# 📊 CSC 302

Introduction to Data Visualization ( 3 credits)- Winter 2022

**Dr. Halil Bisgin**

**M FLINT**

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| 📍 Class Zoom: 99356809506 | TR 11:00AM-12:15PM | 🧍 Office Zoom: 2509859732 | ☑ TR 4.00 - 5.30PM |
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## Course Description

- Study of basic visualization techniques using different platforms ranging from scripting languages to off-the-shelf software packages along with necessary statistical measures. Includes an introduction to design and information literacy, fundamental data preprocessing techniques, dimension reduction, representation of time, spatial and network data, and ethical aspects in visualization. Examination of select topics in data science and machine learning.

- This class will not only introduce fundamentals of data visualizations, but also expose you several visualization tools, such as R, Python, Cytoscape, which will prepare you for any future project. Almost every class will be run like a workshop which will let you start practicing principles and methods covered on the same day. We will also cover some high-level statistical and linear algebra concepts through their applications on sample datasets which aim to broaden your vision regarding data preprocessing and manipulation steps before visualization.

## Prerequisites

CSC 122; one from SCM 211, SOC 215, SWR 270, PSY 322, PHS 347, or prior or concurrent election of MTH 370 or MTH 372; or consent of instructor.

## 📖 Textbook

There is no required textbook for this course, but here are some recommended books which I will be using in course materials.
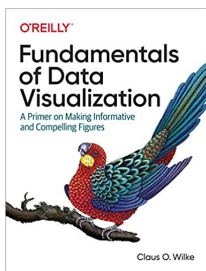


Fundamentals of Data Visualization:
A Primer on Making Informative and Compelling Figures
O'Reilly Media; 1st edition (2019)
by Claus O. Wilke.
ISBN: 978-1492031086
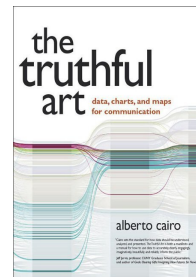


The Truthful Art,
Data, Charts, and
Maps for Communication
New Riders
by Albert Cairo
ISBN: 978-0321934079
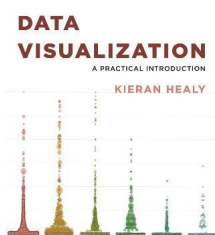


Data Visualization: A practical introduction,
Princeton University Press; 1st edition (2019)
by Kieran Healy
ISBN: 978-0691181622
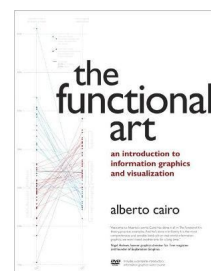


The Functional Art,
An introduction to
information graphics
and visualization
New Riders
by Albert Cairo
ISBN: 978-0321834737
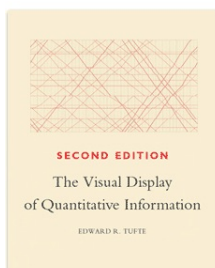


The Visual Display of Quantitative Information,
Graphics Press; 2nd edition (2001)
by Edward R. Tufte
ISBN: 978-1930824133

# 🔧 Tools

- R (`https://www.r-project.org/`), RStudio(`https://www.rstudio.com/`)
- Python (`https://docs.continuum.io/anaconda/ide_integration`, `https://www.python.org/`, `https://colab.research.google.com`)
- PyCharm(`https://www.jetbrains.com/pycharm/`)
- Leaflet (`https://leafletjs.com/`)
- ArcGIS (`ArcGIS.com`)
- Cytoscape (`https://cytoscape.org/`)
- Gephi (`https://gephi.org/users/download/`)
- Tableau (`https://www.tableau.com/academic/students`, `https://public.tableau.com/s/`)

# ⊘ Course Objectives

- Understand the fundamental principles for effective data visualization.
- Familiarize with available visualization tools.
- Have an understanding of the distinction between good, bad, and ugly figures.
- Learn why and how figures can misinform or mislead.
- Know how to create a wide range of plots by using different platforms

# ⚗ Student Learning Outcomes

(Based on Bloom's taxonomy of cognitive domain as marked in parenthesis after each learning outcome) You will:

