

# COS 326

## Data Visualization

Department of Computer Science and Engineering  
Taylor University

Three Credit Hours  
Euler Science 040 • MWF 1:00–1:50  
Final Exam: W/12-May, 8:00–10:00

### 1 Instructor

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**Dr. Tom Nurkkala**

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Hours	Mon, Wed 2:00–3:00 Tue, Thu 10:00–12:00 <i>Or by appointment</i>

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### 2 Description

**Prerequisites:** COS 120, COS 143; **encouraged:** MAT 311, Statistics course

**From the catalog:** This course introduces explanatory and exploratory data visualization, including principles, techniques, and tools, that facilitate understanding and action based on very big data sets. Principles from graphic design, visual perception, and cognitive science are considered. Students employ modern tools and languages to access, analyze, and visualize Internet-scale data.

### 3 Learning Objectives

Upon successful completion of this course, you will be able to:

1. Articulate and employ standards of excellence in the presentation of visual information.
2. Understand key aspects of human perception of visual information.

3. Employ conventional tools for visualization (e.g., office software suites) to communicate data clearly and consistently.
4. Identify, extract, and clean Internet-scale data sets in preparation for visualization.
5. Use purpose built tools to analyze and visualize large, complex data sets (e.g., [Observable](#), [Jupyter](#), [matplotlib](#), [ggplot2](#), [R Studio](#)).
6. Write robust software in languages relevant to data science and data visualization (e.g., [Python](#), [R](#), [JavaScript](#), [TypeScript](#))
7. Develop custom, interactive, Web-based visualizations that allow rich exploration of complex data using standard tools (e.g., [D3](#)).
8. Critique the clarity and efficacy of visualizations from other data scientists.
9. Work as a team to create visualizations of complex and socially relevant data.

## 4 Team Project

During the course, you and a partner will create non-trivial visualizations of real world data that:

1. Exercises your understanding of data visualization.
2. Showcases your ability and experience with data visualization techniques and tools
3. Clarifies the facts of a complex or controversial topic of relevance to contemporary society.

## 5 Texts

Our principle text will be Wilke [\[13\]](#).

For programming exercises, I recommend Murray [\[5\]](#) and Janert [\[3\]](#) for D3, VanderPlas [\[11\]](#) for Python, and Wickham [\[12\]](#) for R.

Other volumes of utility for D3 are Meeks [\[4\]](#) (a title from the normally terrific Manning, this one is comprehensive but uninspiring visually) and Heydt [\[2\]](#) (a surprisingly clear text published by the very uneven Packt). Our custom visualizations will use Scalable Vector Graphics (SVG); Bellamy [\[1\]](#) is a good overview.

Finally, Edward Tufte is the leading expert on data visualization in the last 50 years. His book *The Visual Display of Quantitative Information* [\[9\]](#) is the modern classic in the field. His other major publications ([\[7\]](#), [\[10\]](#), and [\[6\]](#)) also warrant close inspection for instruction and inspiration. His thin *Cognitive Style of PowerPoint* [\[8\]](#)

is a fantastic critique of modern “slide ware,” [how it makes you dumb](#), and how it helped bring down the Space Shuttle *Challenger*.

## 5.1 Safari

Rather than selecting a traditional textbook that you are “forced” to purchase by the bookstore, I encourage you to take advantage of [O’Reilly Learning](#) (formerly Safari Books Online). O’Reilly Learning is an outstanding subscription service that gives you access to thousands of technical titles, including many for this course. You can also download complete books for off-line access on your mobile devices.

For students, the cost to subscribe directly is about \$40/month. Access is also included in the very affordable student membership in the [Association for Computing Machinery](#) (ACM). The ACM is (along with the [IEEE Computer Society](#)) one of the two main professional societies for computer scientists.

Why use O’Reilly Learning instead of a standard textbook?

1. Rather than asking you to buy an entire textbook and use only *portions* of it, we will be draw on multiple resources that are *directly related* to the topics covered throughout the semester.
2. Your total cost will be about \$120, which is less than the cost of some single textbooks. If you are taking other courses from me this semester, you only need to pay the fee once.
3. You should have experience learning from written and electronic resources, which you will do throughout your technical career. I have been a member of O’Reilly Learning for many years and find it to be an invaluable resource when I am learning a new technology or buffing up my understanding of a familiar one.
4. You will have immediate access to a rich collection of technical material to advance your learning in this or other computer science courses.

## 6 Evaluation

The grading breakdown for the course is shown in Table [1](#). Refer to my *Periodic Table of the Grades* for the grading scheme. I reserve the right to award a higher grade than strictly earned; outstanding attendance and class participation figure prominently in such decisions.

## 7 Course Expectations

Following are my expectations regarding the course.

