and sound generation, bringing together a range of different neural networks architectures in order to compose a single media experience.

Final Project
Inspired by the concepts and techniques seen earlier in the course, students will develop a longer and more in depth project, pursuing their own personal interests in art, design, interaction, artificial intelligence, and neural networks.

Learning Objectives

The course is divided into two parts: 4 short exercises (2-week long), and one final project (8-week long); providing students with an opportunity to become familiarized with commonly used machine learning techniques, while also deeply pursuing their own research and creative interests.

Content is particularly adapted to provide a foundation and help students situate themselves within a large and rapidly expanding discipline, without the need for an understanding of the complex mathematical ideas behind deep learning. Instead, the focus is placed on developing a practical, hands-on knowledge and intuition for the behavior and capabilities of neural networks, and how they augment a creative practice.

Upon completion of this course, the student should have a firm understanding of:

- Historical context and precedents in science, art and design.
- Different neural network architectures, what problems they solve, and their limitations.
- Common pipelines for creating and training networks, as well as curating and preparing data for training.
- How to apply neural networks across different creative domains (2D, 3D, motion, interaction, music, etc).
- How to continue learning and pursue their interests in this space through more advanced courses or individual study.
- How to develop a creative practice that is augmented by machine intelligence, working in tandem with other computational and traditional modes of creative production.
- Design criticism and the role of feedback in art and design development.

Where to Find Things and Communication

General class materials and grades will be posted on Canvas:
https://canvas.mit.edu/courses/13656 *(* we will use the 4.S00 Canvas, not 4.S12)*

General class communication will take place through **Discord**. *(We will send invites).*

Important communication will take place directly through email. Please include both marceloc@mit.edu and dipinoch@mit.edu on all emails.

Your final project deliverables will be submitted on Google Drive. *(Link to be provided after first class).*

Completion Requirements

Completion of each of the exercises, rigor in process and clarity in representation, as well as the overall progress of the semester (including attendance) will be fundamental to completing the course.

Evaluation Criteria and Grading

The following criteria will be used for the evaluation of students' work, both in terms of helping their progress and in final grading.

1. **Thesis:** How clearly is the student articulating the conceptual intentions?
2. **Translation of Thesis:** How well is the student using their thesis to develop a design response to given problems, interests, or ideas?
3. **Appropriateness:** How well matched is their choice of representation and prototyping strategy to convey their intentions?
4. **Quality:** How accomplished are they with drawing, modeling, digital representation, fabrication, etc? To what degree does their product convey what they ought to?
5. **Oral Presentation Skills:** How clearly are they presenting their ideas orally, whether at their desk, in class discussions, or to a more formal jury?
6. **Participation in Discussions:** How actively and how constructively are they involved in class discussions, both formally and informally?
7. **Response to Criticism:** How do they effectively take advantage of criticism from instructors, classmates and outside jurors?
8. **Auto-Critical Skills:** To what extent are they able to critique their own work regularly and effectively?
9. **Attendance:** – see below.

A: Excellent - Project surpasses expectations in terms of inventiveness, appropriateness, verbal and visual ability, conceptual rigor, craft, and personal development. Student pursues concepts and techniques above and beyond what is discussed in class.

B: Above Average - Project is thorough, well researched, diligently pursued, and successfully completed. Student pursues ideas and suggestions presented in class and puts in effort to resolve required projects. Project is complete on all levels and demonstrates potential for excellence.

C: Average - Project meets the minimum requirements. Suggestions made in class are not pursued with dedication or rigor. Project is incomplete in one or more areas.

D: Poor - Project is incomplete. Basic skills including graphic skills, model-making skills, verbal clarity or logic of presentation are not level-appropriate. Student does not demonstrate the required design skill and knowledge base.

F: Failure - Project is unresolved. Minimum objectives are not met. Performance is not acceptable. This grade will be assigned when you have excessive unexcused absences.