1. understand the foundations of the visualization processes, from basic building blocks to taxonomies and frameworks (knowledge, comprehension)
2. understand the visualization pipeline (comprehension, synthesis, evaluation)
3. understand the design considerations for the components of the good visualization (synthesis)
4. know the methods and algorithms used to map data to graphical depictions (synthesis, application)
5. understand the visualization design process (knowledge, evaluation)
6. know a wide range of interaction techniques and styles (knowledge, comprehension, analysis)
7. understand the characteristics and methods that are needed for the visualization of geospatial data (knowledge, comprehension, application)
8. know some commercial data visualization packages with functionality (knowledge, comprehension, application)

# 📅 Tentative Schedule:

| Date | Topics | Assignments/Deadlines |
|---|---|---|
| Thursday, January 6 | Introduction to the Course and Data Visualization | |
| Tuesday, January 11 | Introduction to Data Visualization (Cont.d) | |
| Thursday, January 13 | Mapping Data onto Aesthetics, Coordinate Systems and Axes | |
| Tuesday, January 18 | Data Manipulation with Python | |
| Thursday, January 20 | | HW1 out |
| Tuesday, January 25 | Data Manipulation with R | Group formation |
| Thursday, January 27 | | HW2 out |
| Tuesday, February 1 | Color Scales, Directory of Visualizations | |
| Thursday, February 3 | Visualizing Amounts, Visualizing Distributions: Histograms And Density Plots | HW3 out |

| | | |
|---|---|---|
| Tuesday, February 8 | Visualizing Many Distributions At Once<br>Visualizing Proportions | Dataset due |
| Thursday, February 10 | Visualizing Nested Proportions & Associations | |
| Tuesday, February 15 | Visualizing Time Series & Trends | HW4 out |
| Thursday, February 17 | Visualizing Geospatial Data | |
| Tuesday, February 22 | **Midterm Presentations** | |
| Thursday, February 24 | | |
| Tuesday, March 8 | Visualizing Geospatial Data | HW5 out |
| Thursday, March 10 | Multipanel Figures | |
| Tuesday, March 15 | Titles, Captions, and Tables | |
| Thursday, March 17 | Network Visualization with Cytoscape - An overview | |
| Tuesday, March 22 | | HW6 out |
| Thursday, March 24 | Tableau - An overview | |
| Tuesday, March 29 | | HW7 out |
| Thursday, March 31 | How to refine our Plots | |
| Tuesday, April 5 | | |
| Thursday, April 7 | Undestanding image formats & choosing right software | |
| Tuesday, April 12 | Story telling with your data | |
| Thursday, April 14 | **Final Presentations** | |
| Tuesday, April 19 | | |

| ⚠ **Important Dates** | |
|---|---|
| Group formation | Jan 25 |
| Dataset Due | Feb 8 |
| Midterm Presentations | Feb 17, 22 |
| Final Presentations | Apr 14, 19 |
| Drop individual class(es) 100% refund | Jan 19 , 5pm. |
| Drop individual class(es) no refund w/W grade | Jan 20-Feb 25 |
| Withdraw (drop all classes) 50% refund w/W grade | Jan 20-Feb 25 |
| Last Day to Withdraw (drop all classes) | Feb 25 |

# ▦ Assessment of Student Learning Outcomes

| | |
|---|---|
| Group formation | 5% |
| Dataset | 5% |
| Homework | 25% |
| In-class Assignments (ICAs*) | 20% |
| Midterm Presentation | 20% |
| Final Presentation | 25% |

*Almost every class, we will have hands-on practices or discussion threads and some of them will be asked to be submitted as your ICA. While regular homework assignments will be graded based on the quality of the work, ICAs will be granted 100 upon submission even if they're incomplete.

# ⚖ Grading Scale

| | | | |
|---|---|---|---|
| A+ | 97-100 | C+ | 78-79 |
| A | 92-96 | C | 72-77 |
| A- | 90-91 | C- | 70-71 |
| B+ | 88-89 | D+ | 68-69 |
| B | 82-87 | D | 60-67 |
| B- | 80-81 | E | 0-59 |

🍃 Grading may be curved if the class performance warrants it. Curving can only improve grades from the grading scale above

# 🏠 Homework Remarks

- These are individual home works, and not group assignments. Although you are allowed and even encouraged to discuss the general concepts behind the home works and even outline of solutions with your classmates, multiple students MUST NOT work out one answer, and then submit this answer.

- I will accept late assignments. However, late assignments carry with them a 10% reduction in the grade, per week.

