Subject Number(s)

4.570 (H) /4.550 (UG)

Subject Title and Subtitle

[Computation Design Lab]

Learning from design heritage: Research workshop on data-driven method

Term offered

Spring 2022

Instructor(s)

Takehiko Nagakura

Collaborator: Daniel Tsai and Guzden Varinlioglu

Guest speakers: Wenzhe Peng, Xiaoyun Zhang, Nikolaos Vlavianos

TA(s)

Charles Wu

Credit Units

2 – 2 – 8 = 12 units

Level

4.570 (H) /4.550 (UG)

Prerequisites

There is no specific prerequisite, but students are expected to have a background in architectural design and computation, and be familiar with basic representational skills for image processing, drafting, modeling and scripting.

Schedule

Lecture/Review: Mon 11:00-2:00, Room 8-119

Lab and Seminar: Tue 7:00-8:30pm, Room 5-216

Subject Description

This class investigates recent technologies that helps studying "design heritage", spatial designs that surround our lives. In the class, design heritage is to broadly include architecture, city and landscape; the built, demolished, and planned; and culturally important as well as the banal ones. We will look at various data-driven methods relevant to learn them, such as photogrammetry, image/video feature detection and semantic analysis, machine learning, physiological sensors, natural language processing, augmented and virtual reality, and gamification. By examining how to collect data, how to process the raw data into forms useful for evaluation, and how to interpret and apply the findings, the students build a foundation for research projects bettering our understanding of the design heritage around us.
Each week during the first half of the class, the class will invite a guest speaker, conduct a short hands-on exercise on a data processing tool, and read relevant literature from previous research projects in design

heritage. A selection of relevant past MIT theses projects in SMarchS and PhD programs are included as major referential works and examples. The second half is run in a workshop format with desk critiques, where students are expected to design and develop a small research project individually or in a group. There is no requirement for computational skills for this class, although familiarity with some scripting language is an advantage.

No fieldwork/field trip is planned for Spring 2022 class.

List of Subject Objectives
Develop ability to represent an architectural/landscape/city design heritage and historic places
Survey various data-driven approaches for analytical research of design heritage
Practice design of research method/pipeline using data-driven approaches
Practice field methodology for capturing spatial forms and events
Explore means to deliver digitally enhanced architectural representation online, on-site, or in museum setting

Evaluation Criteria

Class participation: 25%
Short exercises (6 assignments): 30%
Final Project Development: 15%
Final review: 30% (Participation is required.)

Schedule of Exercises, Projects, Quizzes, Exams or Assignments

Week 01	**Mon, Jan. 31**	Introduction
	+ Tue, Feb. 1	Using image data: Scraping SNS, Online crowd-sourcing
		Impression of Heritage Places, Mechanical Turk
		Ex0 out: Q/A (Student Selection)
		Guest Speaker: Wenzhe Peng
		Ex1 out: Learning through image data
Week 02	**Mon, Feb. 7**	Using videos: segmentation, panoramic projection, HMD
	+ Tue, Feb. 8	Ethnography of Heritage Places, Pedestrian simulation
		Ex1 in: Review and discussion
		Guest Speaker: Chales Wu
		Ex2 out: Analysis from video recordings
Week 03	**Mon, Feb. 14**	Finding patterns through Machine Learning
	+ Tue, Feb. 15	Spatial layout, sketches
		Ex2 in: Review and discussion
		Guest Speaker: Xiaoyun Zhang
		Ex3 out: Finding and generating patterns by Machine Learning
Week 04	**Mon, Feb. 21**	***Presidents Day Holiday (All Monday classes shift to Tuesday)***
	+ Tue, Feb. 22	Representations and UI
		Ex3 in: Review and discussion

Guest Speaker: Guzden Varinlioglu
Ex4 out: Gamification for design research

Week 05	**Mon, Feb. 28** **+ Tue, Mar. 1**	Measuring human response to spatial designs Physiological sensor, eye-tracking **Ex4 in**: Review and discussion Guest Speaker: Nikolaos Vlavianos **Ex5 out**: VR and Physiological measurement **Final project introduced** Brainstorming of Student Projects (Title, Initial Idea)
Week 06	**Mon, Mar. 7** **+ Tue, Mar. 8**	Examining literature on spatial designs Natural Language Processing **Final project proposal brainstorming session** (Method, deliverable, resource) **Ex5 in**: Review and discussion Guest Speaker: Daniel Tsai **Ex6 out**: Analyzing design through text
Week 07	**Mon, Mar. 14** **+ Tue, Mar. 15**	**Ex6 in:** Review and discussion **Final project proposal review**
Week 08	*Mar. 21 – Mar. 25*	*MIT Spring Break*
Week 09	**Mon, Mar. 28** **+ Tue, Mar. 29**	3D forms, photogrammetric capture, HBIM, drone Workshop/desk critique
Week 10	**Mon, Apr. 04** **+ Tue, Apr. 05**	Project Re-calibration Workshop/desk critique
Week 11	**Mon, Apr. 11** **+ Tue, Apr. 12**	Design heritage in Museums, AR, and Online Distribution Workshop/desk critique
Week 12	***Mon, Apr. 18*** **+ Tue, Apr. 19**	*Patriots Day Holiday* No class
Week 13	**Mon, Apr. 25** **+ Tue, Apr. 26**	**Final project mid-term review** Workshop/desk critique
Week 14	**Mon, May 2** **+ Tue, May 3**	TBA Workshop/desk critique
Week 15	**Mon, May 9** **Tue, May 10**	**Final presentation** *(Last day of class at MIT)*
	May 13-18	*Exam week*