Grade Distribution

Each of the 6 exercises, the final project, and class participation will count towards your grade:

Exercise 1	10%
Exercise 2	10%
Exercise 3	10%
Exercise 4	10%
Final Project	50%
Participation	10%

Studio Culture

Work in the studio will build sequentially. Therefore, your commitment to incremental development on a daily basis is of paramount importance. The demanding nature and pace of studio courses necessitates your regular attendance and requires that deadlines be consistently met. In addition to lowering your grade, late work will prevent you from following the overall structure of the course.

It is important that you take advantage of the studio environment. Magnification of your development as a designer is made possible by the collective nature of the studio. Working in studio, instead of at home, will allow you to participate in the dialogue of the studio setting. Group reviews are collective for a reason. Each of you has something to gain from your peers.

Since the studio is a place for all, it necessitates careful attention to the needs of everyone in it. Please see your instructors or TAs if there are any problems that you are unable to resolve on your own.

Attendance

Attendance for the full duration of each studio is mandatory. **You are allowed three excused absences for the semester.** An excused absence is defined as one that was discussed with and approved by the professor at least 24 hours prior to the date of absence, or a family or medical emergency that is confirmed by your physician or a dean in Student Support Services. Absences

beyond the three allotted will result in a decrease in your final grade. If you miss six or more studio classes, you will be asked to drop the subject or receive a failing grade.

Due to the nature of our current times, we will be accommodating to unforeseen circumstances and will work with you to make sure you can successfully complete the course. Please do reach out early and often if you believe you might have trouble completing the course.

Academic Integrity + Honesty

MIT's expectations and policies regarding academic integrity should be read carefully and adhered to diligently: http://integrity.mit.edu

Documentation

Students are expected to visually document and post their assignments, research, prototypes, and any pertinent material. Strategies for visually documenting students' design work will be presented throughout the semester. We strongly suggest you dedicate a sketchbook exclusively for the class.

Final Studio Deliverables

Grades will not be posted for students to view on their grade report until their work has been archived. The projects need to be properly prepared and formatted, and delivered to the Archiving TA. Studio TA's will collect project archives from each student following the review. Submission details will be provided with each assignment.

Contact Information

Lead Instructor:
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Spring 2022 T 7-9 F 2-5 pm

Schedule (*** *tentative schedule, some things may change)*

Week 1	Introduction to Neural Networks
02/01	Introduction to Course and Creative AI
02/04	Introduction to Neural Networks
Week 2	Data + Tools of the trade
02/08	Technology stack (p5js, ml5, python, colab) **Due: Exercise 1**
02/11	Data and datasets
Week 3	Convolutional Neural Networks
02/15	Introduction to CNN
02/18	CNN implementation on the browser
Week 4	Introduction to Generative Models, Autoencoders / UNet
02/22	No class
02/25	Introduction to Generative Models, Autoencoders, and UNet **Due: Exercise 2**
Week 5	Generative Adversarial Networks
03/01	Introduction to GANs
03/04	Modern GAN Architectures
Week 6	Recurrent Neural Networks + Transformers
03/08	Introduction to RNNs **Due: Exercise 3**
03/11	Work Session
Week 7	Introduction to Final Project
03/15	Final Project Brief **Due: Exercise 4**
03/18	Concept reviews Speaker: Rinon Gal (tentative)

Week 8	No Class (Spring Break)
03/22	No Class (Spring Break)
03/25	No Class (Spring Break)
Week 9	Concepts and Prototypes
03/29	Review concepts, research, and prototypes
04/01	Mini-Crit: Concept Presentations
Week 10	Design and Fabrication
04/05	Work session
04/08	Speaker: Cristóbal Valenzuela (Runway) Work session
Week 11	Design and Fabrication
04/12	Work session
04/15	Work session
Week 12	Finish
04/19	Work session
04/22	Work session Mini-Crit: Group review of current progress
Week 13	Documentation
04/26	Tips for documentation Work session
04/29	Work session
Week 14	Critique
05/03	Pre-review of slides and documentation
05/06	Final crit
Week 15	Wrap-Up
05/10	Debrief + Collect Documentation