Syllabus

Course Prerequisites

The coursework includes projects that require some programming using Python or JavaScript. While previous knowledge is not required, being proficient and comfortable with programming is a fundamental prerequisite for this course. Previous experience with computer graphics, algebra, geometry, data science, and analysis can also help but not required.

Course Description

Being able to analyze and present data visually has become one of the most important skills for work in data science, finance, and related fields. Information Visualization teaches you how to design effective interactive visualizations of complex data for data understanding discovery and presentation.

The course is a blend of theoretical and practical knowledge aimed at developing a well-rounded set of skills to ideate, design, implement, and evaluate sophisticated data visualization projects. The course will proceed with 3 meta sections: 1) fundamental algebra/geometry and basic computer graphics; 2) information visualization techniques/models of visual encoding, perception, and practical applications; 3) modern medium visualization topics such as VR/AR, deep learning visualization, and multimodal interfaces. Through the course as an example, you will develop core academic and industrial skillset including reading/writing, presentation, and mathematical/computational skills.

The theoretical part contains low-level optical and computational methods of how individual pixels are drawn on the screen, and how they are perceived by the human eyeball, the retina, and the brain.  The practical part aims at teaching the skills needed to develop effective interactive data visualizations for analysis and presentation.

The course also includes a series of small practical projects which enable students to gain experience with the development of fully-working interactive graphics/visualization techniques. The final project, with the freedom to select among several topics, is organized in a way to simulate conditions happening in real-world data analysis and communication projects and includes activities to gain feedback from the instructor and the teaching assistants.

**Course Objectives**

* Develop low-level knowledge of visual computing, including basic algebra, computer graphics, and optics
* Develop an understanding of the unique human visual and cognitive system while perceiving digital content
* Identify what kind of problems visualization can solve
* Explain why and when visualization works
* Develop analytical questions for a data analysis problem and develop appropriate data manipulations and graphs to answer them
* Describe how to evaluate a visualization project: identify the elements of a project that need to be evaluated and strategies to carry out effective evaluations
* Identify the right type of graph for a data analysis and presentation problem based on tabular data
* Identify the appropriate graph for a given problem
* Describe what the limitations of a visualization method are and how they can be overcome
* Recall the set of marks and channels visualization methods can use and describe their advantages and disadvantages
* Describe a visualization in terms of its encoding strategy (marks and channels used) and identify its potential limitations
* Describe the concepts of channel effectiveness and expressiveness and demonstrate how to apply them in the design and evaluation of data visualizations
* Use appropriate visual representations for a problem with geographical, time-oriented, and network data
* Read and summarize the state-of-the-art research literature
* Gain hands-on experience on modern and interdisciplinary visualization topics and platforms, such as VR/AR and deep learning.

Course Structure

The course includes lectures, mini (programming) assignment, readings, reports, and design/development of visual computing projects.

**Textbooks**

There are no required textbooks. However, the following books are those that contain most of the information taught in the course:

[Visualization Analysis and Design](https://www.crcpress.com/Visualization-Analysis-and-Design/Munzner/9781466508910), Tamara Munzner, CRC Press 2014

[Fund of Computer Graphics](https://nyu.follettdiscover.com/courses/CS-GY.6313/terms/1218/sections/CS-GY.6313.A.1218/division/DFLT/materials/9781482229394/details), Steve Marschner,  Taylor & Francis Group, LLC 2016

Other recommended texts are:

Published articles in IEEE Vis/TVCG and ACM ToG/SIGGRAPH

**Course requirements**

The course requires:

* Attendance: full attendance of weekly classes;
* Projects: development and submission of assigned mini-assignments and projects;
* Literature reading and survey: based on your selected project, summarize and present previous literature.

Grading breakdown:

* Attendance: 5%
* Mini-projects: 40% (20% + 20%)
* Article survey report: 15%
* Final project: 40%

**Attendance**

The course requires full attendance of classes for the face-to-face section of the course and virtual meetings for the online section. Attendance counts as 10% of the final grade (10 points out of 100). Missed meetings result in a reduction of attendance points as follows:

|  |  |
| --- | --- |
| Missed Classes (excluding sickness/quarantine etc) | Pt. reduction |
| 1, 2, 3 | 0 |
| 4, 5, 6 | 2 |
| 7 or more | 5 |

For special situations such as sickness, quarantine, religious festivities, problems with transport, no attendance points will be removed as long as you send your instructor a note via email before the class starts. Attendance will be randomly recorded at the beginning or end of each meeting every week.

**Mini and Final Projects**

Two mini-projects consist of an assigned data set and a problem the visualization is supposed to solve. The solution requires designing a solution and implementing it in D3/javascript or OpenGL/Python/C++.

The final project will be a larger scale implementation of state-of-the-art research. Various options will be provided.

The students will have to submit for each assigned project the following material:

* Design sketches (developed before coding)
* Short description of the design and its rationale
* Working code showing the implementation

(More details will be provided at the time the projects are assigned.)

**Peer-Review**

As part of the assignment, each student will have to review two submissions from other students. The peer-review will be graded with the same criteria used for the rest of the homework.

**Literature reading and survey**

An essential skill is to read and summarize prior work and literature. After selecting the final project topic, you will start searching and summarizing prior literature along the same direction. An 8-page survey will be written to assess your domain-specific knowledge in both breadth and depth.

**Schedule**

This is the tentative schedule for the course. Note that the schedule may change to adapt to the specific needs of the class.

|  |  |  |
| --- | --- | --- |
| 1 | 09/07 | Introduction and syllabus |
| 2 | 09/14 | Fundamental algebra and geometry |
| 3 | 09/21 | Introduction to graphics I |
| 4 | 09/28 | Programming Tutorial (by CA) |
| 5 | 10/04 | Introduction to graphics II |
|  | 10/11 | Fall Break - No Class |
| 6 | 10/18 | Visual data processing |
| 7 | 10/25 | Color and visual perception |
| 8 | 11/2 | Visualizing spatial data |
| 9 | 11/9 | Visualizing temporal data |
| 10 | 11/16 | Guest lecture (TBD) |
| 11 | 11/23 | Modern topics - deep learning |
| 12 | 11/30 | Modern topics - VR/AR/Interaction |
| 13 | 12/7 | Final project presentation I |
| 14 | 12/14 | Final project presentation II |

Note that the schedule may slightly vary during the semester. Make sure to check frequently for possible changes!

Quoting Policy and Collaboration

The work students submit for individual assignments and class projects must be their own original work. When ideas are borrowed from existing work it is necessary to provide citations and a clear statement that describes which part has been adopted and which is original.

For all projects, students are NOT allowed to collaborate with their peers or copy from open-source solutions. The submitted projects must be produced and submitted individually.

Academic Dishonesty

It's always annoying having to explain that copying work or cheating is not allowed. I like to totally trust each and every one of you. But bad things happen and I have to warn you that academic dishonesty is a very serious thing and you might get in very serious trouble if caught cheating. Students caught in dishonest behavior get an F score for the course and are reported to the school.

Please refer to NYU Tandon’s code of conduct to guide your academic behavior: <https://engineering.nyu.edu/campus-and-community/student-life/office-student-affairs/policies/student-code-conduct>

Moses Center Statement of Disability

If you are a student with a disability who is requesting accommodations, please contact New York University’s Moses Center for Students with Disabilities at [212-998-4980](https://brightspace.nyu.edu/javascript:/) or [mosescsd@nyu.edu](mailto:mosescsd@nyu.edu). You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at [www.nyu.edu/csd](http://www.nyu.edu/csd). The Moses Center is located at 726 Broadway on the 2nd floor.