- All assignments must be turned in by three calendar weeks of their due date or you will receive a zero (0) grade for the assignment.

- Please note that if you are unable to turn an assignment in on the due date, then it will be considered late unless you have made arrangements with me at least twenty-four (24) hours before the assignment is due.

- Only submission via Canvas will be accepted.

- Some of the homework assignments may have to be demonstrated to the instructor.

# 📦 Project Remarks

The project has two milestones, i.e., midterm and final, as indicated in the schedule. Both milestones require a presentation in class by the project groups where contribution of each member should be clear. While **midterm presentations** should have at least four different plots to describe the dataset and variables with your conclusions and inferences, final presentations should have more extensive visualizations with the new techniques and tools introduced. In both stages, you are expected to provide the following content in your presentations:

1. Figures and their titles. Please make sure you use at least **four types of figures**, e.g., bar plot, scatter plot, etc. for the midterm and **12 figures (at least four types)** for the final by using every tool introduced so far. If your dataset doesn't have spatial and network data, you're not required to use Cytoscape and spatial data visualization tools.

2. Reasons to generate those figures. What was your purpose and why do you think these figures will capture the information you want to convey.

3. Your inferences for every figure. For instance, you can say "We observe a positive correlation between height and weight. As height increases, weight also increases according to the figure"

4. Your conclusions after presenting all visualizations.

The deadline to form a project group is **Jan 25**. Pleases visit 👍*google spread sheet* to fill your group info. Notice that forming a group is worth 5 points towards final score.

You are encouraged to form groups with a maximum of three members. The scope of the project is such that a student by themselves can successfully complete the project. You must form your own groups. Talk to your peers (in class, using Slack etc) to form groups.

Here are some resources where you can find sample datasets and research problems:

1. UN Data:
   `http://data.un.org/`

2. Kaggle repository:
   `https://www.kaggle.com/`

3. UC Irvine Machine Learning Repository:
   `http://archive.ics.uci.edu/ml/index.php`

4. National Consortium for the Study of Terrorism and Responses to Terrorism:
   `http://start.umd.edu/data-and-tools/start-datasets`

# 🎓 Academic Integrity

(`http://catalog.umflint.edu/content.php?catoid=2&navoid=80#Student_rights/`)

Intellectual integrity is the most fundamental value of an academic community. Students and faculty alike are expected to uphold the highest standards of honesty and integrity in their scholarship. No departure from the highest standards of intellectual integrity, whether by cheating, plagiarism, fabrication, falsification, or aiding and abetting dishonesty by another

person, can be tolerated in a community of scholars. Such transgressions may result in action ranging from reduced grade or failure of a course, to expulsion from the University or revocation of degree.

It is the responsibility of all students and faculty to know the policies on academic integrity in the instructional units at the University of Michigan-Flint. Information about these policies and the appeals process is available from the appropriate administrative office of the instructional units: in the College of Arts and Sciences, the Office of the Dean of the College of Arts and Sciences; in the School of Education and Human Services, the Office of the Dean of the School of Education and Human Services; in the School of Management, the Office of the Dean of the School of Management; in the School of Health Professions and Studies, the Office of the Dean of the School of Health Professions and Studies and for graduate students, the Office of the Dean of Graduate Programs. Departments and programs within these instructional units may have specific policies and procedures which further delineate academic integrity. In such cases students are bound by the University policy on academic integrity as well as these department or program policies.

# ⚖ Procedural Rights of the Accused Student

A student who is charged with academic dishonesty by an instructor, administrator, or another student may be assured that he/she has the right to a fair hearing of the charges and the evidence, the right to question witnesses, to invite witnesses on his/her behalf, and to introduce whatever other evidence may be relevant to the charge.

# 🏛 Code of Academic Conduct

The University, like all communities, functions best when its members treat one another with honesty, fairness, respect, and trust. Therefore, an individual should realize that deception for the purpose of individual gain is an offense against the members of the community. Such dishonesty includes:

- **Plagiarism:** taking credit for someone else's work or ideas, submitting a piece of work (for example, an essay, research paper, assignment, laboratory report) which in part or in whole is not entirely the student's own work without fully and accurately attributing those same portions to their correct source.