Textbooks and Reading Sources

All materials are provided online from the resource section of the class home page as links to text, video, and interactive media. The followings is a snapshot of the resource section.

Machine Learning + Image/Video/3D models

[ML]   (architecture) W. Peng, F. Zhang, T. Nagakura   2017 paper   2018 Smarchs Thesis
Machines' Perception of Space: Employing 3D Isovist Methods and a Convolutional Neural Network in Architectural Space Classification

[ML]   (architecture) C. Wu 2020 March thesis
Machine learning in housing design : exploration of generative adversarial network in site plan / floorplan generation

[ML]   (heritage)   P. Gonzalez, T. Nagakura   2020 paper   2021 PhD thesis (not for distribution)
AI Visitor: Tracking and simulating pedestrian trajectories in Machu Picchu

[ML]   (architecture) R. Villalon   2017 PhD Thesis
Data mining, inference, and predictive analytics for the built environment with images, text, and WiFi data

[ML]   (architecture)   X. Zhang   2021 Smarchs Thesis
Envisage: Investigating Design Intentions, Visual Perception through Eye Tracking of Architectural Sketches

[ML]   (architecture)   J. Park 2015 PhD Thesis
Synthetic tutor : profiling students and mass-customizing learning processes dynamically in design scripting education

[ML]   (urbanism)   Q. Liang, M. Wang, T. Nagakura   2020 paper   2020 Smarchs Thesis   Video
Urban Immersion: A Web-based Crowdsourcing Platform for Collecting Urban Space Perception Data.

[ML]   (architecture)   J. Peraino   2020 March thesis
Architectural epidemiology : a computational framework

[ML]   (architecture) Y. Liu 2020 Smarchs Thesis
Measuring the immeasurable : an experiment for a machine to map low-level features to high-level semantic representation of architectural space using a single view photo

[ML]   (urbanism)   T. Sun 2020 Smarchs Thesis
Synthesizing 3D morphology from a collection of urban design concepts

Data Mining/Visualization/Analysis (for reference)

[crowd-sourcing] (urbanism)   Y. Yoshimura, S. He, G Hack, T Nagakura, C Ratti   2020 paper   2014 Smarchs Thesis
Quantifying Memories: Mapping Urban Perception

[data mining]   (urbanism)   X. Chen   2011 Smarchs Thesis   demo video (Singapore)   demo video (Paris)
Seeing differently : cartography for subjective maps based on dynamic urban data

[data mining]   (urbanism)   N. Chen   2016 Smarchs Thesis
Urban data mining : social media data analysis as a complementary tool for urban design

[data mining]   (architecture)   S. Zhang   2020 March thesis
Value in design? Features, pricing, and design strategies

Other Projects (for reference)

[ML]   (toolkit)   Chin-Yi Cheng   2017 Smarchs Thesis
Interactive design process based on augmented intelligence : a framework and toolkit for designers to interact and collaborate with AI algorithms

[Measurment]   (handcraft)   G. Bernal   2014 Smarchs Thesis
Learning from master's muscles : EMG-based bio-feedback tool for augmenting manual fabrication and crafting

[BIM]   (architecture) T. Nagakura and W. Sung   2017 paper
Spatial Typology for BIM - Preassembling for Synthetic Architectural Design

[Participatory]   (architecture)   J. Choi 2014 March Thesis
Democratic Play : crowd-sourcing through games for architectural design

[Participatory]   (architecture) Y. Hou 2016 March Thesis
Engaging public voice in big data society : an on-line participatory design experiment

AI Platform Tools (for reference)

[ai tool]   (image-based GAN)   Pix2Pix   toolkit

[ai tool]   (image/video-based)   Google Vision AI   toolkit

[ai tool]   (comprehensive)   Microsoft Azure Cognitive Services toolkit

[ai tool]   (video-based)   Moments in Time Dataset   toolkit

[ai tool]   (video-based) STAR toolkit

[ai tool]   (Agent-based)   Unity ML-Agents Toolkit   toolkit

[ai tool]   (Reinforcement Learning)   Gym   toolkit

Lab Fees (if any)

None