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	Weight
Homework	10%
Programming	20%
Participation	10%
Project	20%
Midterm	20%
Final	20%
Total	100%

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Table 1: Grading details

## 7.1 Attendance

You are required to attend all class sessions. I will be in class each day, and I expect you to be there also.

In general, I am very understanding about students who must miss class due to a sanctioned Taylor activity, medical appointment, job interview, family emergency, and the like. If possible, let me know in advance that you will not be in class; I will work with you to arrange make-up instruction, homework, exams, etc.

## 7.2 Late Work

All course assignments will include an unambiguous due date. Usually, assignments are due at the beginning of class on the due date. If there are multiple sections of a class, the assignment is due at the beginning of the earliest such section. Barring exceptional circumstances like those mentioned in section 7.1, I expect your work to be submitted *on the due date*. Late work will *not* be accepted.

This policy on late work is intended to prepare you for real-world experience after graduation. In the marketplace, late work is not merely an inconvenience. Missing a deadline may alienate your customer, upset your manager, ruin your project, or terminate your employment! *Now* is the time to learn the self discipline and time management skills required to complete your work when it is due.

## 7.3 Conduct

I expect you to be prepared, awake, aware, and participatory during class. I will not hesitate to ask you to stand or move if you are distracted or sleepy.

I expect you to join in discussions, respond to questions from me and from your colleagues, and ask questions of me. I expect you to hold my feet to the fire if I am being unclear, unkind, or contradictory.

## 7.4 Gizmos

You may not use a laptop, tablet, or similar device to check e-mail, engage in social networking, surf the web, or any other activity not directly relevant to current classroom activity. If you use an electronic gizmo during class for legitimate academic purposes (e.g., note taking), be prepared to demonstrate relevant use on demand at any time.

## 8 Pandemic

We will adhere to university guidance regarding the COVID-19 pandemic.

Taylor University is committed to its academic and spiritual mission, even as we teach and learn in a global pandemic. In the interest of your safety, and the health and wellness of others in the classroom, campus, and community, you can expect to have social distancing and precautionary measures used in the classroom. **This means you are required to wear your own face mask in class.** You may also be asked to remain seated at a distance away from other students when you are in the classroom. Some larger classes may create discussion groups and establish a rotation for some students to join the class using virtual tools. As students, you can expect that your professor will communicate clearly and regularly about expectations for this course. If course delivery methods need to change or adapt to health concerns, updates will be announced in class sessions.

## 9 Course Management

We use several systems to help manage the course and for on-line communication.

### 9.1 Email

Electronic mail is an official channel of communication between all members of the university community. You are responsible to check your email regularly (daily) for information related to the course.

### 9.2 Canvas

The Computer Science and Engineering department uses Canvas as our Learning Management System. The URL for Canvas is <https://canvas.cse.taylor.edu>.

You are responsible for checking Canvas regularly to keep up with assignment due dates and other announcements. For due dates, *the Canvas calendar is your friend*.

### 9.3 Slack

This course will use Slack for informal communication, Q&A, last minute announcements, jokes, and the like. Find the *TU CSE Student* slack team at [tucsestudents.slack.com](https://tucsestudents.slack.com). Look there for a *channel* dedicated to the course.

## 10 Academic Integrity

As a student at an institution whose goal is to honor Christ in all that it does, I expect you to uphold the strictest standards of academic integrity. You must do your own work, cite others when you present their work, and never misrepresent your academic performance in any way. Violation of these standards stains the reputations of you as a student, Taylor as an institution, and Jesus as our Lord.

Every assignment should indicate clearly that it is either:

- An **individual** assignment, to be done *entirely by you*, without any direct participation from other students.
- A **group** assignment, to be done *collectively with a group*

Unless otherwise stated, assignments are **individual** assignments.

You are *always* welcome to get help from the instructor on *any* homework assignment or project, whether an individual or group assignment.

### 10.1 What Constitutes Academic Dishonesty?

For purposes of this course, the following are *non-exhaustive* examples of violations of academic integrity.

1. Sharing code or other electronic files by copying, retyping, looking at, or supplying a copy of a file from this or a previous semester.
2. Sharing written assignments or exams by looking at, copying, or supplying an assignment or exam.
3. Using another student's code. Using code from this or previous offerings of the class, from courses at other institutions, or from any other source (e.g., software found on the Internet).
4. Looking at another student's code. Although mentioned above, it bears repeating: looking at other students' code or allowing others to look at yours is academic dishonesty. There is no notion of looking "too much," since no looking is allowed at all.

## 10.2 What Does Not Constitute Academic Dishonesty?

In contrast, the following are *non-exhaustive* examples of activities that *do not* violate academic integrity.