- **Cheating:** using unauthorized notes, or study aids, or information from another student or student's paper on an examination; altering a graded work after it has been returned, then submitting the work for regrading; allowing another person to do one's work, then submitting the work under one's own name.

- **Fabrication:** fabricating data; selectively reporting or omitting conflicting data for deceptive purposes; presenting data in a piece of work when the data were not gathered in accordance with guidelines defining the appropriate methods of collecting or generating data; failing to include a substantially accurate account of the method by which the data were gathered or collected.

- **Aiding and Abetting Dishonesty:** providing material or information to another person when it should reasonably be expected that such action could result in these materials or information being used in a manner that would violate this code of academic integrity.

- **Falsification of Records and Official Documents:** altering documents affecting academic records; forging a signature of authorization or falsifying or omitting necessary information on an official academic document, election form, grade report, letter of permission, petition, or any document designed to meet or exempt a student from an established College or University academic regulation; falsification or unauthorized altering of information in any official academic computer file.

- **Identity Theft:** Assuming another person's identity or role through deception or without proper authorization. Communicating or acting under the guise, name, identification, email address, signature, or indicia of another person without proper authorization, or communicating under the rubric of an organization, entity, or unit that you do not have the authority to represent.

- **Misrepresentation and Other Acts of Academic Dishonesty:** Fraudulently obtaining and/or using academic materials that would give oneself an unfair advantage over other students or would deceive the person evaluating one's academic performance.

*An attempt to commit an act prohibited by this code may be punished to the same extent as a completed violation.*

# ♿ Accessibility Issues

It is my intention to support the full participation of all students in the learning process of this class. Students with disabilities that may restrict their full participation in course activities are encouraged to meet with the instructor or to contact the Office

of Accessibility Services.

Accommodations: The University of Michigan?Flint strives to make learning experiences as accessible as possible and complies with Section 504 of the Rehabilitation Act of 1973 and the American with Disabilities Act. The university provides individuals with disabilities reasonable accommodations to participate in educational programs, activities, and services. Students with disabilities requiring accommodations to participate in class activities or meet course requirements must self-identify with Disability and Accessibility Support Services as early as possible at (810) 762-3456 or dassflint@umich.edu. The office is located in 264 University Center, inside the CAPS Office. Once your eligibility for an accommodation has been determined you will be issued an Accommodation Letter. Please present this letter to each faculty member in each class at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, project, etc.).

# ⊗ Available Support Services

There is a plethora of support services available to students from tutoring to mental health services. Many times students are unaware of the services available to them. One such service is tutoring:

`http://www.umflint.edu/tutoring/student-success-center-tutoring`

For other services, please check Student Success Center at

`http://www.umflint.edu/studentsuccess/student-success-center`

# 🚑 Covid -19 Remarks

The University of Michigan-Flint aims to deliver its mission while protecting the health and safety of our faculty, staff and students and minimizing the potential spread of disease within our community. Please follow these steps if you are experiencing ANY of the following:

- COVID-19 symptomatic (symptoms may change as determined by the CDC)

- Fever or chills; Cough; Shortness of breath or difficulty breathing; Fatigue; Muscle or body aches; Headache; New loss of taste or smell; Sore throat Congestion or runny nose; Nausea or vomiting; Diarrhea

- Asymptomatic but were exposed to someone who tested positive (within 6' for greater than 15 minutes)

- Tested positive for COVID-19

1. Stay home and self-isolate until provided with further advice from your physician and direction from the University.

2. Notify your instructors.

3. Complete the Student COVID-19 Illness Reporting Form at `www.umflint.edu/covid-19`.

4. Consider being tested.

5. If testing is required, the Office of the Dean of Students will monitor the situation in partnership with the Genesee County Health Department to coordinate return to campus when appropriate.

*Last but not least your health is my top priority. We can always make up a test or an assignment. So, please don't hesitate to reach me out if you or your family members have any health issues which don't have to be related to Covid-19.*

# 🗋 Notes

I reserve the right to modify course policies, the course calendar, assignment point values, and due dates. Any extenuating circumstances that hinder your participation in the course should be discussed with me as soon as those circumstances are known. Make-ups for graded activities may be arranged if an absence is caused by documented illness or personal emergency. A written explanation, including supporting documentation, must be submitted to me; if the explanation is acceptable, then an alternative to the graded activity will be arranged. Whenever possible, make-up arrangements must be completed prior to the scheduled activity.