1. Clarifying ambiguities or vague points in class handouts or textbooks.
2. Helping others use the computer systems, networks, compilers, debuggers, profilers, or other system facilities without regard to a particular assignment or project.
3. Helping others with high-level design issues.
4. Helping others with high-level (*not* code-based) debugging.
5. Using code provided by the instructor from the course web site or elsewhere.

## 10.3 From the Provost

Taylor's Provost<sup>1</sup> defines *plagiarism* as follows:

In an instructional setting, plagiarism occurs when a person presents or turns in work that includes someone else's ideas, language, or other (not common-knowledge<sup>2</sup>) material without giving appropriate credit to the source. Plagiarism will not be tolerated and may result in failing this course, and may also result in further consequences as stipulated in the [Taylor catalog](#).

The Provost goes on to say:

Academic dishonesty constitutes a serious violation of academic integrity and scholarship standards at Taylor that can result in substantial penalties, at the sole discretion of the University, including but not limited to, denial of credit in a course as well as dismissal from the University.

In short, a student violates academic integrity when he or she claims credit for any work not his or her own (words, ideas, answers, data, program codes, music, etc.) or when a student misrepresents any academic performance. Please see [the catalog](#) for a complete statement.

## 11 Support Services

Be aware of the following support services available to you as a Taylor student.

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<sup>1</sup>At Taylor, the *Provost* is our Chief Academic Officer.

<sup>2</sup>*Common knowledge* means any knowledge or facts that could be found in multiple places or as defined by a discipline, department, or faculty member.

### 11.1 Academic Assistance

The Academic Enrichment Center (AEC), located in the Zondervan Library, provides individualized academic skills help (e.g. test preparation, note taking, planning, etc.). Contact **Dr. Scott Gaier**, [scgaier@taylor.edu](mailto:scgaier@taylor.edu).

### 11.2 Tutoring

Peer Tutoring Services, located in the AEC in Zondervan Library, provides free help to students in most content areas. For further information, contact **Darci Nurkkala**, [drnurkkala@taylor.edu](mailto:drnurkkala@taylor.edu).

### 11.3 Students with Special Needs

The Academic Enrichment Center provides a variety of services for students who have disabilities. This includes, but is not limited to, mental, emotional, physical, and learning disabilities. Contact **Dr. Scott Barrett**, [scott\\_barrett@taylor.edu](mailto:scott_barrett@taylor.edu), to learn more. If you need accommodations due to a disability, please also see me so that I can help accordingly.

### 11.4 Writing Center

Writing Center tutors can help you on all of your writing in any stage of your writing process, but they will usually focus on content and organization before they look at grammar and style. Expect to be actively involved during your session, whether you are developing a better thesis, reorganizing your main points, or consulting a style manual to understand formatting rules. To arrange an appointment visit [taylor.mywconline.com](http://taylor.mywconline.com).

## References

- [1] J.D.E.A. Bellamy-Royds. *SVG Essentials, 2nd Edition*. O'Reilly Media, Incorporated, 2014. ISBN: 9781491945308.
- [2] M. Heydt. *D3.js By Example*. Packt Publishing, 2015. ISBN: 9781785280641.
- [3] P.K. Janert. *D3 for the Impatient: Interactive Graphics for Programmers and Scientists*. O'Reilly Media, 2019. ISBN: 9781492046752.
- [4] E. Meeks. *D3.js in Action: Data visualization with JavaScript*. Manning Publications, 2017. ISBN: 9781617294488.
- [5] S. Murray. *Interactive Data Visualization for the Web: An Introduction to Designing with D3*. O'Reilly Media, 2017. ISBN: 9781491921326.
- [6] E.R. Tufte. *Beautiful Evidence*. Graphics Press, 2006. ISBN: 9780961392178.



- [7] E.R. Tufte. *Envisioning information*. Envisioning Information v. 914. Graphics Press, 1990.
- [8] E.R. Tufte. *The Cognitive Style of PowerPoint: Pitching Out Corrupts Within*. Graphics Press, 2006. ISBN: 9780961392161.
- [9] E.R. Tufte. *The Visual Display of Quantitative Information*. Graphics Press, 1983. ISBN: 9780961392109.
- [10] E.R. Tufte. *Visual Explanations: Images and Quantities, Evidence and Narrative*. Graphics Press, 1997. ISBN: 9781930824157.
- [11] J. VanderPlas. *Python Data Science Handbook: Essential Tools for Working with Data*. O'Reilly Media, 2016. ISBN: 9781491912133.
- [12] H. Wickham and G. Grolemund. *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. O'Reilly Media, 2016. ISBN: 9781491910368.
- [13] C.O. Wilke. *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*. O'Reilly Media, 2019. ISBN: 9781492031031.

*This document last updated January 31, 2021.*